Supporting Seamless Learning: Students' Use of Multiple Devices in Open and Distance Learning Universities

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Submitted in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

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e-Learning Doctoral Programme

Universitat Oberta de Catalunya (UOC)

Deposited: 11 October 2017

Accepted for Defence: 17 November 2017

Abstract

The widespread access to mobile and personal technologies, together with internet services, has created the potential for the continuity of learning experiences across different technologies, contexts and settings. These digital technologies include both fixed (desktops and laptops) and handheld technologies (tablets and smartphones). The use of emerging technologies in education is associated with emerging educational practices. Educators need to be aware of not only what their students learn, but how and why as well. However, there is a lack of awareness of how students use their different devices for learning and how Open and Distance Learning (ODL) universities can effectively support them to do so. The purpose of this exploratory study is to understand the learning habits and behaviours of students using different devices for learning. This is to determine how students move between technologies, locations and learning activities and the types of support they require. The research uses the concept of seamless learning as a theoretical framework, where students can continue their learning experiences across different contexts. A case study approach was followed. Two ODL universities were explored, Universitat Oberta de Catalunya in Spain and the University of South Africa in South Africa. A mixed methods design was used with a sequential explanatory strategy. Quantitative data (online surveys) was first collected from undergraduate students in each case to identify the significant variables and relationships. This data was analysed using descriptive, correlation and regression analyses. This was followed by the collection of qualitative data (semi-structured interviews) to build on the quantitative data and to explain the relationships. This data was analysed using a grounded theory approach. The results indicate that students are using multiple devices in multiple locations to perform different learning activities. Although students make use of technologies in different ways (according to their needs), some patterns emerged. Access to devices is no longer an issue as the majority of students have access to three or four digital devices for learning. Students use their devices in a variety of public and private locations, yet home is still the preferred location for study. The more portable a device, the more places it is used. Fixed devices are seen as central devices for study purposes and used for almost all learning activities. However, handheld devices are seen as supplementary devices and are used for fewer, more specific, learning activities. The results also indicate that students use their devices together to be more efficient and productive. The use of devices together can be classified as sequential (moving from one device to another) or simultaneous (using two or more devices at the same time). The movement between devices is facilitated by cloud services that enable automatic synchronisation. However, internet access is still an issue for some students. The use of multiple devices, together with the associated software and services, are affecting study habits. Conversely, most educators do not take students' use of multiple devices into account in the design, facilitation or support of learning experiences. Students using multiple devices require both academic and technological support to succeed. The findings have been synthesised to propose a framework for student use of multi-devices for learning to assist educators to design better learning experiences or offer improved support to students. The main influencers of how frequently a device is used for learning are: i) the learning activity or goal; ii) the location or environment; and iii) the devices the student accesses and uses for learning. However, the frequency is also influenced, to a lesser extent, by the time available, the perceived importance of the device to academic success, the level of digital expertise and the device affordances. The majority of students are able to move between devices and contexts and continue their learning experiences seamlessly. However, this does mean there is a minority of students who cannot yet learn seamlessly. These students may require additional levels of support. These findings indicate that ODL universities need to refine their learning design and support services to better meet the needs of students using multiple devices.

Keywords: multiple devices, seamless learning, learner support, mobile learning, open and distance learning

Resumen

La facilidad de acceso a las tecnologías móviles y personales, junto con los servicios de Internet, han redibujado el panorama educativo posibilitando experiencias de aprendizaje en diferentes contextos y escenarios. Estas tecnologías incluyen tanto tecnología de sobremesa (ordenadores de escritorio y portátiles) como de mano (tabletas y teléfonos inteligentes). El uso de tecnologías emergentes en la educación se asocia con las prácticas educativas emergentes. Los educadores deben ser conscientes no sólo de lo que sus estudiantes aprenden, sino también del cómo y porqué. Sin embargo, a día de hoy existe una falta de conciencia de cómo los estudiantes utilizan sus diferentes dispositivos para el aprendizaje y cómo las universidades de Aprendizaje Abierto y a Distancia (AAD) pueden facilitar el uso eficiente de dichas tecnologías durante el aprendizaje. En este contexto, el propósito de este estudio exploratorio es entender los hábitos y comportamientos de aprendizaje de los estudiantes que utilizan diferentes dispositivos para el aprendizaje. En otras palabras, este estudio pretende determinar cómo los estudiantes realizan las actividades de aprendizaje utilizando las diferentes tecnologías de las que disponen en los diferentes lugares en los que se mueven, además de, diagnosticar los diferentes tipos de apoyo que requieren durante el aprendizaje. La investigación utiliza el concepto de aprendizaje ininterrumpido como marco teórico, es decir, cómo los estudiantes son capaces de continuar sus experiencias de aprendizaje en diferentes contextos. Para ello se siguió un enfoque de estudio de casos. Se utilizaron como muestra de estudio dos universidades de la AAD: la Universitat Oberta de Catalunya, en España, y la University of South Africa, en Sudáfrica. Se utilizó un diseño de métodos mixtos, concretamente, un diseño explicativo secuencial. En primer lugar, se recopilaron datos cuantitativos (cuestionarios en línea) de estudiantes de grado para identificar las variables y relaciones significativas que prevalecen en el contexto de aprendizaje presentado. Los datos se analizaron mediante análisis descriptivo y análisis de correlación y regresión. En segundo lugar, se recogieron datos cualitativos (entrevistas semi-estructuradas) para apoyar los datos cuantitativos. Los datos se analizaron utilizando un enfoque basado en la teoría fundamentada. En términos de resultados, se destaca que los estudiantes están usando múltiples dispositivos en múltiples ubicaciones para realizar diferentes actividades de aprendizaje. Aunque los estudiantes hacen uso de las tecnologías de diferentes modos (según sus necesidades), han surgido diferentes patrones. El acceso a los dispositivos ya no es un problema ya que la mayoría de los estudiantes tienen acceso a tres o cuatro dispositivos electrónicos para el aprendizaje. Los estudiantes usan sus dispositivos en varios lugares públicos y privados. Sin embargo, el hogar sigue siendo el lugar preferido para el estudio. A mayor portabilidad del dispositivo electrónico, mayor uso del mismo. Los dispositivos de mesa se consideran esenciales para fines de estudio y se utilizan para casi todas las actividades de aprendizaje. Sin embargo, los dispositivos portátiles se ven como dispositivos complementarios y se utilizan con menos frecuencia y para actividades de aprendizaje más específicas. Los resultados también indican que los estudiantes usan sus dispositivos de forma simultánea para ser más eficientes y productivos. Así, el uso de dispositivos en paralelo puede ser

clasificado como secuencial (moviéndose de un dispositivo a otro en diferentes espacios de tiempo) o simultáneo (usando dos o más dispositivos al mismo tiempo). En este sentido, el uso simultáneo entre dispositivos se explica por la sincronización automática que permite la nube. Entre los resultados, también se destaca como el acceso a Internet sigue siendo un problema para algunos estudiantes. El uso de múltiples dispositivos, junto con el software y los servicios asociados, está afectando los hábitos de estudio. Por el contrario, la mayoría de los educadores no toman en cuenta el uso de dispositivos múltiples por parte de los estudiantes en el diseño, la facilitación o el apoyo durante las experiencias de aprendizaje. Los resultados muestran que los estudiantes que usan múltiples dispositivos requieren apoyo académico y tecnológico para tener éxito. Para aunar los diversos hallazgos de este estudio se ha propuesto un marco que ayude a entender el uso de múltiples dispositivos por parte de los estudiantes durante su aprendizaje y, en definitiva, que ayude a los educadores a diseñar mejores experiencias de aprendizaje y ofrecer un mejor apoyo a los estudiantes durante el proceso de enseñanza-aprendizaje. Las principales variables a destacar en la temática relativa a la frecuencia con que se utiliza un dispositivo para el aprendizaje son: i) la actividad o finalidad de aprendizaje, ii) la ubicación o el entorno que rodea al estudiante; y iii) los dispositivos a los que el estudiante accede y utiliza para el aprendizaje. A pesar de ello, el tiempo disponible del estudiante para realizar la actividad de aprendizaje, la importancia que el estudiante percibe sobre el dispositivo para el éxito académico, el nivel de experiencia digital y los ofrecimientos del dispositivo, también son variables que pueden influenciar, en menor medida, la frecuencia con que se utiliza un dispositivo para el aprendizaje. La mayoría de los estudiantes son capaces de moverse entre dispositivos y en diferentes contextos durante la experiencia de enseñanza-aprendizaje. Aunque esto también refleja la existencia de que hay una minoría de estudiantes que no pueden aprender de forma adecuada en las circunstancias mencionadas. En este sentido, estos últimos estudiantes se caracterizan por requerir niveles adicionales de apoyo durante su proceso de aprendizaje. Los hallazgos de este estudio indican que las universidades de AAD necesitan redefinir su diseño de aprendizaje y servicios de apoyo al estudiante durante el aprendizaje para satisfacer mejor las necesidades de aquellos estudiantes que utilizan múltiples dispositivos en la experiencia de enseñanza-aprendizaje.

Resum

L'accés generalitzat a mòbils i tecnologies personals, junt amb els serveis di internet, ha creat el potencial per a la continuïtat de les experiències d'aprenentatge a través de diverses tecnologies, contexts i entorns. Aquestes tecnologies inclouen tots dos tipus de tecnologies, fixes (sobretaula i portàtils) i de mà (tauleta i telèfons intel·ligents). L'ús de les tecnologies emergents en educació és associada amb l'aparició de noves pràctiques educatives. Els educadors necessiten ser conscients, no només d'allò que aprenen els seus estudiants, sinó de com i perquè ho aprenen. No obstant, hi ha una mancança en relació a com els estudiants fan ús dels seus diferents dispositius per aprendre i com les universitats d'Educació Oberta i a Distància (EOD) poden recolzar el seu ús de manera efectiva. El propòsit d'aquest estudi exploratori és entendre els hàbits d'aprenentatge i comportaments dels estudiants en l'utilització de distints dispositius per a l'aprenentatge. Concretament amb la finalitat de determinar com els estudiants és mouen entre les tecnologies, les ubicacions i les activitats d'aprenentatge, i els tipus de suport que requereixen. La recerca utilitza el concepte d'aprenentatge ininterromput ("seamless learning") com a marc teòric, al qual els estudiants són capaços de continuar amb les seves experiències d'aprenentatge mitjançant diferents contextos. S'ha seguit una aproximació d'estudi de cas. Dos universitats EOD han estat analitzades, la Universitat Oberta de Catalunya a Espanya i la University of South Africa a Sudàfrica. S'ha utilitzat un disseny mixt amb una estratègia explicativa seqüencial. Les dades quantitatives (enquestes online) van ser primer recollides entre els estudiants de grau en cada cas per a identificar variables i relacions entre elles. Les dades van ser analitzades mitjançant anàlisis estadístics descriptius, de correlació i regressió. Això va ser per seguir la recolecció de les dades qualitatives (entrevistes semiestructurades) per a informar les dades quantitatives i així explicar les relacions. Les dades van ser analitzades segons els principis de la teoria fonamentada. Els resultats indiquen que els estudiants estan utilitzant múltiples dispositius a múltiples espais per a realitzar diferents activitats d'aprenentatge. Encara que, els estudiants fan ús de les tecnologies de diverses maneres (depenent de les seves necessitats), alguns patrons han sorgit. L'accés als dispositius ja no es un problema, ja que per a la majoria dels estudiants tenen accés a tres o quatre dispositius electrònics per aprendre. Els estudiants utilitzen els seus dispositius en una varietat de llocs públics i privats, encara que la llar continua sent el lloc preferit per a estudiar. Quant més portàtil és el dispositiu, en més llocs és utilitzat. Els dispositius fixes són vistos com a dispositius centrals per als propòsits d'estudi i utilitzats per a pràcticament totes les activitats d'aprenentatge. Tanmateix, els dispositius de mà són vistos com dispositius complementaris i són utilitzats per a un nombre menor i més específic d'activitats. Els resultats també indiquen que els estudiants utilitzen els seus dispositius conjuntament per a ser més eficients i productius. L'ús de dispositius de manera conjunta pot ser classificada com seqüencial (canviant d'un dispositiu a un altre) o simultani (utilitzant un o més dispositius al mateix temps). El canvi entre dispositius és facilitat per els serveis en el núvol que permeten una sincronització automàtica. Tanmateix, l'accés a internet és encara un problema per a alguns estudiants. L'ús de

múltiples dispositius, juntament amb l'ús dels softwares i serveis associats a ells, està afectant els hàbits d'estudi. Al contrari, la majoria d'educadors no tenen en compte l'ús de múltiples dispositius que fan els estudiants en el disseny, facilitació i suport de les experiències d'aprenentatge. Els estudiants utilitzant múltiples dispositius requereixen ambdós tipus de suport, tècnic acadèmic per a tindre èxit. Una consolidació de les troballes ha estat utilitzada per a proposar un marc per a l'ús de múltiples dispositius dels estudiants amb la finalitat di ajudar als educadors a dissenyar millors experiències d'aprenentatge o per a oferir un millor suport als estudiants. Els factors que més influencien amb quina freqüència un dispositiu és utilitzat per aprendre és: i) l'activitat d'aprenentatge o objectiu, ii) el lloc o entorn, iii) els dispositius als que l'estudiant té accés i utilitza per aprendre. Tanmateix, la freqüència també és veu influenciada, en un menor grau, per el temps de qué és disposa, la importància percebuda del dispositiu per a l'èxit acadèmic, el nivell de domini digital i els potencials del dispositiu. La majoria dels estudiants tenen la capacitat de moune's entre dispositius i contextos i continuar les seves experiències d'aprenentatge sense interrupcions. Tanmateix, això significa que hi ha una minoria d'estudiants que no pot aprendre de manera ininterrompuda. Aquest estudiants necessitaran uns nivells superiors de suport. Aquests resultats indiquen que les universitats EOD necessiten redefinir el seu disseny educatiu i recolzar serveis per a respondre millor a les necessitats dels estudiants que utilitzen múltiples dispositius.

Acknowledgements

I would like to express my deep gratitude to my supervisor, Dr Josep M Duart, for his support and assistance throughout this PhD journey. He has provided me with advice and guidance as well as the opportunities to expand my research horizons.

Although doing a PhD is often a solitary journey, I could not have enjoyed the process without the support and encouragement provided by my PhD colleagues. I would especially like to thank the e-Learning Doctoral Fellows at UOC for all their support and assistance during my stay in Barcelona. I would particularly like to thank Marta Fondo García and Dr Pilar Gómez del Rey who assisted me as research fieldworkers in collecting interview data and providing translation support. I would also like to thank Juan-Francisco Martínez Cerdá for his help in reviewing my statistical analysis. My thanks go to the other students in 22@ who provided support and assistance during my time at UOC.

I would like to thank the group of researchers and academics from various institutions across the world who helped me at various points throughout this process by providing ideas, acting as sounding boards or reviewing pieces of writing. Although I cannot mention them all here, I would like to especially thank Brenda Mallinson and Dr Fernanda Pires de Sá for acting as critical readers. I would also like to thank Prof Mpine Makoe, Prof Jenny Roberts and the other members of the Unisa Institute for Open and Distance Learning (IODL) for hosting my research stay.

Thank you to the various professors and administrators at UOC and Unisa who gave their time to assist me with various matters. A great deal of thanks to the students at these universities who volunteered to participate in my research.

I would like to thank my family for all their love and support. I would like to thank Yuan Khan for his continuous encouragement and unwavering belief in me.

Finally, I would like to thank the UOC Doctoral School for providing me with a grant to be able to pursue my dream to study towards a PhD full-time.

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Chapter 1

Introduction

This chapter outlines the background (Section 1.1) and context (Section 1.2) of the research. The justification for the research is presented (Section 1.3) and the purpose of the research is then defined (Section 1.4). The significance and the scope of the research as well as the specific objectives are described (Section 1.5). An outline of each of the chapters in the thesis is provided (Section 1.6). A short summary then concludes the chapter (Section 1.7).

1.1 Background

We become what we behold. We shape our tools and then our tools shape us.

(John Culkin, 1967)

In the current information or knowledge society, the way that people interact with information and connect with each other has profoundly changed (Vosloo, 2012). These changes have been enabled through the internet and digital media (Gros, 2016b). There are concerns that education has not kept pace with the digital society (European Commission, 2013), therefore, educators face challenges to teach in ways that help to develop the knowledge and skills needed in society and to develop teaching methods that are appropriate for a diverse student body. Other challenges relate to the changing nature of work and expanding access in the face of the rising costs of higher education (Bates, 2015). An education system is needed that "creates and develops capable lifelong learners who have a rounded set of skills" for managing rapid change and who have an accompanying desire to learn (Blaschke & Hase, 2016, p. 27). In order for institutions and educators to enable as many students as possible to succeed, more focus needs to be given to the teaching and learning methods that lead to student success, such as greater personalisation of learning and more flexible delivery methods. However, these developments add to the responsibility of educators (as well as students), and require higher levels of skills in teaching and learning (Bates, 2015).

Student use of digital technologies is now a standard feature of higher education, with the widespread use of the institutional Virtual Learning Environment (VLE), online library services and the use of word-processing, email and search engines (Henderson, Selwyn, Finger, & Aston, 2015; Selwyn, 2016). Together with these established technologies, newer technologies regularly emerge. The use of these emerging technologies is accompanied by the emergence of educational practices. Emerging technologies refer to tools, innovations and advancements, while emerging practices refer to the concepts (such as pedagogies) and environments that surround the technologies (Veletsianos, 2016). Pedagogies refer to the relationships between teaching and learning (Gros, 2016b). Thus, echoing the quote at the beginning of this chapter, the selection or use of technologies and educational practices are intertwined, with each one shaping or influencing the other. Authors have referred to this as a dialogue (Gros, 2016b), being interrelated (Sølvberg & Rismark, 2012) or being intertwined in a dance where "the technology sets the beat and creates the music, while the pedagogy defines the moves" (Anderson & Dron, 2011, p. 81).

Veletsianos (2016) characterises emerging technologies and emerging practices as being:

- *Not defined by newness*: Emerging technologies and practices may or may not be recent developments.
- *Evolving organisms that exist in a* state of "coming into being": Emerging technologies and practices are continuously being refined and developed.

- *Not yet fully understood or researched ("not-yetness")*: The implications for teaching and learning as well as the contextual, negotiated and symbiotic relationships between technologies and practices are not yet understood.
- *Have promising but as yet unfulfilled potential*: Emerging technologies and practices show promise of significant impact, but this is not yet fulfilled.

Personal digital devices can be seen as examples of emerging digital technologies that are intertwined with emerging teaching and learning practices. The past fifteen years have seen rapid growth in mobile services, making mobile devices one of the world's most ubiquitous technologies (International Telecommunication Union, 2016). With the increasing availability of wireless mobile devices, educational institutions and researchers have explored how the features and affordances of these devices can be applied in learning contexts (Alrasheedi & Capretz, 2015; Frohberg, Göth, & Schwabe, 2009; Liu, Li, & Carlsson, 2010; Parsons, 2014) and the effect on learning (Sung, Chang, & Liu, 2016; Wu et al., 2012). The aim of the majority of mobile learning studies was to improve access to or the quality of teaching and learning. Enhancing the quality of teaching and learning experiences continues to be the primary motivation for the use of technology-supported learning (Brown & Mbati, 2015; Walker et al., 2016). The use of digital technologies in teaching and learning has therefore been classified as "a means and not an end" (Bates, 2015, p. 266) or an enabler and not a driver (Brown & Mbati, 2015). More generally, educators aim to enhance educational practice in order to improve learning (Ellis & Goodyear, 2010).

Although "practitioners and researchers anticipate and hope that emerging technologies and practices will prove to be powerful instruments" to enhance teaching and learning, the possibilities and implications of these technologies are still being explored (Veletsianos, 2016, p. 11). It takes time for researchers and educators to make sense of the affordances of emerging technologies and the associated emerging pedagogies. It takes more time to develop useful guides for others and disseminate them (Ellis & Goodyear, 2010). The opportunity for research into educational practice is created by the absence of a large empirical or theoretical base to guide the use of emerging technologies and practices (Veletsianos, 2016). On the one hand, emerging technologies and practices can be applied to the same challenges and problems that inspired educators and researchers working with established technologies (Anderson, 2016). On the other hand, current teaching and learning approaches may not adequately serve contemporary or future educational purposes. Technologies also change the way people live and behave, therefore, the application of emerging practices to education may require the development of new pedagogies and theories (Veletsianos, 2016). The use of different technologies in higher education is affected not only by the technology itself, but by the prevailing theories of learning and current educational practices. New developments in technologies require a review of learning theories and the redesign of educational practices (Sølvberg & Rismark, 2012).

However, research about technologies in education needs to be approached cautiously so that it is nuanced and understanding of the complexities that exist (Ross & Collier, 2016). Teaching is a highly complex undertaking, which needs to adapt to varieties in contexts, subject matter and learners themselves. Any guidelines or principles (based on best practices, theory and research) must be modified for local contexts and settings (Bates, 2015). The use of technology is sometimes referred to as a potential cause of or a solution to the multiple “problems” in education, where “utopian and dystopian narratives of technology are widespread in discussions of online education” (Ross & Collier, 2016, p. 17). One viewpoint holds that digital technologies are framed in the literature as having a neutral or even benign presence, with little focus on the detrimental aspects of digital technologies in higher education (Selwyn, 2016). Media or technologies are not neutral nor objective, they can be used (positively or negatively) to influence “the interpretation of meaning and hence our understanding” (Bates, 2015, p. 195). Utopian narratives manifest a technological determinist position or “technological imperative” where action must be taken because a particular technology will inevitably lead to change (Chandler, 2002, as cited in Ross & Collier, 2016). However, there is value in considering the mess and complexity in education, particularly surrounding emerging technologies (Ross & Collier, 2016). Technology use in universities is “complicated, messy, ambiguous and not wholly satisfactory” (Selwyn, 2016, p. 1019). One of the key aspects of emerging technologies and practices is their “not-yetness” thus requiring educators and researchers to deal with uncertainty. Teaching and learning are by their nature, messy activities and “research should attempt to explore, not simplify, these complexities” (Ross & Collier, 2016, p. 26).

A nuanced understanding of the extent and nature of digital technology use by university students requires insight into the contexts in which the technologies are being used. Therefore, educators need to experiment “with different technologies in their teaching to evaluate the educational effectiveness” of these tools in local contexts and share these results (Margaryan, Littlejohn, & Vojt, 2011, p. 439). Educators need to develop a comprehensive understanding of how students use digital technologies that takes into account factors such as pedagogical design, discipline differences, student characteristics such as age, gender, socio-economic backgrounds and personal psychological characteristics (Gallardo-Echenique, Marqués-Molías, Bullen, & Strijbos, 2015; Schulmeister 2008, as cited in Margaryan et al., 2011). Educational research on emerging technologies and practices should not only concern itself with how well learners perform on assessments, but also on their contexts and other aspects of their lives and the complexities of the interactions between these areas (Ross & Collier, 2016). This understanding is not only important for educators, but for students themselves.

Students’ attitudes to learning appear to be influenced by the teaching approaches used by educators (Margaryan et al., 2011). Educators can have teaching-focused conceptions, where teaching is viewed as the transmission of information, skills and attitudes, or learning-focused conceptions, where the focus is on “bringing about conceptual change in students' understanding of the world” (Prosser &

Trigwell, 1998, as cited in Biggs, 1999, p. 61). These conceptions influence educator approaches to teaching and how they use technology in teaching and learning (Kirkwood & Price, 2013). While some educators have sought to "effectively integrate technology as an educational tool to promote student-centred learning", in many cases, the focus of the integration of technology in teaching and learning has led to low-level uses of technology (such as looking up information or drill and practice exercises) (Gros, 2016a, p. 6). The use of digital technology is shaped by the dominant model of "transmission" of learning, where technology is used as a part of a "passive reception of information and instruction", together with individually-driven research and generation of assessments (Henderson et al., 2015, p. 317). Emerging technologies are often used with the same previous pedagogical approaches, despite offering a number of pedagogical opportunities. Not all of these pedagogical opportunities will be new, for example, some pedagogical approaches simply become pragmatically more realisable with the aid of digital technologies (Cope & Kalantzis, 2009; Kalantzis & Cope, 2015). A shift in mind-set is required for educators to integrate technologies for "higher-level" uses (such as creativity, collaboration and multimedia productivity) (Gros, 2016a). Teaching methods that focus on conceptual development, knowledge management and "experiential learning in real-world contexts, are more likely to develop the high level conceptual skills required in a digital age" (Bates, 2015, p. 64).

Educators need to acknowledge the diversity and variety of ways in which undergraduates engage with digital technology. This includes the more mundane digital practices that form the majority of students' experiences of higher education. Basic levels of digital engagement are shaped by the contexts of higher education, pedagogical practices and non-digital contexts such as student differences, curricula, assessment and notions of student success (Henderson et al., 2015). Educational policy and practice needs to be based on evidence of "what technologies students have access to and what their preferences are" (Kennedy et al., 2008 as cited in Margaryan et al., 2011, p. 438), but more importantly on an understanding of the educational value of these technologies and how they support learning processes and outcomes. Students need to understand not only how to use digital technologies in their learning but why it benefits them to do so (Kirkwood and Price, 2005, as cited in Margaryan et al., 2011). A need still exists to better support students to "analyse, decode and make meanings of the digital technologies that they encounter in university" (Selwyn, 2016, p. 1019). Empirical evidence is needed to improve a university's understanding of the nature and extent of students' uptake of technologies (Ellis & Goodyear, 2010; Margaryan et al., 2011). Universities need to make an effort to gather data about the habits and expectations of their students. They also require "the conceptual tools and self-belief needed to make sense of this evidence and use it to construct and monitor learning and teaching policies" (Ellis & Goodyear, 2010, p. 39).

1.2 Context

This section sets the scope of this study. In the past, for many educational sectors, a goal was seen to be to reach a stage where each learner had access to a personal device for learning. The ratio of learners to devices used to be many students to one device and then gradually moved to "one device or more per student" (Chan et al., 2006; Cheung & Hew, 2009; Lentz & Carson, 2012). An era has now begun where the ratio has become one learner to many devices. It is expected that personal devices will become more ubiquitous and learners themselves will be more mobile (Ally & Prieto-Blázquez, 2014). The key benefit of ubiquitous technology-supported learning is that it enables the continuity of learning experiences across different learning settings. This is known as "seamless learning" (Chan et al., 2006). This study aims to explore students' use of multiple devices across different learning settings.

This study is situated within technology-supported learning within higher education. Specifically, the research will focus on Open and Distance Learning (ODL) institutions in higher education. Student experiences at two ODL universities in two different countries are used as case studies: Universitat Oberta de Catalunya (UOC) and The University of South Africa (Unisa). The research is thus situated in formal learning environments. The study will focus specifically on the experiences of undergraduate students.

The UOC (www.uoc.edu) is an online university, based in Barcelona, Spain. It was established in 1994 in the regional Catalan higher education system and each year serves about 50 000 students both within Spain and internationally. The university makes use of online learning technologies for students to interact with educators and each other and learning mostly takes place asynchronously. The main languages of instruction are Catalan and Spanish (Garrett, 2016). Unisa (www.unisa.ac.za) is a large ODL university, based in Pretoria, South Africa. Established in 1873 as an examination agency, it was accredited as a distance university in 1946. It serves about 350 000 students each year in South Africa and across the African continent. The university has recently moved from a primarily distance or correspondence model to a more blended approach that combines distance and online learning. The main language of instruction is English (Garrett, 2016).

1.3 Justification for the Study

This section highlights the main reasons why this study was undertaken. The use of technologies in teaching and learning and the interrelationships between emerging technologies and emerging pedagogies means that the integration of technologies in education cannot be viewed as a solved problem (Ellis & Goodyear, 2010). The use of personal devices impacts on the study habits of students, however, there are very few studies that consider "the extent (what tools, how frequently) and the nature of technology use (what the technology is used for) in learning" as well as student motivations in using specific technologies (Margaryan et al., 2011, p. 431). Further research is required that recognises and works with the lived reality of students' use of digital technologies and their experiences (Selwyn, 2016), providing greater insight into situated practice. A focus on situated practices enables the observation of contexts and practices, "without seeking to control them" (Wright & Parchoma, 2011, p. 255). This research study will focus on the use of fixed and handheld devices that ODL students have access to.

The use of digital technologies in higher education enables more flexible access to learning resources, academic staff and administrative services. This means that students come to expect such flexibility (Ellis & Goodyear, 2010). Students want to be able to choose when they learn, where they learn and how they access learning resources (Sølvberg & Rismark, 2012). To develop more effective learning tools and strategies, researchers need to know more about students' learning performance, their perceptions and learning patterns (Gros, 2016a). It is therefore important to know which personal devices students have access to, how students use various media and technologies for study purposes, which tools support their learning and the settings they are used in. Insights into the use of technologies for learning can lead to better informed decisions for designing learning programmes and activities with regard to the selection of media and activities (Schroeder, 2013; Zawacki-Richter, Müskens, Krause, Alturki, & Aldraiweesh, 2015).

Although there are many studies available that assess the extent of device ownership and use of devices for academic purposes in higher education, almost all of these studies focus on traditional face-to-face campuses (Brooks, 2016; Dahlstrom, Brooks, Grajek, & Reeves, 2015). While there are a few studies that focus on the use of devices within ODL universities (Cheung, 2012; Cross, Sharples, & Healing, 2015; Liebenberg, Chetty, & Prinsloo, 2012), none of these studies specifically focus on how students make use of their different devices together nor the associated support needs. This study aims to explore how ODL students make use of different devices together for learning as part of their day-to-day realities.

Although it has been established in the literature that mobile learning has great potential in higher education (Chen, Seilhamer, Bennett, & Bauer, 2015; Gikas & Grant, 2013; Green, Naidoo, Olminkhof, & Dyson, 2016), currently, the use of mobile learning is underutilised or limited (Dahlstrom et al., 2015; Zawacki-Richter, Brown, & Delport, 2009). Although universities have provided access to learning environments from mobile devices (Walker et al., 2016), the majority of teaching and learning practices have not been affected by the use of mobile devices (Farley et al., 2015; Traxler, 2016). Further research is needed to investigate the prevalence of complex mobile learning practices in individual and groups of learners (Barden & Bygroves, 2017). Many mobile learning studies focus on the use of specific mobile devices, while somewhat ignoring that students make use of larger devices as well (Green et al., 2016; Reid & Pechenkina, 2016). Therefore, research is needed that assesses students' use of "multiple devices for their studies, such as smartphones, laptops, and tablets, and the relative merits of these for different tasks" (Green et al., 2016, p. 63). This study will explore how ODL students make use of handheld devices for learning, together with the use of fixed devices.

There is growing interest in the role and adoption of devices in learning and the associated changes in learning experiences of students using these devices. This requires a move beyond the understanding of device adoption towards a "deeper, more nuanced insight into how existing and emerging study habits" impact on student learning (Cross et al., 2015, p. 1). This study will explore the emerging practices and technologies surrounding the different digital devices used for learning. It will also explore whether study habits are changing because of the use of multiple devices. Although the use of personal devices for study is not new, their combined use is not fully understood or researched. The use of multiple devices shows promise, but as yet there is unfulfilled potential in education.

This research study explores the pedagogical and technological implications from ODL students' use of multiple devices. This research aims to contribute insights, both for students and university staff, of how students make use of multiple devices for studies. It also focuses on the kinds of academic and technological support students using multiple devices require. Specifically, this research contributes to the body of knowledge of how students make use of multiple devices in different ways and in different contexts. The outcomes of this research can contribute to university academics purposefully designing better learning experiences and providing more effective support mechanisms for students using multiple devices, to promote student access and success.

1.4 Research Problem and Questions

This section outlines the research problem to be addressed by this study and provides the research questions that form the basis of the study. Students in ODL universities make use of their own devices, or the devices of others, to assist them in their studies (Cross et al., 2015). However, access to devices does not imply that the devices are used effectively for studies. There are significant studies available on how to integrate various devices into teaching and learning in higher education, for example, the integration of mobile devices (Hwang & Tsai, 2011; Song, 2014; Wu et al., 2012). However, there is very little research into how students make use of different mobiles devices for their learning (Gikas & Grant, 2013) or learn with the use of mobile and fixed devices. In order for learners to develop into "seamless" learners, they require ongoing support. More research and knowledge is needed to facilitate the nurturing of "seamless" learners as well as how to provide the associated technological support (Milrad et al., 2013). Thus, it can be seen that there is a lack of effective academic and technological support provided to ODL students using multiple devices. The research problem to be addressed by this study is the lack of awareness of how students make use of multiple devices for learning and how ODL universities can effectively support them to do so. This research aims to explore how ODL students use multiple devices for learning and their associated support needs. The benefit of addressing this research problem is to improve the design of learning experiences and the level of support provided to ODL students so that they can take advantage of seamless learning experiences. With more relevant learning experiences and better support, ODL students can remain engaged and motivated.

The main research question addressed in this exploratory research is: “How do students at open and distance learning universities use multiple devices to seamlessly support their learning?”. This question is supported by several sub-questions:

1. RQ1: Which digital devices, and for which purposes and locations, are ODL university students using to perform their learning activities?
2. RQ2: How do ODL university students make use of handheld devices together with fixed devices to perform learning activities?
3. RQ3: What academic and technological support do students learning with multiple devices require from ODL universities?

1.5 Research Objectives

A set of research objectives were formulated that link to the research questions listed above. The purpose of this exploratory research study is to understand the learning habits and behaviours of ODL students using different devices for learning. This is in order to determine how students move between technologies, locations and learning activities and how students can be effectively supported. The main objective of this exploratory research is to gain an understanding of existing and potential behaviours and habits of ODL university students using multiple devices to create seamless learning experiences. This objective is supported by three sub-objectives:

1. RO1: To explore the learning activities, locations and purposes of how ODL university students learn using the digital devices they have access to.
2. RO2: To explain how ODL students make use of multiple devices, either sequentially or simultaneously, to perform their learning activities.
3. RO3: To analyse the academic and technological support needs of ODL students learning with multiple devices.

1.6 Thesis Organisation

This thesis is organised into eight chapters. Each of the chapters is briefly summarised here:

Chapter 1 (this chapter) provides the background and introduction to the research. It provides the research questions and objectives of the study.

Chapter 2 provides the theoretical framework for the research. The aim is to contextualise the research within the domain of seamless learning and describe the main theoretical concepts underpinning this research.

Chapter 3 examines the previous research published in this area. The aim is to analyse recent literature in the areas of the integration of technologies into distance education, mobile learning in higher education and the use of devices for academic purposes at universities and identify the trends and issues.

Chapter 4 specifies the design of the research and explains the methodology followed for this research. The research uses a mixed methods approach, with quantitative data collected through surveys, followed by qualitative data collected through interviews.

Chapter 5 presents the results of the quantitative and qualitative research undertaken in the first case study in this research, Universitat Oberta de Catalunya (UOC). The results are organised according to the research questions.

Chapter 6 presents the results of the quantitative and qualitative research undertaken in the second case study in this research, the University of South Africa (Unisa). The results are organised according to the research questions.

Chapter 7 provides a discussion of the synthesis of the findings from the two case studies. The results from the two previous chapters are analysed, evaluated and interpreted.

Chapter 8 concludes the thesis by drawing conclusions from the findings, and provides the contributions of the research, the study limitations and recommendations for future research.

1.7 Summary

This chapter introduced this research study and provided the background to the research. Emerging technologies, together with the emerging educational practices that surround them, provide an opportunity to improve the quality of teaching and learning. However, it is important to take into account that teaching and learning takes place within specific contexts and cultures. Therefore, emerging technologies and educational practices are shaped by their contexts and change over time. This research will contribute to the body of knowledge regarding the role of digital technologies in student learning, specifically in the context of ODL universities. The purpose of the research is to understand the learning habits and behaviours of ODL students using multiple devices in order to facilitate or support seamless learning experiences. The significance and the scope of the research were outlined, followed by the justification for the research. The specific research objectives were then defined and the chapter concluded with an outline of each of the chapters in this thesis. The next chapter will introduce the theoretical framework used in this research study.

Chapter 2

Theoretical Framework

This chapter introduces the theoretical framework underpinning this study (Section 2.1) and situates the research in a socio-cultural theoretical perspective (Section 2.2). The concept of seamless learning is then explored (Section 2.3). The design of learning activities is considered (Section 2.4), followed by a discussion of a framework for considering the use of mobile devices in education (Section 2.5). The summary (Section 2.6) concludes the chapter.

2.1 Introduction

This chapter provides the theoretical framework that underpins this research. Two frameworks (the Mobile-assisted Seamless Learning (MSL) framework and the Framework for the Rational Analysis of Mobile Education (FRAME)) are used to outline the research. Theoretical models are useful for guiding thoughtful integration of technology into educational practices and contexts. There are a number of models and frameworks available to guide meaningful technology adoption in educational practices that can be used as lenses through which the roles of technologies in learning are interpreted (Kimmons & Hall, 2016). The chapter begins by situating the research with a socio-cultural theoretical perspective that forms the background of the research. The research is foregrounded with the aspiration of seamless learning, where students can continue learning experiences across different settings, with the aid of personal devices. Seamless learning is compared to similar concepts in the literature, such as ubiquitous learning and learning ecologies. The MSL framework provides key concepts for this study to explore further, namely multiple learning activities performed across different times and places with the use of multiple devices. The next section considers the design of learning tasks that influence the activities that learners perform using different devices. This is followed by a review of FRAME which considers how the technical aspects of mobile devices intersect with the social and personal aspects of learning. A summary then draws the chapter to a close.

2.2 The Socio-cultural Theoretical Perspective

This section explores the socio-cultural theoretical perspective. This perspective suggests that learning is “affected and modified by the tools used for learning, and that reciprocally the learning tools are modified by the ways that they are used for learning” (Kearney, Schuck, Burden, & Aubusson, 2012, “Introduction”, para. 2). Researchers have advocated exploring the use of technologies in learning using a wider socio-cultural lens than the narrower “technology determinism” view (Toh, So, Seow, Chen, & Looi, 2013). Learning is a situated and social activity that is facilitated and developed through social interactions and conversations between people (Vygotsky, 1978). Learning is also mediated through the use of tools that shape the learning (Wertsch, 1993). This perspective is widely shared in the literature as technologies are seen as the products of social needs (Cope & Kalantzis, 2009), or that teaching and learning is situated in specific contexts and influenced by local cultures (Veletsianos, 2016). Learners have complex identities and “are connected to families and communities, and located within economic, cultural, and political systems” (Morrison, 2008 as cited in Ross & Collier, 2016, p. 26). The nature of digital technologies in education is socio-technical, it results from the “interactions and relations between people and technology, and shaped by the social, cultural, economic and political relations that inform these interactions” (Selwyn, 2016, p. 1019). Socio-cultural factors designate technologies and practices to be emergent in certain contexts. For example, learners and educators “can accept or reject particular technologies or practices" when it comes to teaching and learning. They are also "capable of finding alternative uses for them" to better meet their needs and values (Veletsianos, 2016, p. 7). The context surrounding emerging technologies and practices "shifts and changes over time, creating a negotiated relationship between the maturation of a technology/practice and the environment that surrounds it" (Veletsianos, 2016, p. 9).

An important concept in the social-cultural perspective is the zone of proximal development. This zone represents the difference between what a learner can do independently and what the same learner can do when assisted by others (Vygotsky, 1978). These others may include educators, tutors, other students or even assistance through technologies. Scaffolding is an important element provided by both human and nonhuman agents, whereby educators or more knowledgeable learners prompt and support learners in acquiring their own competence (Vygotsky & Luria, 1981, as cited in Anderson, 2016). This is a key aspect for learners in an ODL context.

The notion of the importance of interactions is especially relevant in distance education. Effective teaching and learning occurs in distance education through interactions between educators and learners, learners and content and between learners themselves (Moore, 1989; Moore & Kearsley, 2005). The theory of transactional distance bridges the gap of understanding between educators and students caused by distance through the design and facilitation of interactions. Three interrelated variables affect the transactional distance: dialogue, structure and autonomy. Dialogue refers to the extent or series of interactions between educator and student in order to improve student understanding. Structure refers to the extent of how flexible a programme or course is in responding to individual student needs. Learner autonomy refers to the extent to which students make decisions about their learning (Moore & Kearsley, 2005). A more autonomous learner is able to develop their own learning plan.

2.3 Seamless Learning

The aim of this section is to explore the theoretical concept of seamless learning that underpins this study. A key aspect of this study is to consider how students continue their learning experience across settings and make use of different devices to complete different learning activities in different locations. Seamless learning is discussed within the context of ubiquitous or pervasive learning as well as in relation to the concept of learning ecologies. The MSL framework is examined.

2.3.1 Ubiquitous or Pervasive Learning

Ubiquitous or pervasive computing deals with computing technologies that have interfaces for communication with humans, network protocols and context-aware applications (based on information sensed from the physical and computational environment) (Lucke & Rensing, 2014). These ubiquitous computing technologies include mobile phones, wearable machines, sensors, Radio Frequency Identification (RFID) tags and wireless sensor networks (Marinagi, Skourlas, & Belsis, 2013; Shuib, Shamshirband, & Ismail, 2015). Ubiquitous computing can be applied to learning. A ubiquitous learning environment provides "an interoperable, pervasive, and seamless learning architecture to connect, integrate, and share three major dimensions of learning resources: learning collaborators, learning contents, and learning services" (Yang, 2006, as cited in Gilman, Sanchez, Cortes, & Riekki, 2015, p. 55). This is seen as a "new educational paradigm made possible in part by the affordances of digital media" (Cope & Kalantzis, 2009, p. 4). Digital media include text, graphics, audio, video and computing (Bates, 2015). In a ubiquitous environment "all students have access to a variety of digital devices and services, including computers connected to the internet and mobile computing devices, whenever and wherever they need them" (van't Hooft et al., 2007, p. 6, as cited in Park, 2011). The advantage of ubiquitous learning is that it overcomes the limitations of restricting learners to pre-defined locations, times, interactions and tools. The real-world can be seamlessly connected with virtual artefacts and activities, flowing across online and face-to-face learning, both formally and informally, allowing students to immerse themselves fully into different learning situations (Chin & Chen, 2013; Lucke & Rensing, 2014).

The pervasiveness of mobile technologies means that "learners use mobility and awareness of their immediate context as starting points for keeping social contact alive", accessing content, obtaining local information and "becoming visible as creators and producers of content" (Kukulska-Hulme, 2010, p. 11). Integrating intelligent tutoring systems with ubiquitous learning enables highly personal learning experiences that adapt to learners' abilities and learning progress. Ubiquitous learning focuses on the context of the learner, the awareness of the context and importantly, adaptivity to that context (Gilman et al., 2015; Lucke & Rensing, 2014). Context-awareness or "situatedness" senses the situation of learners so that the learning system is able to provide adaptive support or personalised information and enrich learning experiences (Gilman et al., 2015; Kukulska-Hulme, 2010; Marinagi et al., 2013). Context-aware technologies can detect a learner's presence in a particular area or in relation to nearby people or objects and can augment the learner's environment with supportive services or information (Brown & Mbati, 2015; Kukulska-Hulme, 2010). "Digital information, triggered by geo-location data through" a smart device can be overlaid onto the real world (Brown & Mbati, 2015, p. 121). Learners can take advantage of their current context (time, location, activity, surrounding) to interact with their surrounding (Brown & Mbati, 2015).

Ubiquitous learning can also be referred to as "smart learning". In smart learning environments, the location data in real time is required to adapt the situation and content to the learner. The design of smart learning environments orchestrates "the different locations in which a person can learn, combining formal and informal situations" (Gros, 2016a, p. 4). A smart learning environment is "context-aware, able to offer students instant and adaptive support and adapt the learner interface and subject contents" (Hwang, 2014, as cited in Gros, 2016a, p. 4).

Some authors, such as Chin & Chen (2013), view seamless learning as a part of ubiquitous learning, together with context-aware computing and adaptive services. However, other authors consider them to be separate concepts. For example, Gilman et al. (2015, p. 56) see ubiquitous learning systems as supporting learners "by utilising embedded and networked computational technologies, sensors and actuators". In contrast, seamless learning focuses on ensuring seamless transitions between formal and informal learning environments. Similarly, Lucke & Rensing (2014) view ubiquitous learning as the detection of the informational context of the learner as well as the adaptation of pedagogical strategies according to this context. However, they view seamless learning as the continuity of the learning experience across different environments. This study will abide by this distinction and focus on the concept of seamless learning as this research is primarily interested in how students can continue their learning (or transition) between different contexts and environments.

2.3.2 Seamless Learning

> *A student taking part in an online course might start the day during travel with the reading of the course textbook, continue at work joining an online discussion of a specific problem during the coffee break, and finish in the evening watching video contents of the course while laid on the sofa during commercial breaks on TV* (Tabuenca, Kalz, Drachsler, & Specht, 2015, p. 53).

The quote above emphasises the reality of students learning across different settings in their daily lives. Learning takes place "in scattered moments, in different learning contexts, in different learning formats, and with different learning technologies" (Tabuenca et al., 2015, p. 53). Ubiquitous access to personal handheld devices allows the potential for the "continuity of the learning experience across different environments" or "seamless learning" (Chan et al., 2006, p. 6). Seamless learning means that "a student can learn whenever they are curious in a variety of scenarios and that they can switch from one scenario to another easily and quickly using the personal device as a mediator" (Chan et al., 2006, p. 6). These scenarios include students learning individually or in groups, either face-to-face or online. Students can easily move between real and virtual learning locations such as home, the bus, libraries, and the VLE (Barden & Bygroves, 2017). These learning scenarios can also be supported by teachers, mentors, professionals, family members and other communities. Seamless learning can be both intentional, such as starting a learning activity in class and then continuing online at home, or incidental, such as when television content or news sparks a discussion (Sharples et al., 2012).

The concept of seamless learning can be considered to be similar to the notion of situated learning, which involves the "application of knowledge and skills to specific contexts", such as learners completing courses while working or in their own spaces and applying what they learn at the same time

(Ally & Prieto-Blázquez, 2014, p. 145). However, seamless learning enables situated learning to be applied across situations. Seamless learning should be seen as an aspiration, rather than a collection of resources and activities. Although seamless learning is not dependent on personal networked devices such as tablets or smartphones, these devices enable a "fluidity" of learning activity. Previous periods of "'dead time', for example travelling on a train or waiting to collect a child from school, can now be used to browse information, continue an online conversation, or make a note to be expanded later on a desktop computer" (Sharples et al., 2012, p. 24). This has caused a disappearance or blurring of seams "between learning episodes in formal and informal settings, at specific times of the day, in resource-rich places, or with available experts" (Sharples et al., 2012, p. 24).

An earlier characterisation of seamless learning spaces referred to "the collection of the various learning scenarios supported by one-to-one technology" (Chan et al., 2006, p. 6). One-to-one technology-enhanced learning means that "a student uses at least one computing device for learning" (Chan et al., 2006, p. 7). At a school level, the goal for many mobile learning projects is to supply every learner with their own mobile device (Shuler, Winters, & West, 2013). However, one-to-technologies have now become many-to-many technologies. Therefore, a more relevant definition of seamless learning is that "seamless learning is when a person experiences a continuity of learning, and consciously bridges the multifaceted learning efforts, across a combination of locations, times, technologies or social settings" (Wong, 2015, p. 10, adapted from Sharples et al., 2012).

The development of seamless learning, supported by theories of social learning, situated learning and knowledge building, aims to influence the nature, process and outcomes of learning. Earlier mobile learning research, however, "typically focused on either formal or informal settings and failed to examine the integrated and synergetic effects of linking these two contexts" (Looi et al., 2010, p. 2). The origin of the term "seamless learning" did not include a technology component. The American College Personnel Association (1994, as cited in Wong & Looi, 2011) highlighted the importance of linking students' in-class and out-of-class experiences to facilitate seamless learning and academic success. Kuh (1996, as cited in Wong & Looi, 2011, & Wong, 2015) expanded the term to involve off-campus experiences to enable students to make use of their life experiences to make meaning of classroom materials. Chan et al. (2006) then introduced the role of devices to support the continuity of learning across scenarios. Milrad et al. (2013, p. 96) describe the important role played by devices in seamless connectivity:

> *Seamless connectivity enables the continuity of the learning experience by maintaining the learning across devices and settings, enabling learners to carry on where they left off, and to easily re-establish a learning activity from a previous time, by providing means to search back in time for a learning content or activity and then recall its context and connection.*

Students can use different types of technologies, taking advantage of the affordances of each device type to maintain the continuity of the learning experience across settings and devices (Shuler et al., 2013). Tools that support seamless learning "include Dropbox and Google Docs which make it possible to store resources and engage in learning activities on a shared web server, accessed from multiple personal devices" (Sharples et al., 2012, p. 25). A student can rely on cloud computing to access prior work, not worry about losing work and "seamlessly integrate new ideas and research, both within the classroom and beyond it" (Barden & Bygroves, 2017, p. 6). This is supported by the use of mobile devices, together with an organised storage system and knowledge of the system. The benefits for maintaining a flow of learning include the continuation of topics in different places, "notes can be made whenever a thought occurs" and "ideas can be shared with people wherever they are" (Sharples et al., 2013, p. 17).

An important consideration in seamless learning research is understanding how learning activities unfold in various situations. The portability, connectivity and versatility associated with mobile technologies "enable learning to be ubiquitous in and out of classrooms, provide potential opportunities for collaborative learning, and enrich learning experiences with the support of technologies" (Looi et al., 2010, p. 8). Seamless learning can be related to cooperative or collaborative learning. Seamless learning spaces occur when "learners are active, productive, creative, and collaborative across different environments and settings" (Chan et al., 2006, p. 10). Institutions can support seamless learning by "encouraging students to draw on supplementary learning resources outside, to see themselves as continuous learners, and to use students' life experiences to make meaning of material introduced in classes" (Sharples et al., 2012, p. 25). Furthermore, when designing mobile learning, the design needs to promote enriching conversations within and across contexts (Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009).

Although seamless learning offers many benefits for learners, there may be some associated challenges. The first set of challenges relate to technical issues. Intermittent or weak internet connections can cause breaks in the flow of learning. Complex management is required to ensure that resources are always accessible or synchronised (Sharples et al., 2012). Another technical challenge may be the limited battery life of devices. There may also be challenges related to network access from different locations (private and public) where students need to know how to manage these settings. The next set of challenges can be categorised as social. For example, various locations may restrict access to certain websites or social networks. There may also be issues related to data ownership and rights over data hosted in commercial platforms such as Facebook. A further challenge is the monitoring and tracking of student progress outside of academic environments (Sharples et al., 2012).

2.3.3 Learning Ecologies

Another concept similar to the aspiration of seamless learning is a learning ecology. Although this research will focus on seamless learning, it is worth noting the similarities in the focus on contexts. The concept of a learning ecology is based on ecological perspectives as well as drawing on constructs from socio-cultural theory and activity theory (Barron, 2006). It provides the means to visualise the dynamics of a complex learning process and understand how the elements of the ecology fit together in a holistic way (Jackson, 2013). A learning ecology consists of the "set of contexts found in physical or virtual spaces that provide opportunities for learning" (Barron, 2004, as cited in Barron, 2006, p. 195). Learning is seen as a process that connects learners to their environment and to others.

Learning ecologies occur in formal and informal learning contexts. A university course creates an ecology for learning that is organised by educators (with disciplinary and pedagogical expertise) within an institution that provides support and resources to aid learning. The educators determine the structure through the objectives, content and processes that engage learners in activities through which they learn and can be assessed. There is a supportive infrastructure where interactions occur between educators and learners and between learners and learners (in physical environments and virtual spaces). Depending on the teaching approach followed, the learning ecology of learners may be tightly or loosely controlled in terms of what is learned, how it is learned and when it is learned (adapted from Richardson, 2002, as cited in Jackson, 2013).

Outside the formal learning environment, people create informal or personal "learning ecologies that reflect the different social environments, contexts, purposes and activities they engage in and generate across their lives", such as at work, with family or friends or in hobbies (adapted from Richardson, 2002, as cited in Jackson, 2013, p. 10). An individual's learning ecology comprises "their process and set of contexts, relationships and interactions that provide opportunities and resources for learning, development and achievement" (Jackson, 2013, p. 2). Each physical or virtual context comprises "a unique configuration of purposes, activities, material resources, relationships and interactions and mediated learning that emerge from them" (Jackson, 2013, p. 2).

The concepts of seamless learning and learning ecologies are aligned to the concepts of lifelong and lifewide learning (Maina & García-González, 2016). These concepts recognise that learning does not only happen during formal education and that most learning actually occurs in informal situations across a person's life (Banks et al., 2007; Cross, 2007, as cited in Martindale & Dowdy, 2016). Learning ecologies have temporal and spatial dimensions and "the capability to connect different spaces and contexts existing simultaneously" (lifewide) and "different spaces and contexts existing through time" (lifelong) (Jackson, 2013, p. 1). The concept of lifelong learning has gained importance in educational policies and refers to education being a process during one's lifespan, where development happens in different stages and domains of life. Lifelong learning is "characterised by its flexibility and diversity in content, learning tools and techniques, and time of learning" (Dave, 1976, as cited in Stöter, Bullen, Zawacki-Richter, & Von Prümmer, 2014, p. 426). Lifelong learning represents what individuals learn throughout their lifespan. It is necessary for individuals to enhance their knowledge and competence in a continuous process of learning, not just in formal schooling (Skolverkert, 2000, as cited in Jackson, 2012; Toffler, 1991, as cited in Siemens, Gasevic, & Dawson, 2015). Lifewide learning refers to learning in a variety of environments and situations or contexts and covers formal, non-formal and informal learning (Skolverket, 2000, as cited in Jackson, 2012). Lifewide learning can include intentional learning but also unintentional or incidental learning (Reischmann, 1986, as cited in Jackson, 2012).

2.3.4 A Framework for Mobile-assisted Seamless Learning

After a review of research on mobile-assisted seamless learning (MSL), Wong & Looi (2011) identified ten dimensions that characterise MSL. This framework can be used to identify research gaps in MSL as well as help practitioners in MSL to refine their learning designs. The goal is to remove the "seams" and empower and support learners "wherever and whenever they are stimulated to learn" (Wong & Looi, 2011, p. 2364). The ten dimensions can be broadly grouped into a technology focus (knowledge access and multiple devices), a pedagogy focus (multiple learning tasks and pedagogical models) and a learner focus. The ten dimensions are:

- (MSL1) Encompassing formal and informal learning.
- (MSL2) Encompassing personalised and social learning.
- (MSL3) Across time.
- (MSL4) Across locations.
- (MSL5) Ubiquitous knowledge access (a combination of context-aware learning, augmented reality learning and ubiquitous internet access).
- (MSL6) Encompassing physical and digital worlds.
- (MSL7) Combined use of multiple device types (including "stable" technologies such as desktop computers and interactive whiteboards).
- (MSL8) Seamless switching between multiple learning tasks (such as data, analysis and communication).
- (MSL9) Knowledge synthesis (a combination of prior and new knowledge, multiple levels of thinking skills and multi-disciplinary learning).
- (MSL10) Encompassing multiple pedagogical or learning activity models.

Wong (2012) later revised the dimensions slightly and created a diagram (Figure 2.1) to visualise the relationships between the dimensions. The diagram depicts the perspective of the individual seamless learner. The diagram is intended to signify a hierarchical view of the ten dimensions. MSL3 (across time) and MSL4 (across locations) create a two-dimensional space for the other dimensions. Within this space, there are there three continuums of learning, namely, MSL1 (formal/informal learning), MSL2 (personalised/social learning) and MSL6 (physical/digital worlds). A learner may use multiple devices (MSL7) to mediate multiple learning tasks (MSL8) which may lead to knowledge synthesis (MSL9). Two external inputs, MSL5 (ubiquitous access to learning resources) and MSL10 (multiple pedagogical/learning activity models) shape or enhance the learner's specific learning tasks (Wong, 2012).

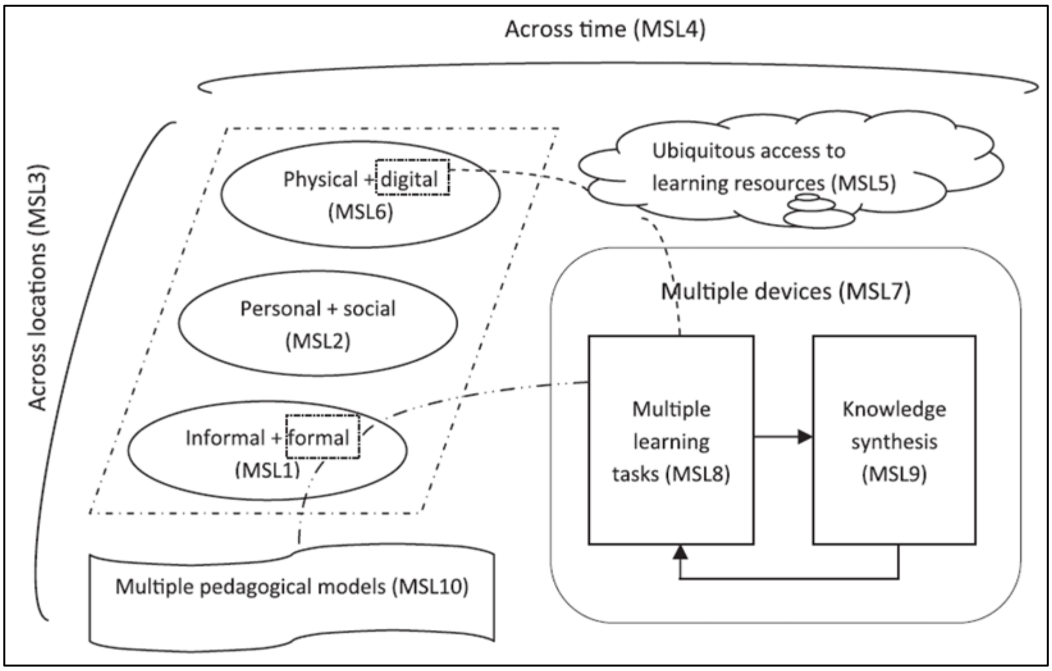

Figure 2.1: Mobile-assisted Seamless Learning (MSL) Framework (Source: Wong, 2012)

Wong & Looi (2011) encourage researchers to further investigate specific dimensions of this framework, for example, how learners switch between multiple learning activities. The MSL Framework has been applied across university and school settings. Milrad et al. (2013) used the MSL framework to describe a set of seamless learning projects in Asia and Europe. Another study used the framework in a review of the learning practices of lifelong learners (Tabuenca, Ternier, & Specht, 2013). A further study used the MSL framework to develop guidelines for the design of a mobile student response system (Malandrino et al., 2015). Another study used the MSL framework to analyse how three university programmes implemented seamless learning environments with mobile devices (Marín et al., 2016). An area where further research is required is the application of the framework to ODL universities. As the concept of seamless learning was initially proposed to consider the movement between in-class (formal learning) and out-of-class (informal learning) experiences, it has been applied within school and traditional higher education contexts. It is useful to consider how the concept of seamless learning can be applied to an ODL context.

2.4 The Design of Learning Tasks and Learner Activities

This section considers the design of learning tasks and the associated learner activities. A key aspect of this study is to explore how students use multiple devices to undertake multiple learning activities. Some characteristics of good learning in higher education are that learning is active, cumulative, individual, self-regulated, goal-oriented and situated (Ellis & Goodyear, 2010). According to Ellis & Goodyear (2010) (based on studies using the 3P model of learning by Trigwell & Prosser, 1997), key aspects of the student learning experience in higher education are:

- Student perceptions of leaning context (clarity of goals, course standards and quality of teaching).
- Student conceptions of their learning (what they think they are learning).
- Student approaches to learning (what they do when they learn, intentions and strategies).
- Characteristics of students (including prior experience).
- Course and departmental context (course design, teaching methods, assessment).

An important focus for educators is the quality of what the learner does (and what they think) because any changes in competence or understanding are dependent on the approaches and actions of the learner (Biggs, 1999; Ellis & Goodyear, 2010). Educators have long considered the relationships between learning goals and learning activities, for example through the development of Bloom's cognitive taxonomy of educational objectives (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956, as cited in Krathwohl, 2002). The original Bloom's taxonomy has subsequently been revised (Krathwohl, 2002). To improve educational outcomes, it is essential to focus on learner activity. The design of learning experiences then aims to ensure "that the quality of students' learning activity is as good as it can be" (Ellis & Goodyear, 2010, p. 120). The learning outcomes (either cognitive, psychomotor or affective, based on Bloom's taxonomy) are dependent on what the learner does. A learner activity may be mental or physical, or a combination of both and is usually performed with the aid of tools or resources, such as computers or books.

There is a difference between learning tasks and learning activities. Educators set learning tasks that influence learner activity. Educators set tasks that usually require students to perform multiple activities with some creative interpretation to complete the task. Students then adapt the tasks to better fit their own needs and interests. For tasks that require significant time, the processes that shape and reshape the activity can be quite complex. Thus, “it is the student’s activity that mediates between the task as set and the educational outcomes achieved” (Ellis & Goodyear, 2010, p. 122).

There are many tasks that educators can design to engage students in formal learning environments. However, all tasks need to be clearly linked to the stated learning outcomes for the course and to the assessments (Bates, 2015; Biggs, 1999). For example, if learning outcomes are focused on skills development, then tasks should be designed to give students opportunities to develop or practice those skills. These tasks also need to be regularly spaced and an estimate provided of the time students will need to complete the tasks (Bates, 2015).

Tasks are not the only influencers on learning activity. For example, students may face competing demands on their time. The learning activity is also influenced by the physical and social context in which it occurs. The physical (or digital) context determines the tools and resources that are available, while the social (or cultural) context refers to relationships with other people such as educators, other students, groups, friends and family or other learning communities (Ellis & Goodyear, 2010). The physical-digital and social-cultural contexts need to be considered by educators when designing learning tasks. Although educators cannot design the details for these contexts, they do have a responsibility to provide some of the physical-digital and social-cultural resources that students will need. For example, educators cannot design all the details of the learning spaces in which a learning activity takes place. Students configure their learning spaces and make choices about the tools and resources they will use. However, learning often takes place in an environment that is not created by students themselves. Students, educators and others co-configure the learning environments (at home, work or while travelling). Similarly, educators cannot design the social relationships within which a learner’s activity is embedded. Universities and educators create classes and groups, but students choose “who to spend their time with, who they talk to about their work and whose views they most value” (Ellis & Goodyear, 2010, p. 125). Even in required group work, students choose how much effort to invest in group tasks and the extent to which they rely on other group members. “Students exhibit agency – a significant level of control over their activity – within a context that influences, but is also created by, aspects of their activity” (Ellis & Goodyear, 2010, p. 126). Learning design can thus be considered a process whereby educators influence, but not control, student activity.

A successful student experience of learning occurs when the movement across physical and virtual contexts is not fragmented either conceptually or in approach. The conception of learning refers to “a learner’s sense of what can be learnt and how they should go about their learning” (Ellis & Goodyear, 2010, p. 12). A learning approach explains how students “translate tasks they are set into actual learning activity” and consists of intentions (what students hope to achieve by acting in specific ways) and strategies (what they actually do) (Ellis & Goodyear, 2010, p. 122). The approaches to learning can be deep-level, where “the learner expends considerable effort in making personal sense of new information, with the result that they can be said to understand it”, or surface-level, where “the learner adds the information to memory in such a way that they can repeat it", without any real understanding (Ellis & Goodyear, 2010, p. 25). Deep approaches encourage activities that are appropriate to handle the task so that an appropriate outcome is achieved, while surface approaches yield fragmented outcomes (Biggs, 1999; Ellis & Goodyear, 2010). Research has shown that students change their approach to learning based on their perceptions of what a learning task requires and their previous success using a particular approach (Bennett, Maton, & Kervin, 2008).

2.5 The FRAME Model

This section reviews the FRAME model. A key aspect of this study is to explore how students make use of handheld devices for learning. Therefore, it is important to consider aspects related to mobile devices, learners and social interactions. The Framework for the Rational Analysis of Mobile Education (FRAME) model describes "mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction" (Koole, 2009, p. 25). This model was designed within a distance education context. The model considers the technical characteristics of mobile devices as well as social and personal aspects of learning (Koole, 2006). The model describes "a mode of learning in which learners may move within different physical and virtual locations and thereby participate and interact with other people, information, or systems – anytime, anywhere" (Koole, 2009, p. 26). The model draws on psychological theories such as activity theory, Vygotsky's work on mediation and zone of proximal development and the learning theory of social constructivism (Koole, 2009). The FRAME model fits within the socio-cultural view of learning, as it considers both the technical characteristics of mobile devices as well as personal and social learning processes (Kearney et al., 2012).

This model can be used to design more effective mobile learning experiences by "assessing the degree to which all the areas of the FRAME model are utilized within a mobile learning situation" (Koole, 2009). A useful checklist is also provided help with the development and assessment of mobile learning environments. The FRAME model is represented by a Venn diagram in which the three aspects of Device (D), Learner (L) and Social (S) intersect (Figure 2.2).

The device aspect refers to the physical, technical and functional characteristics of a mobile device (including hardware and software). The learner aspect refers to the learner's cognitive abilities, prior knowledge and motivations. The social aspect refers to the processes of social interaction and cooperation. The device and learner aspects intersect at Device Usability (DL) that describes how devices are used for learning activities. The device and social aspects intersect at Social Technology (DS) that describes how mobile devices enable communication and collaboration among multiple individuals and systems. Learner and social aspects intersect at Interaction Learning (LS) that describes how learners interact with each other, the educator and the materials. Effective mobile learning occurs at the intersection of these three aspects (DLS) (Koole, 2009). A suggested area of future research using this model is to investigate how the portability of devices affects study patterns and how devices affect social interaction patterns among learners (Koole, 2006).

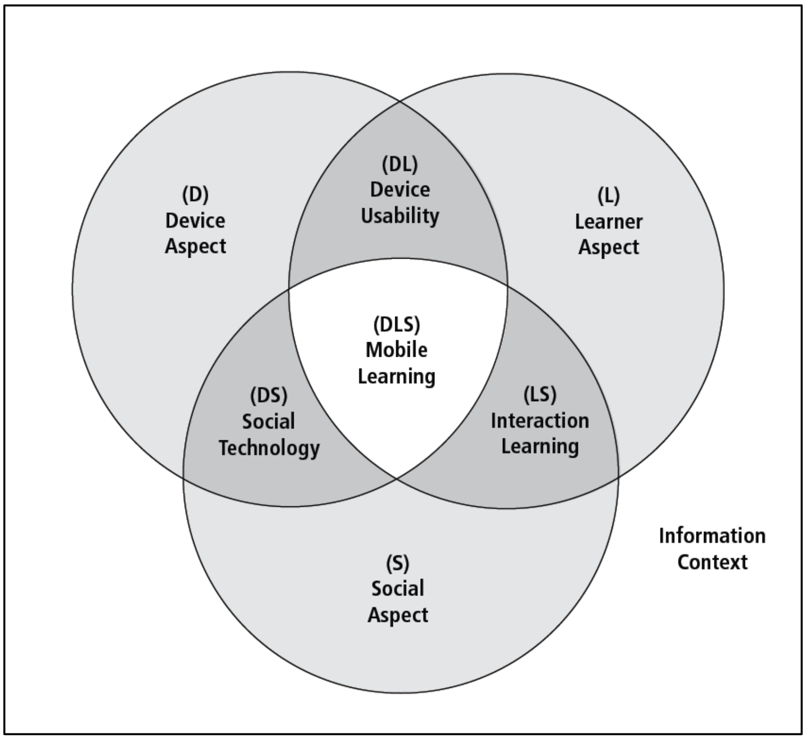

Figure 2.2: The FRAME Model (Source: Koole, 2009)

The FRAME model has been applied in various contexts in the literature. It was used to assess the potential of mobile learning for nursing education in a rural higher education setting (Kenny, Park, van Neste-Kenny, Burton, & Meiers, 2009). The model was used together with Transactional Control Theory to explore the usability, learning, and social interaction of mobile access to online course materials at a distance university (Koole, McQuilkin, & Ally, 2009). The checklist accompanying the FRAME model was used in the analysis of the effect of mobile device interventions for student support services in a postgraduate distance programme at the Indira Gandhi National Open University (Kumar, Jamatia, Aggarwal, & Kannan, 2011). Researchers have integrated the FRAME model with the Community of Inquiry Model to measure student engagement with a mobile learning tool (Parscal, Sherman, & Lucas, 2012). Boyinbode, Ng'ambi, & Bagula (2013) combined the FRAME model with Anderson's interactions to establish a model for the development of an interactive mobile lecturing tool to supplement a face-to-face environment. The FRAME model was also used to evaluate mobile assisted language learning for technical and engineering students (Šimonová, 2015).

There are several areas of overlap between the MSL Framework and the FRAME model. Both the MSL Framework and the FRAME model consider the essential aspects of learners and the use of devices/technologies. A key consideration is the mobility of the learner in different physical and virtual contexts. Both frameworks are also underpinned by a social-cultural view of learning. These frameworks will be used as a basis to explore the concepts in the literature and in the empirical work.

2.6 Summary

This chapter provided the theoretical framework that underpins this research by establishing the research in a socio-cultural theoretical perspective and exploring the concept of seamless learning. The relationship between the design of learning tasks and learning activities was also considered. Two relevant frameworks (Mobile-assisted Seamless Learning framework and the Framework for the Rational Analysis of Mobile Education) were described and evaluated. The relevant key concepts that this research study will investigate, within the context of the MSL Framework, include how ODL students use multiple devices (MSL7) to mediate multiple learning tasks (MSL8) across time (MSL3) and locations (MSL4). The study will also draw upon the mobile device, learner and social aspects of learning from the FRAME model. The next chapter will review the current literature.

Chapter 3

Literature Review

This chapter introduces the main literature reviewed in this study (Section 3.1) and situates the context of the research within the integration of technologies into Open and Distance Learning (ODL) (Section 3.2). The key concepts related to mobile learning are then discussed (Section 3.3) and key trends and issues in mobile learning in higher education are highlighted (Section 3.4). The shift from individual digital devices to multiple devices by users is featured (Section 3.5) and the use of multiple devices for learning is then explored (Section 3.6). Previous similar studies of device access and use at ODL universities are reviewed (Section 3.7) and the key concepts emerging from the literature are highlighted (Section 3.8). Finally, a summary brings the chapter to an end (Section 3.9).

3.1 Introduction

This research is situated within wider research into student ownership, use and expectations of the use of technologies in learning. A consideration for universities is how best to facilitate learning experiences and support their students who make use of different technologies (Cross et al., 2015). This requires an understanding of whether students have access (or not) to certain technologies, why and where they study and their digital literacy skills (Cross, Sharples, & Healing, 2016).

This chapter provides an explanation of what has been published about the use of devices in higher education and what knowledge and ideas have been established in this field. It looks at the main concepts under study as well as the key trends and issues. This chapter begins by situating the research within the context of Open and Distance Learning (ODL) and the integration of technologies within this mode of education. The next section looks at the state of research in mobile learning in general and focuses on the issues related to device access and use. This is followed by a review of the key trends and issues within mobile learning in higher education. A key consideration for this study is students' use of multiple devices, so the following section focuses on the general use of multiple devices. This is followed by an overview of the use of different devices for specific learning tasks. The next section focuses on similar previous surveys of device access and use at other ODL universities, while the final section highlights the key concepts from the theoretical framework and literature that inform this study. A summary then concludes the chapter.

3.2 Open and Distance Learning (ODL) and the Integration of Technologies

The aim of this section is to situate the research within the broader context of technology integration in ODL university settings as this research is conducted at two ODL university case studies. This section looks at ODL and the integration of technologies into the provision of ODL. It also focuses on understanding who ODL learners are and how they use technologies. It then looks at the role of student support in ODL and how technologies affect support services.

3.2.1 ODL

Distance learning is "learning that takes place where there is no face to face interaction between students and between students and teachers" and where any interaction between students and educators is mediated by technology (Andrews & Tynan, 2012, p. 565; Moore & Kearsley, 2005). The distinctive feature of distance education is the separation between educators and students. This distance refers to more than simply geographic distance, but "time, economic, social, educational, epistemological and communication distances" (Heydenrych & Prinsloo, 2010, p. 6). Distance education can be thought of as both a collection of methods and a mode of provision (Council on Higher Education, 2014). In many countries, distance education makes up a significant part of the university education sector and some of these countries, such as South Africa, have specific policies for the provision of distance education (Department of Higher Education and Training, 2014).

Another form of carrying out education, supported by digital technologies, is open education or open learning. The focus of open learning is the removal of barriers to learning. This implies "no prior qualifications to study, no discrimination by gender, age, religion" or disability and affordability for all (Bates, 2015, p. 337). Increasingly, governments are looking for ways to broaden access to learning and remove barriers, as evidenced by the European Union's agenda for opening up education (European Commission, 2013, 2017; Inamorato dos Santos, Punie, & Castaño-Muñoz, 2016) and South Africa's proposed post-school open learning policy framework (Department of Higher Education and Training, 2017). Over time, distance education has broadened to include Open and Distance Learning (ODL), a system that combines the methodology of distance education "with the concepts of open and flexible learning" (Belawati & Baggaley, 2009, as cited in Heydenrych & Prinsloo, 2010, p. 7). ODL is characterised by "the separation of instructors and students in either time or place, or both time and place", the use of a variety of media (including electronic and print) and two-way communication that allows educators and students to interact (Commonwealth of Learning, 2000, as cited in Cheung, 2012, p. 93).

The affordances of digital technologies provide opportunities to improve the quality of ODL provision, for increasing student engagement in general and for communication with and support of remote students in particular. It is essential for universities to prepare their graduates for participation in a digital world or information society (Department of Higher Education and Training, 2014). The next section explores the integration of technologies in ODL.

3.2.2 The Integration of Technologies into ODL

Several trends have influenced ODL over the past decade, one of which is the growth of online learning linked to the widespread use of Information and Communication Technologies (ICTs) to support teaching and learning (Andrews & Tynan, 2012). The use of technologies in teaching and learning is influenced by the modality of courses in which they are used (face-to-face, blended or online) (Chen & DeNoyelles, 2013). However, the distinction between distance and face-to-face education delivery is increasingly blurred with the expansion of blended or hybrid forms of delivery (Andrews & Tynan, 2012; Heydenrych & Prinsloo, 2010). The integration of technology can play a similar and different role in both face-to-face and distance education. For example, face-to-face universities have explored using asynchronous teaching and support strategies, while distance education universities have explored synchronous communication between the institution and students. Almost all face-to-face universities utilise e-learning through blended learning programmes or in support of teaching (Stöter et al., 2014). e-Learning denotes the "systematic use of networked, multimedia computer technologies to improve learning" (Ellis & Goodyear, 2010, p. 32).

The purpose of integrating technology in teaching and learning contexts is to enhance the learning experience. A challenge for ODL providers is the affordable and sustainable use of digital technologies in appropriate ways to continue to promote greater access to learning opportunities, in ways that enhance opportunities for success in programmes that develop meaningful graduate competencies and promote lifelong learning (Council on Higher Education, 2014). The extent of e-learning can vary within ODL provision (Figure 3.1). At one end of the continuum, there are programmes with no internet support (offline learning), such as traditional correspondence programmes. At the other end of the continuum, there are fully online programmes where all interactions, resources, activities, assessments and support services occur online. In between, there are internet-supported programmes where online participation is optional and supplementary (for example, additional resources are available online) and internet-dependent programmes where regular online participation is required (however, some resources, activities or assessments occur face-to-face) (Council on Higher Education, 2014).

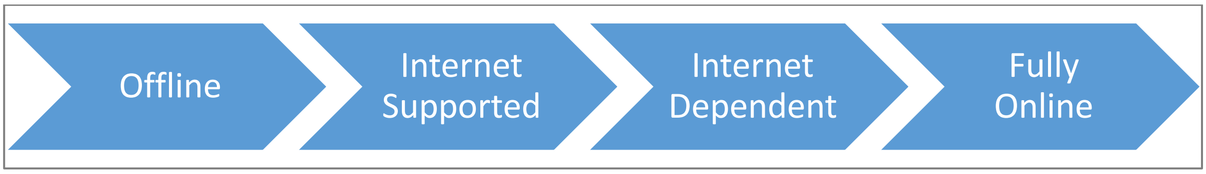

Figure 3.1: Continuum of Internet Support in ODL Provision (Source: Council on Higher Education, 2014)

Although the use of ICTs is leading to a blurring of the modes of education provision, it is worth reviewing the role of technologies in the provision of ODL. The adoption of contemporary technologies in distance education is not new (Tait, 2014). Distance institutions have evolved by integrating predominate technologies into their learning experiences (Anderson & Dron, 2012; Andrews & Tynan, 2012). Several authors, such as Moore & Kearsley (2005), have proposed generational models that show how technologies have impacted on the possibilities for learning design and support in distance education. The generations of distance technology models have been criticised for downplaying the role of pedagogy and ignoring earlier roots of distance education (Heydenrych & Prinsloo, 2010). Similarly, Anderson & Dron (2012) recognise that while technologies influence the teaching and learning design, the predominant pedagogical models may better define the generations of distance education. For "each mode of engagement, different types of knowledge, learning and contexts" demand that "distance educators and students be skilled and informed to select the best mix(es) of both pedagogy and technology" (Anderson & Dron, 2012, p. 11). Table 3.1 shows the availability of generational technologies to support the types of pedagogical models that can be developed (Anderson & Dron, 2011; Heydenrych & Prinsloo, 2010; Moore & Kearsley, 2005) as well as the provision of learner support (Tait, 2014).

Table 3.1: Distance Education Generations of Technologies, Pedagogies and Support Mechanisms

Distance Education Technologies	Distance Education Pedagogies	Distance Education Support Mechanisms
Correspondence – single medium (print), mass production of technology. Radio and television broadcasting	Behaviourism and Cognitivism – focus on the individual learner, learning activities focus on reading and watching. Focus on curriculum development and independent study.	Limited student support, it is assumed learners are autonomously guided through the learning materials.
Combined approach – correspondence assisted by broadcasting (open universities) Telelearning – interactive audio/video and web conferencing	Constructivism and Social Constructivism – focus on group learning, where learning activities focus on discussing, creating and constructing. Includes computer-assisted instruction. Two-way communication technologies enabled direct interactions between educators and students, and between students themselves.	The use of tutors to support learners. Tutors help to create meaning for students in the mediation of the learning materials. There is recognition of the affective dimension of the learning experience. Universities also create regional support centres to provide localised support. However, the creation of learning materials is separate from student support systems.
Online delivery – multimedia interactive content with online communication and support. Supporting technologies are social networks and Web 2.0 technologies.	Connectivism – focus on the network, where learning activities focus on exploring, connecting, creating and evaluating. Increasing openness of knowledge (found outside of university systems and resources).	The division between the curriculum creation system and the student support system is no longer required, as geographic distance is less of a factor. Student support needs to be integrated into the curriculum design and teaching and learning system. Support is offered centrally online, with less localised support options.

(Adapted from Anderson & Dron, 2011; Heydenrych & Prinsloo, 2010; Moore & Kearsley, 2005; Tait, 2014)

There is general agreement about the first three generations of distance education technologies (postal correspondence, followed by the mass media of television, radio and film production, followed by interactive technologies). However, the fourth and fifth generations of distance technologies vary among different authors (Anderson & Dron, 2012; Heydenrych & Prinsloo, 2010). Nonetheless, it is important to note that none of the subsequent generations of distance education pedagogies and technologies have eliminated the previous generations. In effect, the range of pedagogies and technologies available to integrate into distance education have expanded with each generation (Anderson & Dron, 2012). This pedagogical focus is noted by Conole (2014) who traces the shift from behaviourist approaches to learning (focused on the individual with stimulus and response approaches), to more constructivist (building on prior knowledge) and social situative (learning with others in a context), to connectivist pedagogies (focus on personal network development) in distance education. Connectivism is a more recent theory of learning that focuses on the creation of connections and networks (Siemens, 2005), however there is some debate as to whether it is actually a theory of learning or an emerging pedagogy (Kop & Hill, 2008).

Researchers have considered possible future generations of distance education pedagogies, with Anderson & Dron (2011) suggesting more intelligent systems or crowd-based collectives. Heydenrych & Prinsloo (2010) propose a major change in the role of the educator, moving away from content provision to the provision of activities and pathways linked to sources available online. Context- and community-based support and facilitation will be important for future distance education provision. Zawacki-Richter et al. (2009) have questioned whether mobile learning could form the basis of the next generation of distance education pedagogy.

There has been considerable interest in exploring the impact of technology on ODL student learning. However, there are a number of challenges for the use of technologies in ODL. These include a slow uptake of technologies, lack of theoretical foundations for the application of research findings to policy and practice and the challenge to change existing cultures and pedagogical models (Conole, 2014). For example, many educators make little changes to their teaching practices when integrating web-based technologies (Andrews & Tynan, 2012). Interestingly, barriers cited for the use of innovative tools are consistent across the different generations of distance technologies. For example, accessibility, digital literacy skills, educator professional development, budget and culture were issues cited for the lack of integration of audio-visual tools, personal computers and mobile devices (Conole, 2014).

Conole (2014) suggests that one of the topics requiring further research in distance education is the development of mediating artefacts so that students and educators can make more effective use of technologies to support learning. Another topic for research is how the processes of supporting learning (design, delivery and support) change as a result of new technologies. This research study aims to determine how to better support ODL students using multiple devices for learning.

3.2.3 ODL Learners

The previous section reviewed the integration of technologies in previous generations of distance education. This section narrows the focus to ODL learners themselves who will be further explored in this study. Educators need to “make a shift from focusing on education at certain ages to lifelong learning” (Brown, 2005, as cited in Ally & Prieto-Blázquez, 2014, p. 145). ODL supports and encourages the concept of lifelong learning, but also equips students with the tools for self-regulated learning (Peters, 2008 as cited in Stöter et al., 2014). The study skills of ODL learners may be diverse. For example, many lifelong learners (who have previous higher education experience and balance work and family responsibilities) can be self-regulated and autonomous learners. In contrast, other learners (for whom schooling did not prepare for future learning) may lack basic learning skills and confidence in learning. The majority of learners will fall in the middle of this spectrum (Bates, 2015). Self-regulation refers to a continuous process involving forethought (thinking about what needs to be done and deciding what to do), action and then self-reflection on the action (thinking about the experience, consequences and learning) (Zimmerman, 2000, as cited in Jackson, 2013, p. 4). It emphasises the importance of motivation and metacognition (Sha, Looi, Chen, & Zhang, 2012).

The appropriate use of technologies for learning provides opportunities for students to learn in a variety of ways, thus more easily accommodating student differences. Therefore, it is important "to know your students, their similarities and differences, what technologies they already have access to and what digital skills they already possess or lack" (Bates, 2015, p. 264). Table 3.2 shows the different characteristics of ODL students (adapted from Andrews & Tynan, 2012).

3.2.4 Learner Support in ODL

The primary objective of student support in ODL is to assist students to learn successfully (Tait, 2003). Successful ODL depends on student support services to help students overcome feelings of isolation and distance from peers, educators and the institution itself (Kumar et al., 2011). An ODL institution needs to provide personalised support or to recognise and respond to the learner as an individual. This support can take the form of student guidance and counselling, tutor services and effective information and administrative systems (Tait, 2003, 2015). The need for learner support can be characterised as cognitive (supporting and developing learning), affective (related to the emotions that support learning and success) and systemic (helping students to manage rules and systems of the institution in ways that that support persistence) (Tait, 2003). Student support services can also be characterised as academic or non-academic. Academic support deals with the development of cognitive and learning skills, while non-academic support deals with affective and organisational aspects (Simpson, 2000, as cited in Makoe, 2012) such as counselling and guidance services. Academic support includes helping students with how to write assignments, where to look for information and providing feedback on their progress. Through scaffolding, educators diagnose and respond to challenges experienced by students (Bates, 2015).

Students vary widely in their need for support in learning. The Community of Inquiry model (Garrison, Anderson, & Archer, 1999) proposes that learning in an online environment occurs through the interaction of three presences (social, teacher and cognitive). Social presence refers to the ability of learners to identify with the community and communicate purposively. Teacher presence refers to the design and facilitation of the learning processes to achieve learning outcomes. Cognitive presence refers to the construction of meaning through reflection and discourse. Although all three presences are important aspects for the performance of learners, teacher presence in online learning is particularly associated with learner success or failure (Bates, 2015).

Table 3.2: ODL Student Characteristics

ODL Student Characteristics	**Description**
Diversity or "individualness"	• ODL students are highly varied, with a relatively high average age, the majority of whom are employed, have families and many have some post-schooling education (either towards a previous degree or some post-schooling courses) (Andrews & Tynan, 2012; Carnoy, Rabling, Castano-Munoz, Duart-Montoliu, & Sancho-Vinuesa, 2012; Stöter et al., 2014). • Types of lifelong learners including second chance learners, equity groups, deferrers, recurrent learners, returners, refreshers and learners in later life (Shuetze & Slowey, 2012, as cited in Stöter et al., 2014). • However, more and more young people (below 25 years) are entering ODL universities (Stöter et al., 2014), blurring the distinction between traditional and non-traditional students. • Each student has their own specific needs, technologies and contexts of use (Ferran-Ferrer et al., 2014). Students organise their learning spaces and make use of technologies to support their learning differently, depending on their needs and situations (Andrews & Tynan, 2012).
Connectedness	• Students interact with each other, their educators and the university. As ODL institutions have changed their modes of provision, ODL learners have had to shift from print-based correspondence to web-based learning environments (Andrews & Tynan, 2012). • Connectedness includes technical access and the development of a broader range of literacies that are necessary to function effectively within online communities (Tait, 2003). While digital literacy varies (Stöter et al., 2014), many ODL learners are technologically immersed and see technology as central to learning (Conole, 2014). • Students make use of both institutional and external technologies to support connectedness. For example, students participate in informal learning communities or networks (using Facebook, Twitter and others) to support their learning (Andrews & Tynan, 2012).
Mobility	• Due to the need to balance work, family and social responsibilities, mobility is a key aspect of the ODL experience. This includes the ways students interact with learning activities and the technologies they use to support their learning as well as their physical mobility (Andrews & Tynan, 2012). • Due to work and family responsibilities, ODL students have a greater need for flexible study in terms of time and space (Andrews & Tynan, 2012; Kember, 1995, as cited in Stöter et al., 2014; Zawacki-Richter et al., 2015). • Students make use of mobile devices to enable the continuity of their learning as they go about their lives (Andrews & Tynan, 2012; Sharples, 2013). They can access learning content easily via mobile devices during brief moments between work and family responsibilities or while travelling (Murphy, Farley, Lane, Hafeez-Baig, & Carter, 2014).
Resourcefulness	• Students are able to overcome challenges and find ways to achieve satisfactory learning outcomes while managing their other commitments (Andrews & Tynan, 2012). • ODL students require maturity, a high-level of motivation, the ability to multi-task and to work independently and collaboratively. They have to balance their studies with other responsibilities, find and use learning resources, work in groups, read, synthesise and write proficiently (Brindley, 2014). • For technical issues, ODL students are able to "trouble shoot" when institutional help is not available or seek help from friends and family (Andrews & Tynan, 2012).

While ODL university degrees are cheaper for students (in terms of lower income foregone than attending face-to-face universities) and more flexible (engaging in coursework when time is available), they require more self-discipline and more years to complete, partly because they are cheaper and more flexible. Completion-to-degree rates are quite low in ODL universities (Carnoy et al., 2012). Student support aims to enhance the learning experience and diminish drop-out, thus student support must include consideration of student progress and success. Part-time students are more likely to drop out than full-time students due to their other commitments, however drop-out is also a factor of the types of students accepted by the institution (Tait, 2014). Institutions have an obligation to students to help them achieve their goals as effectively as possible. The major causes of failure to progress are time pressure, self-management, family, logistics and support (including technical support) and curriculum relevance (Street, 2010 in Tait, 2014). Inadequate preparation for education is another factor. Other studies identified predictors of completion to be intention to complete, early submission and the completion of previous courses (Moore & Kearsley, 2005). Issues that lie within the direct control of the institution need to be recognised when supporting students (Tait, 2014). For example, the effectiveness of the learning design can reduce the need for support (Bates, 2015) and thus reduce drop-out. Student support systems can be expanded to provide learning support via mobile devices (Zawacki-Richter et al., 2009), such as the use of bulk text messages (Kumar et al., 2011) or the accessibility of administrative and library services via mobile devices (Brindley, 2014). Learning analytics can be used to diagnose and identify how and when learners might need support (Tait, 2014). For example, tutors can be alerted when students have not yet engaged with a part of the course within the expected timeframe. Learner support approaches should focus "on early intervention, anticipatory guidance, preparedness for online study, skill development, and social and academic engagement" (Brindley, 2014, p. 293). Personal, relevant and timely learner support can make the difference between success and failure (Bates, 2015).

An effective student support service in ODL is responsive to student needs, encourages interaction between students and the university and continuously evolves with educational and technological advancements (Makoe, 2012). Students often rely on other students for informal support, by communicating through social media or helping each other with assessments. Educators can formalise this support through the design of cooperative and collaborative activities (Bates, 2015). The widespread use of digital technologies has implications for student support. Not only is geographic distance no longer an organising principle, but students can now source and create their own content, rather than having content delivered (Tait, 2014). Content is increasingly free and available online and students refer to the internet and "digital media for their sources of knowledge" (Bates, 2015, p. 450). As seen in Table 3.1, learning design used to be separate from learner support. However, now the design of materials needs to move from content provision to the design of learning pathways where students are more responsible for finding, evaluating and creating resources. Most contemporary ODL learning is dominated by asynchronous communication such as email and forums. However, web technologies also provide for streaming audio and video, synchronous audio and video conferencing, the development of virtual labs, online collaborative presentations and the creation and sharing of content through social clubs or networks (Facebook, wikis and other similar crowd approaches) (Tait, 2014, 2015).

3.3 Mobile Learning

The aim of this section is to situate the research with the area of mobile learning, where students use their personal devices for learning. This section focuses on the integration of mobile technologies in higher education and the growth of this research field. A brief review of the state of the research is provided and then the key aspects of mobile learning related to this study are discussed. These key aspects relate to access to mobile devices and the use thereof for learning purposes. The applications and services associated with mobile devices are then explored. This is followed by an outline of study locations enabled by mobile learners and the support needs of mobile learners.

3.3.1 Mobile Learning and Learner Mobility

The definition of mobile learning (or m-learning) has been the subject of considerable debate. Early definitions focused on the use of mobile technologies, while later definitions emphasised the mobility of the learner across contexts (Traxler, 2009, 2016). Mobile learning is "about the learner, not the technology" because "the learner is mobile and at the centre of learning" and can learn in any context (Ally & Prieto-Blázquez, 2014, p. 145). Mobility refers to mobility in physical, social and conceptual spaces, in technologies and over time (Sharples et al., 2009). For the purpose of this research study, the definition of mobile learning that is adopted is that mobile learning is "Any sort of learning that happens when the learner is not a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies" (O'Malley et al., 2003, as cited in Schroeder, 2013, p. 106). Many researchers emphasise the social aspect of mobile learning. Mobile learning is a social phenomenon of "people on the move, constructing spontaneous learning contexts and advancing through everyday life by negotiating knowledge and meanings through interactions with settings, people and technology" (Vavoula & Sharples, 2009, as cited in Ally & Prieto-Blázquez, 2014, p. 145). Mobile technologies are inherently social as they are used to quickly communicate, share information and publish content (Schroeder, 2013).

Mobile learning can be utilised in both face-to-face learning and ODL. It can be used as a complete delivery system (a mobile learning environment), or it can also be used to supplement other forms of delivery such as "small components, activities or events within any mode of delivery" (Brown & Mbati, 2015, p. 118). The important aspect is that these components add value to the teaching and learning experience. Mobile learning has been seen as a subset of or complement to e-learning (Zawacki-

Richter et al., 2009). Early mobile learning projects grew out of the e-learning community where the goal was to offer access to resources from any location at any time (Ferran-Ferrer et al., 2014; Traxler, 2009, 2016). Mobile learning cannot be seen as a replica of e-learning, but as a complementary or additional layer that increases opportunities for teaching and learning (Ferran-Ferrer et al., 2014). The additional affordances of mobile devices such as location awareness and synchronous collaborative communication means that they enable educational contexts not possible with computers (Brown & Mbati, 2015; Ferran-Ferrer et al., 2014). However, as mobile technologies continue to develop and expand, media, tools and services will begin to converge, possibly blurring the distinction between m- and e-learning (Zawacki-Richter et al., 2015).

3.3.2 The State of Research in Mobile Learning

Research into the use of mobile devices for learning is about fifteen years old (Traxler, 2016). Parsons (2014) created a timeline of mobile learning through a series of significant events over this period, such as the first mobile learning conferences, books and journals. The first m-learning conference was held in 2002. Many mobile learning research projects were driven by the "exploration of educational theory and exploitation of each new technology" (Traxler, 2016, "Looking backward" para. 2). In the first decade, mobile learning projects focused on the implementation and deployment of specific mobile technologies and were relatively expensive, small-scale, short-term and occurred within formal institutional contexts, where researchers used individual courses to experiment with non-mainstream institutional methods (Rajasingham, 2011; Traxler, 2016). Many early studies focused on pilot studies where a specific mobile device was selected to research. Often, researchers provided students with this device, rather than investigating how students used their own devices (Wright & Parchoma, 2011). Much of the initial literature focused on the use of devices to disseminate information or access university resources from mobile Virtual Learning Environments (VLEs) (Gikas & Grant, 2013; Traxler, 2016). Early studies focused on students' attitudes, motivations and perceptions towards mobile learning, but few focused on mobile learning practices and strategies (Chen & DeNoyelles, 2013).

The first decade of mobile learning (2002 to 2011) saw the growth of research from only a few studies in a few countries to a widespread area of study (as evidenced by the review studies by Cheung & Hew, 2009; Frohberg et al., 2009; Hung & Zhang, 2012; Hwang & Tsai, 2011; Naismith, Lonsdale, Vavoula, & Sharples, 2004; Wingkvist & Ericsson, 2011; Wu et al., 2012). Mobile learning projects developed in "schools, workplaces, museums, cities and rural areas around the world" (Sharples et al., 2009, p. 234). Mobile learning grew from a few small-scale research studies to some larger national and international initiatives, with research evidence mostly available in the form of successes and challenges in project case studies (Sharples, 2013). Research projects have shown how mobile technology can motivate and engage learners, challenge existing educational thinking, reach the "hard-to-reach" and enhance the learning experience (Traxler, 2016).

Later research projects looked at how students can "create and interact with course content, collaborate and learn during the course of their daily lives" (Gikas & Grant, 2013, p. 24). Key technological trends include a shift towards ubiquitous and networked technologies, the emergence of context- and location-aware devices, and widespread availability of mobile and adaptive devices (De Freitas & Conole, 2010, as cited in Conole, 2014). After the first decade of mobile learning research, the next few years saw continued growth and diversification in the field. While general reviews of the field continued (Chee, Yahaya, Ibrahim & Noor Hassan, 2017), researchers became more interested in specific aspects of mobile learning such as methodological issues (Song, 2014), theories and models (Hsu & Ching, 2015), critical success factors (Alrasheedi & Capretz, 2015) and even patents (Chiang et al., 2016). Researchers also became more interested in the application of mobile learning in specific contexts, such as school (Liu et al., 2014; Tingir, Cavlazoglu, Caliskan, Koklu, & Intepe-Tingir, 2017), higher education (Krull & Duart, 2017; Pimmer, Mateescu, & Gröhbiel, 2016) and in specific disciplines, such as language learning (Sung, Chang, & Yang, 2015), science (Crompton, Burke, Gregory, & Gräbe, 2016; Zydney & Warner, 2016) and teacher education (Baran, 2014). At the same time, researchers also continued to look at the educational potential of emerging devices, such as iPads (Nguyen, Barton, & Nguyen, 2015). One of the ongoing challenges in the field was that technologies tended to change at a faster pace than the research that studied them. Studies tended to focus on specific devices and these devices change over time. For example, mobile learning studies moved from basic mobiles to smartphones, from PDAs to tablets and e-readers (Chen & DeNoyelles, 2013).

3.3.3 Access to Mobile Technologies

Universities often undertake surveys to understand student ownership of devices (Chen & DeNoyelles, 2013). Regular such surveys are needed due to the evolution of technologies and the shifts in popularity in different devices (Murphy et al., 2014). Often the calls for using mobile devices in higher education are framed within the high ownership of mobile devices in populations, where students are even more likely than the general population to own mobile devices (Dahlstrom et al., 2015; Farley et al., 2015). This is seen in the high penetration of digital media (especially smartphones) in higher education (Zawacki-Richter et al., 2015) and the suggestion that educators should prepare for changes in student expectations and behaviour because of the growth in personal ownership of mobile devices. Technological ubiquity supposes that a technology is "familiar, commonplace and widely accessible" (Nortcliffe & Middleton, 2013, p. 178).

Access to technologies incorporates both technological and practical access. Technological access refers to physical access to technologies such as computers and mobile phones. Practical access refers to "control over when and to what extent technologies are used", including the ease of access and the adequacy of technology (Czerniewicz, Williams, & Brown, 2009, p. 76). In addition to personal access, students may have access to technologies at the university and in public and private places (Czerniewicz et al., 2009). Learners can develop a set of technology-based practices over time, which require appropriate skills and functional access to relevant technologies (Sharpe & Beetham, 2010):

- *Functional access*: learners gain access to the technology, resources and services that they need. They overcome issues of ownership, mobility and time.
- *Skills*: Learners develop generic, technical, information, communication, learning and organisational skills. They increase in confidence and can use their skills in a variety of learning contexts.
- *Practices*: Learners make informed choices about how to use technologies (for example, alone and with others) and in response to individual and situational needs.
- *Creative appropriation*: Learners make use of the skills and practices they have developed to create their own learning environments.

A common concern in the literature is disadvantaging or excluding students without access to specific technologies and the accompanying connectivity, particularly students from lower socio-economic groups (Cross et al., 2015; Farley et al., 2015; Murphy et al., 2014). For example, students in rural areas are more likely to use shared devices and the sharing of devices inhibits mobile learning (Brown & Mbati, 2015). Learners may be restricted if they cannot afford devices or if they have to restrict their internet data use (Sharples et al., 2014). The "digital divide" between those who have access to technology and those that do not ("the haves" and "have nots") is more nuanced than this distinction implies as the divide incorporates the associated technology skills, levels of digital literacy and language issues (Liebenberg et al., 2012). There are some students who lack both computer experience and opportunities to use computers as they only have access to ICTs at the university (Brown & Czerniewicz, 2010). However, researchers have found that despite students from lower socio-economic groups being likely to have limited access to computers, mobile phone ownership is pervasive (Czerniewicz et al., 2009). Recalling the resourcefulness of ODL students, lower socio-economic group students often "make a plan" to overcome access obstacles in order to meet their learning objectives. This is because either access is seen as a necessity for course requirements or students are motivated by longer-term life goals. Thus, "students are influenced, but not determined by, the barriers they face" (Czerniewicz et al., 2009, p. 86).

To increase student access to devices and internet connectivity, universities can partner with other institutions to work with technology companies and Mobile Network Operators (MNOs) to offer mobile devices or connectivity to students at discounted rates (Chen & DeNoyelles, 2013). Other models considered by higher education institutions are loans, leases or including device and app purchases in the tuition fees. This is not limited to devices, as institutions may provide vouchers for airtime and connectivity (Traxler, 2010).

Demonstrating the interest in students' use of technologies, the EDUCAUSE Center for Applied Research (ECAR) has, since 2004, conducted an annual study of United States of America (USA) undergraduate students to determine how ICTs affect the university experience (Dahlstrom, 2012). Although data is collected from thousands of students in different countries, a representative stratified random sample of 10 000 USA students is used to compile the annual report. Each report explores the ownership, use patterns and perceptions of technology among undergraduate students. One of the aims of this annual report is to assist institutions and educators to better support students' technology needs and expectations. The reports demonstrate that the ownership of technological devices continues to increase, particularly handheld devices such as smartphones and tablets (Dahlstrom, 2012; Dahlstrom, Walker, & Dziuban, 2013). In 2015, for example, students owned more internet-capable devices than ever before (Dahlstrom et al., 2015). Figure 3.2 shows student ownership of specific devices in the ECAR surveys from 2012 to 2016. It shows that student device ownership continues to grow, with laptop and smartphone ownership close to market saturation (Brooks, 2016). It also shows a steady, if levelling, increase in tablet ownership. The diagram also shows device ownership tracking trends. From 2014 onwards, the ECAR survey did not track the ownership of desktop computers anymore (Dahlstrom & Bichsel, 2014). The ownership of e-readers was not tracked from 2015, while wearable technologies (such as fitness devices and smartwatches) started to be tracked (Dahlstrom et al., 2015).

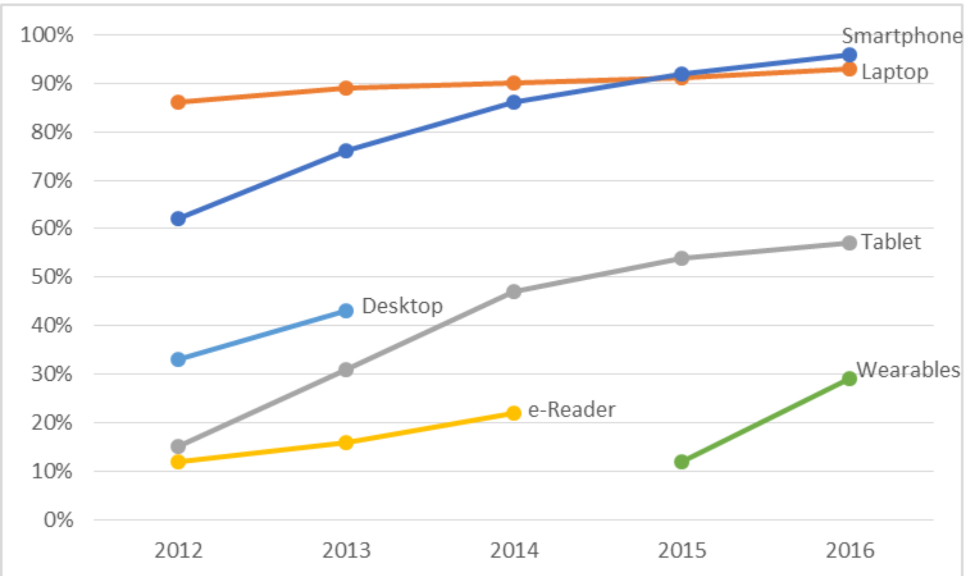

Figure 3.2: Device Ownership History (2012-2016 ECAR Surveys) (Adapted from: Brooks, 2016)

The ECAR annual reports confirm that single-device ownership is rare. In 2013, 58% of students owned three or more internet-capable devices (Dahlstrom et al., 2013). In 2015, this had increased slightly where 64% owned three or more (Dahlstrom et al., 2015). In 2016, 52% of students owned a laptop, a tablet and a smartphone, while 38% owned a laptop and a smartphone (Brooks, 2016). This data indicates that students will likely to continue to value the affordances of different devices. This is in contrast to the argument that future students will have the "touchscreen mentality" and the "digital dexterity to use smartphones as their only computer" (Bonnington, 2015, as cited in Dahlstrom et al., 2015). Although laptops, smartphone and tablets were the most common devices over the past five years, patterns of device ownership continue to change as different devices change in popularity.

3.3.4 Use of Mobile Technologies for Learning

The widespread adoption of mobile phones means that they can be used for learning (Brown & Czerniewicz, 2010). While access to a digital technology is important, having the ability to use the technology effectively for academics is equally important and cannot be assumed (Chen et al., 2015; Dahlstrom et al., 2015; Department of Higher Education and Training, 2013; Liebenberg et al., 2012; Tossell, Kortum, Shepard, Rahmati, & Zhong, 2015). Technology can be used for personal (social) use or academic use (Czerniewicz et al., 2009). For example, the use of smartphones for social and educational purposes are different and there are cost and usability issues involved in the use of mobile phones for education (Tossell et al., 2015).

The generational aspects of young people and their interactions with technologies has led to the emergence of narratives around the "net generation" (Oblinger & Oblinger, 2005) or "digital natives" (Prensky, 2001) because of their familiarity with and reliance on ICT (Bennett et al., 2008). Immersion in technology is believed to influence the skills and interests of young people in significant ways for education and that they learn differently to older "digital immigrants" (Prensky, 2001). However, these assertions were found to have little empirical evidence (Bennett et al., 2008; Brown & Czerniewicz, 2010; Gallardo-Echenique et al., 2015; Jones, Ramanau, Cross, & Healing, 2010; Romero, Guitert, Sangrà, & Bullen, 2013). Research into the access and use of technology by young people offers a more diverse and complex view than previously suggested, with potential differences related to "socio-economic status, culture/ethnic background, gender and discipline specialisation" (Bennett et al., 2008, p. 778). Although some "young people are highly adept at technology and rely on it for a range of information gathering and communication activities", a significant proportion "do not have the levels of access or technological skills" expected for a digital native generation (Bennett et al., 2008, p. 779). Generalisations about how learners learn also miss out on cognitive differences in different age groups and variations within age groups. There may be as much variation within a generation as there is between generations (Bennett et al., 2008; Brown & Czerniewicz, 2010; Ellis & Goodyear, 2010). Students are not homogenous, minorities of students make little use of some technologies that majorities make much more extensive use of. Universities and educators, as always, are faced with choices about how to improve teaching and learning and "these choices need to be better informed about the kinds of students that are entering their institutions (Jones et al., 2010, p. 731). In the South African context, age was found to be less of an influence on digital skills than experience in using computers (Brown & Czerniewicz, 2010). Similarly, data gathered in Spain demonstrated that differences among online students were more influenced by their use of ICT than by their age (Romero et al., 2013). Various researchers have proposed alternatives to overcome some of the difficulties associated with the digital natives narrative, such as a continuum of digital visitors and residents (White & Le Cornu, 2011; Wright, White, Hirst, & Cann, 2014) or the use of the term "digital learners" to reflect the deep influence of digital technologies on learning (Gallardo-Echenique et al., 2015).

The use of mobile devices is learner- and context-dependent. Many learners are "perfectly happy to read on a tiny screen, whilst for others this is a major barrier" (Kukulska-Hulme, 2010, p. 8). Context is an important aspect of learning and institutions need to conduct proper analysis of the needs and characteristics of their learners (Stöter et al., 2014). When planning for mobile learning, educators need to know their intended audience, the tools they are currently using and the settings in which they will be using the tools. It is helpful for educators to know current statistics regarding ownership and use of digital devices (Schroeder, 2013) because trends in availability, ownership, functionality and use of devices are important (Traxler, 2010).

Returning to the ECAR annual reports, the tracking of device ownership is important as the more devices students own, the more likely they are to feel more prepared to use technology, to actively engage with courses that use technology and to be more inclined to see its value for use in academics (Dahlstrom et al., 2013). Students use their devices extensively and view them as important to their academic success (Brooks, 2016). Figure 3.3 shows the usage of laptops, smartphones and tablets for academics in the ECAR reports from 2012 to 2015. Laptops continue to be the main device used for academics, with 95% of students using the laptop in at least one course (Brooks, 2016). However, more students are beginning to use smartphones for academic purposes (Dahlstrom et al., 2013). Tablet usage for study is more stable, this is likely in alignment with smaller increases in the ownership of tablets (Brooks, 2016).

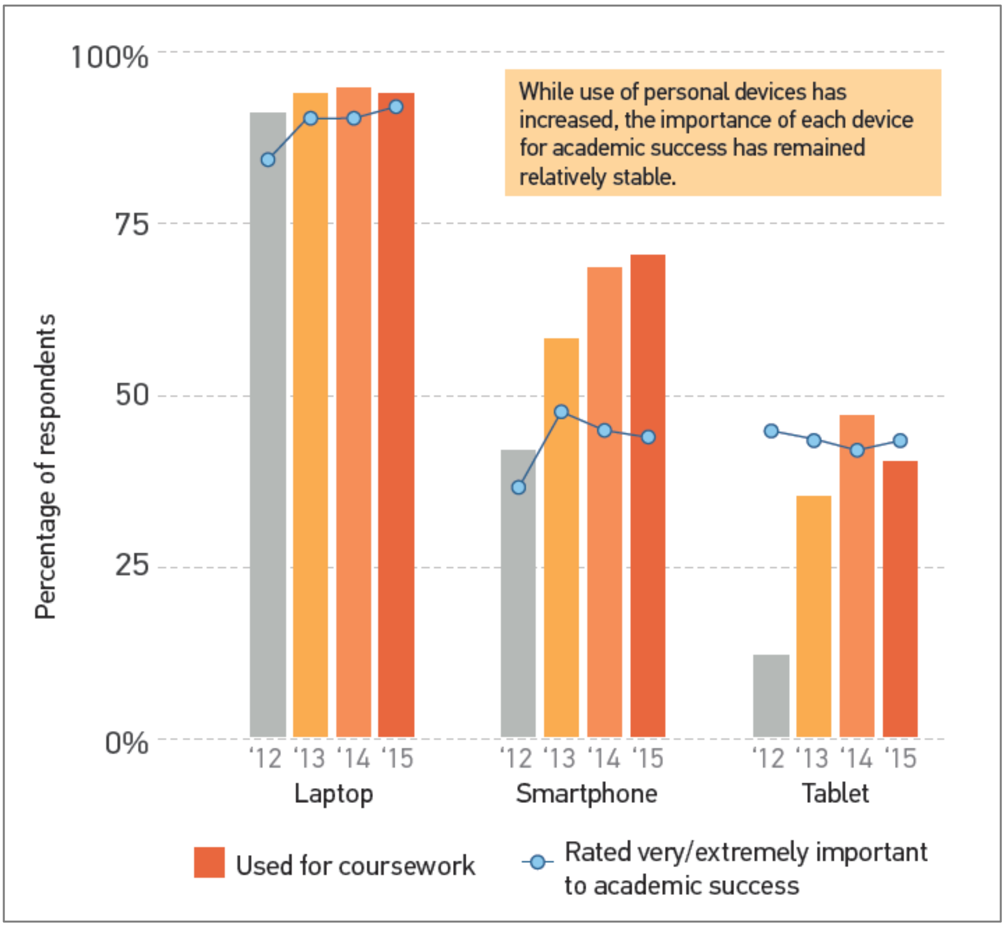

Figure 3.3: Device Use and Importance for Academic Success (Source: Dahlstrom et al., 2015)

Figure 3.3 also shows the importance of each device towards academic success from 2012 to 2015. Device importance towards academic success continues to be relatively stable (Brooks, 2016). Laptops continue to be seen as the most important device, presumably due to their power and flexibility. The importance of smartphones and tablets has remained stable or decreased slightly. Dahlstrom et al. (2015) believe this due to mobile learning not being prioritised at institutions and the discouragement of these devices in class. Only 52% of educators believe that the use of mobile devices in class can enhance learning and many educators would like more professional development around effectively incorporating mobile devices in their courses (Dahlstrom et al., 2015). Students are more likely to use mobile devices for learning when educators encourage their use in class (Dahlstrom & Bichsel, 2014).

Similar to ECAR, JISC in the United Kingdom has established a yearly student digital experience tracker starting in 2017 (Newman & Beetham, 2017). 8 190 higher education students responded to the survey. Students were found to use a variety of portable and non-portable devices to access institutional learning resources and services. Laptops (88%) and smartphones (84%) were the most commonly used personal devices for learning, while desktops (66%) and printers (63%) were the most commonly used organisationally owned devices used for learning. Students made use of, on average, four devices for learning (institutional and personal). The researchers recommend further qualitative research to investigate patterns of ownership and use in more detail and to consider the implications for learning design and technological support (Newman & Beetham, 2017). This study will investigate patterns of use and the support needs for ODL students using multiple devices.

3.3.5 m-Learning Applications and Services

Devices represent only one aspect of engagement with technology. It is also important to consider the resources and tools that students access and use with the aid of their devices. Free and reliable wireless access to the internet is a factor in the continued use of a mobile device (Kukulska-Hulme, 2010). Multiple network connections such as cellular, Wi-Fi, Bluetooth, and Near Field Communication (NFC) provide short- or long-range wireless communication for different mobile devices (Marinagi et al., 2013). Students make use of different types of applications or tools, these include text media (electronic (e-books and pdfs) and printed texts), institutional services (VLEs, library services, lecture recordings and forums), office software (word processing, presentation and spreadsheet software) and general internet tools/services (search engines, email, social networks, wikis, videos, instant messaging and file sharing or storage software) (Zawacki-Richter et al., 2015). The most common digital activity is searching for information online (Dahlstrom et al., 2015; Newman & Beetham, 2017). This is followed by accessing the institutional VLE. Other tools that students access include online collaboration tools, online blogs or discussion tools, software to create multimedia resources, social media and recorded lectures (Dahlstrom et al., 2015). These tools may be housed within the VLE or could be external tools. For university-provided services, students find the VLE, online library services and e-textbooks to be useful. For personal (non-university) services, students rely on internet search engines, audio or video recordings on video sharing sites, specialised academic search services (such as Google Scholar) and social networking sites (such as Facebook) (Henderson et al., 2015).

The web has evolved from a content repository and information mechanism to enable more social mediation and user generated content. Social networking sites enable mechanisms for content production, communication and collaboration. For learning, this means that students and educators can create and share their own content globally (Conole, 2014). Social media encompasses social networking sites as Facebook and Twitter, media sharing sites such as YouTube, and creation and publication tools such as blogs and wikis. Learning interactions are made possible with the use of social media on mobile devices. Social media and mobile devices provide learners with constant connectivity, foster collaborative learning and enable authentic learning on the move (Gikas & Grant, 2013). Device connectivity enables immediacy and fluency where learners can learn together, an important aspect in socially mediated learning (Nortcliffe & Middleton, 2013). Immediacy refers to the ability "to act without delay, to make adjustments and additions" instantly (Barden & Bygroves, 2017, p. 8).

Mobile applications or apps are software programmes developed for use on mobile devices (Pechenkina, 2017). There is an abundance of mobile apps now available, including apps for note-taking, video creation and organisation (Ferran-Ferrer et al., 2014). Apps used by students can be grouped into productivity, organisation, communication and multi-tasking (Nortcliffe & Middleton, 2013). Other categories may include university-specific or general education apps (Chen & DeNoyelles, 2013). Together with promoting third-party apps, universities can develop institutional apps to support teaching and learning. However, many university-developed apps focus on student organisational and administrative aspects, rather than on learning aspects. These include apps for organisation (university life management), navigation and orientation (Pechenkina, 2017). Universities either develop mobile apps available from app stores or develop mobile-friendly interfaces for students to access VLE systems from mobile devices (Chen & DeNoyelles, 2013; Dahlstrom, 2012; Farley et al., 2015; López & Silva, 2014). For example, VLE mobile app versions are available for Android and iOS (Ferran-Ferrer et al., 2014). There is a proliferation of tools to develop mobile apps and marketplaces for publishing them (Chen & DeNoyelles, 2013; Rius, Masip, & Clarisó, 2014). Mobile device operating systems and brands are diverse and there is a need for academic apps that are device-neutral or cross-platform compatible (Dahlstrom, 2012).

Universities can develop "one-stop-shop" (multi-purpose) apps or focus on separate apps for different functions (Pechenkina, 2017). For example, some universities have developed apps for educators to draw on a virtual blackboard while explaining concepts or apps to annotate student assignments on tablets or smartphones (Ferran-Ferrer et al., 2014). Educators can also recommend useful third-party apps for students for various functions such as annotation of course materials, voice recorders and organisers (Farley et al., 2015). If an educator requires the use of a specific app in a course, students need to be informed about this requirement at the beginning of the course and options provided for students without access to a specific device (Chen & DeNoyelles, 2013)

Mobile applications and services are further enabled by the increase in cloud computing. Learning platforms can be integrated with cloud services and different devices to enable cross-context learning (Wong, 2012). For example, collaboration tools such as Google Drive can be used to share files for use in different contexts in a way that is device independent and works across platforms (Lai, Khaddage, & Knezek, 2013). Cloud computing moves processing, data and applications away from specific hardware hosts onto internet services (Traxler, 2010). Cloud computing enables the storage and access of extensive educational resources and provides virtual infrastructure and services, instead of storage on personal mobile devices. Mobile learning has been limited in the past by the low processing power and memory constraints of mobile devices, expensive network connection costs, slow network transmission and limited mobile-friendly educational resources (Li, 2010, as cited in Wang, Chen, &

Khan, 2014). These limitations can be overcome with the use of cloud computing that provides massive data storage, high performance computing and easy access (Dinh et al., 2011, as cited in Wang et al., 2014).

3.3.6 Learner Mobility and Study Locations

Researchers are interested in the locations where students study. This includes the stationary environment of the home, in which most studying occurs, as well as in emerging spaces (Cross et al., 2015). Mobility refers to the ways educational practices can be enacted in almost any location (Traxler, 2009). Learning can take place in spaces such as home or work environments, and to a lesser extent on public transport (buses and trains). While the home environment is often used for studying, students have to choose to study among a multitude of impulses or activities in their home situations (Sølvberg & Rismark, 2012). As previously discussed, mobility is an important aspect for ODL learners. Learners do sometimes learn "on the move" when using public transport such as buses and trains, however, Parsons (2014, as cited in Brown & Mbati, 2015) notes that learners rarely learn while physically moving and that mobility refers to students taking their learning tools along with them to different places. Each learning space has different features that affect how learning occurs. Interactions between participants, the use of mobile technologies and learner perceptions of the student role differ across learning spaces. Students can learn seamlessly, by moving "between various times and places, moving from topic to topic and in and out of technology use" in ways that enhance their learning (Sølvberg & Rismark, 2012, p. 30).

The combination of mobile technology and mobility generates a mobile culture where a learner's specific needs in relation to their current location and context become important stimuli for learning designs. Mobility and physical context are important descriptors in a student's use of mobile devices, while educators "make little reference to how these aspects may impact on how learners behave and what they are expected to achieve" (Kukulska-Hulme, 2010, p. 9). Learners "want to make the best use of their time, wherever they happen to be; yet educators are not used to thinking about time use and the realities of their learners' lives" (Kukulska-Hulme, 2010, p. 9). Educators need to take into account the features of various learning spaces when planning student learning and establishing educational practices (Sølvberg & Rismark, 2012). The learner's experience is affected by lighting, ambient noise and the environment of use. Time and context considerations need to feature in the design of learning. There is a need for "more explicit mapping of what is expected of learners and how mobile technology can help realize these goals" (Kukulska-Hulme, 2010, p. 9). Emerging technologies call for new spaces that "capture the interrelatedness between student learning, times, places, topics and technologies" learning (Sølvberg & Rismark, 2012, p. 30). Finding out about current mobile learning practices involves listening to learners and seeking ways to extend these practices (Kukulska-Hulme, 2010).

Knowledge about how students move about and the choices they make can help educators design more appropriate educational practices to meet the needs of their students (Sølvberg & Rismark, 2012).

3.3.7 m-Learning Learner Support

Student support focuses on the mediated conversation between students and the educator through integrated and structured dialogue in the learning materials and in other development interventions. Mobile learning can be used to facilitate synchronous and asynchronous communication to support and facilitate interactions between individuals and groups. Basic mobile phones can be used for self-assessment quizzes or listening to audio materials, while assessment feedback and course reminders can be sent via text messages. Students can also communicate in groups via instant messaging (Makoe, 2012). Email provides a personal asynchronous form of communication that documents conversations, while the VLE provides a variety of interaction opportunities that are also stored (Dahlstrom et al., 2013). Students prefer the use of email or the VLE to communicate electronically with educators, while preferring instant messaging to communicate electronically with other students (Dahlstrom, 2012; Dahlstrom et al., 2013). Educators have explored the use of mobile instant messaging tools, such as WhatsApp, to communicate with, and support, students (Rambe & Bere, 2013; So, 2016).

When students need technological support or assistance for academic work, most students make use of online searches to find resources via Google or YouTube. Students also look to those close to them for immediate technological assistance (peers, family or friends). Students also reach out to educators or tutors, while a minority of students make use of institutional helpdesks (email, phone or self-service) (Dahlstrom & Bichsel, 2014). Lack of technical support is a commonly cited reason for students not wanting to use mobile apps and devices in their courses (Chen et al., 2015). Educators need to provide adequate technical support to students using mobile apps and devices (Chen et al., 2015; Cheung, 2012). Logistical support is equally important. Students overcome logistical issues with the support from their educator and each other (Gikas & Grant, 2013). Registration requirements about technologies, digital skills and levels of connectivity required need to be clear as well as how students can access technical support channels, such as call centres (Council on Higher Education, 2014).

3.4 Key Trends and Issues in m-Learning in Higher Education

The aim of this section is to review key trends and issues in mobile learning in higher education. It starts by considering the potential of mobile learning in higher education and then considers the actual low adoption of mobile learning. The use of mobile learning is not only affected by devices, but by the digital literacy skills of students. Another trend promoted by mobile learning is the blurring between formal and informal learning. This is followed by an exploration of the support provided by educators (and their professional development) and the institution. The changes in ownership of technologies are highlighted by the proliferation of Bring Your Own Device (BYOD) strategies and these changes highlight the move to learner-centred education, where students have more control over their learning.

3.4.1 The Potential of Mobile Learning: Anytime, Anywhere Learning

Mobile devices have the potential to change how students learn (Chen et al., 2015). In an age of personal and technical mobility, mobile devices are carried anywhere. This creates opportunities for different learning designs: linking real and virtual worlds, creating communities for people on the move and providing expertise on demand to support lifelong learning (Sharples et al., 2009). Mobile learning is attractive for students because of the convenience, flexibility, engagement and interactivity (Chen & DeNoyelles, 2013), especially the quick access to course resources (Reid & Pechenkina, 2016). Many students that enter higher education expect to use their mobile devices as part of the educational process (Guhr & Gair, 2013, as cited in Green, Naidoo, Olminkhof, & Dyson, 2016). Universities have responded by optimising the access of course announcements, grades, email services and course materials from mobile devices (Dahlstrom et al., 2015; López & Silva, 2014; Walker et al., 2016). The advantages of using mobile devices for learning are accessing information quickly, constant communication opportunities, a variety in ways to learn and promotion of situated learning (Gikas & Grant, 2013). Another advantage is that mobile phones can reach rural students who may not have access to other technological devices (Makoe, 2012). The emergence of smartphones, tablets and e-readers provide learners with access to others and a wider range of learning materials (Conole, 2014). Applications on mobile devices enable students to discover, consume and produce content easily (Chen & DeNoyelles, 2013; Chen et al., 2015). Several studies refer to the affordances of mobile devices. Although the use of the term can be problematic (Wright & Parchoma, 2011), it is commonly used in the literature. Affordances refer to "the potential and perceived range of actions made possible by an object or an environment", specifically the main properties that determine the possible uses (Norman, 1988, as cited in Ellaway, Fink, Graves, & Campbell, 2014, p. 137).

Traditional educational provision is built around time and place; however, university services, connections, discussions and content are no longer constrained by physical space or time (Ng et al., 2010, as cited in Nguyen et al., 2015; Traxler, 2010). Formal learning occurs in fixed, physical spaces and is situated in fixed temporal slots such as teaching periods, timetables and semesters (Kearney et al., 2012; Traxler, 2009). m-Learning can transcend these spatial and temporal restrictions. A variety of alternative spaces become available, including virtual or non-geographical spaces. In temporal terms, individuals can be more flexible about when they learn. However, further research is required to explore the time-space continuum in more detail and how it could be organised to enhance learning mediated by mobile technologies (Kearney et al., 2012).

Mobile learning allows students to access flexible education and the personalisation of learning experiences (Johnson et al., 2011, as cited in Nguyen et al., 2015). Ubiquitous computing is taken for granted, with students and educators "constantly connected to a network of online environments, allowing them to engage in learning anywhere and at any time" (van Oostveen et al., 2011, as cited in Green et al., 2016, p. 52). Mobile learning enhances learning effectiveness by enabling greater flexibility in time and locations for learning and can encourage active and collaborative learning (Cheung, 2012). Wireless portable devices can be used "anywhere and anytime to interact with other learners to share information and expertise, complete a task or work collaboratively" (Ally & Prieto-Blázquez, 2014, p. 144). Students perceive that using apps and mobile devices increases communication and interactivity with other students and educators (Chen & DeNoyelles, 2013; Chen et al., 2015). The conversational, connected aspects of m-learning enable collaboration through conversation and information sharing (Kearney et al., 2012). Notions of "anytime, anywhere" learning have been widened "through any device" and "with the support of anyone" (European Commission, 2013).

Context is critically important in mobile learning (Sharples et al., 2009), with the aspect of authenticity considering opportunities for contextualised, situated and participatory learning (Kearney et al., 2012; Schroeder, 2013). Mobile learning can take place in situated informal settings such as educator-mediated experiences in semi-formal locations such as museums and libraries or more self-determined experiences in public locations such as cafes and public transport (Luckin, 2010, as cited in Kearney et al., 2012). Naismith & Corlett (2006, as cited in Sharples et al., 2009) identified several critical success factors for mobile learning projects: i) access (making technology available when needed, either prescribed or own devices); ii) ownership (personal ownership or treating a device as personal); iii) connectivity (to access resources and to communicate and share with others); iv) integration (integrating mobile learning projects into the curriculum or student life); and v) institutional support (mobile-friendly formats, training and technical support).

3.4.2 The Low Adoption of Mobile Learning

Despite high student access to mobile devices, universities have not been able to change teaching and learning practices to take advantage of this (Farley et al., 2015). Although students and educators have similarly high levels of interest in using mobile devices to enhance learning and make use of these technologies, the use of mobile devices is currently limited in most universities (Dahlstrom et al., 2015; Kobus, Rietveld, & Van Ommeren, 2013). Most mobile technologies never became formally or fully integrated into higher education (Traxler, 2016), while levels of mobile learning in ODL are low and have yet to reach mainstream practices (Zawacki-Richter et al., 2009). Mobile devices have not been embraced by educators as "engaging teaching and learning tools, and students have yet to see the value in using them for their academic work" (Dahlstrom & Bichsel, 2014, p. 19). There is a gap between the number of students who own mobile devices and those that use their devices for learning. Universities need to find ways to reduce this disparity (Chen & DeNoyelles, 2013).

Mobile learning has faced several difficulties becoming embedded in institutions and thereby achieving its full potential. Many developmental m-learning projects did not become embedded due to financial and cultural challenges. Finances were limited because the innovation appeared to be an extra cost for an unquantified benefit, while cultural challenges existed because innovators were driven by different ideals and objectives to mainstream educators and managers (Traxler, 2016). Project sustainability was difficult due to small sample sizes, where budgets were required for new devices. Due to advances in technologies and searches for funding, researchers tended to move from one innovation to the next, further reducing sustainability (Traxler, 2016). Hew & Brush (2007, as cited in Farley et al., 2015) suggest that mobile learning barriers include a lack of resources, lack of knowledge and skills, institutional issues, educator attitudes and beliefs, assessment issues and a non-conducive subject culture. A significant commitment is required to change leadership, pedagogy and infrastructure in order to engage with mobile learning. For example, educators need to change their teaching strategies, yet struggle with the time pressures to do so (Farley et al., 2015).

Students actively look for ways to use their mobile technologies to support their learning to take advantage of "anywhere, anytime" learning. However, little has been done to integrate mobile learning into online learning materials and activities (Andrews & Tynan, 2012). This incompatibility may be less about the technology, but more about educational models that limit the opportunities for informal learning. For example, "simply providing access to a smartphone, without specific directed learning activities, may actually be detrimental to the overall learning process" (Tossell et al., 2015, p. 723). Similarly, the learning design can limit the mobility of learners when materials are difficult to use in flexible ways (Andrews & Tynan, 2012).

There are other reasons for the low adoption of mobile learning. Gikas & Grant (2013) found that educators are seen as anti-technology in class. Other issues limiting mobile learning include privacy and a lack of guidelines on acceptable conduct (Kukulska-Hulme, 2010). Interestingly, challenges identified in early m-learning projects still remain relevant today: scale, sustainability, inclusion, personalisation and the blending of established and emerging educational technologies, as well as tracking changes in technologies (Traxler, 2009).

For some students, factors limiting the uptake of mobile learning may include the costs of devices and limited availability of internet access (Murphy et al., 2014). Screen size can be a barrier for some students, although larger screen devices may diminish, but not eliminate, this issue (Rajasingham, 2011). Another issue is that learners in rural areas do not enjoy the same access to wireless infrastructure as those in urban areas. Low-bandwidth restricts the use of materials such as audio and video streaming and downloading of large files. The majority of devices in rural areas are likely to be less expensive devices. In developing countries, monthly voice and data contracts are unaffordable for many people who rely on more expensive "prepaid" options. Thus, for learners in low income communities, internet access can be very limited and expensive (Brown & Mbati, 2015).

Mobile technologies are often perceived as a distraction in traditional learning environments, a concern shared by both educators and students (Chen et al., 2015; Dahlstrom & Bichsel, 2014). Many educators consider mobile devices to be distracting in class, with 55% discouraging or banning the use of mobile devices in class (Dahlstrom & Bichsel, 2014). Students feel that these devices can distract them from class activities just as easily as they can improve learning experiences (Dahlstrom et al., 2013). In class, students use laptops more than other devices for academic activities (such as notetaking, accessing learning materials or educator-directed activities), while smartphones are used more for non-class activities (such as checking email or texting) (Dahlstrom et al., 2015).

An idea linked to the narrative of digital natives is that they are adept at "multiprocessing" or multi-tasking (Brown, 2000, as cited in Bennett et al., 2008). Mobile devices promote multi-tasking behaviour as they are pervasive and can be used in diverse contexts (Nortcliffe & Middleton, 2013). Although mobile devices provide opportunities to immediately record and share information, multi-tasking while engaging in learning is not a new phenomenon (Bennett et al., 2008; Nortcliffe & Middleton, 2013). There are questions about the quality of learning when multi-tasking (Nortcliffe & Middleton, 2013) due to the distraction (Chen & Yan, 2016) and the "loss of concentration and cognitive 'overload' as the brain shifts between competing stimuli" (Bennett et al., 2008, p. 779). 52% of students in an ECAR survey felt that multi-tasking with their devices prevents them from concentrating in class (Dahlstrom et al., 2015).

3.4.3 Digital Literacy Skills and Skills Development

Alongside traditional communication and numerical skills, digital literacy skills have emerged as important skills for educators to develop in their students (Wright et al., 2014). Everyday technological practices undertaken by technically adept young people do not imply a relevance to educational activities as many of these skills relate to quick searches for immediate answers. Education has an important role to develop digital literacies to support learning (Bennett et al., 2008). Effective use of mobile devices means that students have the required digital literacy skills to access, manage and evaluate digital resources (Chen & DeNoyelles, 2013). Recognising the significance of digital literacy skills for lifelong learning in the 21st century, researchers have developed frameworks such as the DIGCOMP framework to enhance digital competences (Ferrari, 2013). Digital literacy can be an issue for both staff and students, with the level of digital competency varying widely (Andrews & Tynan, 2012; Brown & Mbati, 2015). For the use of mobile technologies, students consider the development of skills and technical training important. Students need support and guidance on how to use their mobile technologies effectively for learning (Chen & DeNoyelles, 2013; Reid & Pechenkina, 2016). Even though most students feel prepared to use technologies at university, many students want or need to develop better technology skills (Dahlstrom, 2012). However, this training needs to be integrated into the design of each course as the need or the occasion to use the technology arises and not as separate courses or resources (Dahlstrom et al., 2013).

3.4.4 Formal versus Informal Learning

One of the challenges for educators is understanding not only what their learners learn, but also how and when they learn. Learning can be seen as a continuum between formal and informal, with the degree of formality determined by the extent of control learners have over the learning process (Bernstein, 1971, as cited in Lai et al., 2013). Many educators want a better understanding of "how learners learn informally, and use that understanding to inform formal and informal learning practices" (Looi et al., 2010, p. 2). Most mobile learning research focuses either on enhancing formal learning or understanding informal learning. Formal learning looks at the use of portable technology to support curriculum learning in the classroom, such as the use of mobiles for handheld response systems, sending questions via text messaging, small group learning or participatory simulations. Informal learning looks at the use of personal mobile technologies for learning on the move, such as self-directed language learning and the weaving of devices into every day practices and leisure activities (Sharples, 2013). Informal learning and formal learning may be linked, because opportunities for informal learning are diminished in the absence of formal learning requirements (Tossell et al., 2015). Educators, as well as learners, are able to share expertise and learn informally from one another through social media and online support networks. Mobile access enlarges those communities and networks. Learners are increasingly engaging in educational activities motivated by their personal needs and circumstances. For example, language learning is one of the most popular areas for mobile learning, with a wealth of formal and informal mobile tools and resources available (Kukulska-Hulme, 2010).

Mobile learning often provides learning opportunities outside of a formal learning environment, with the use of personal mobile devices (Brown & Mbati, 2015; Chen & DeNoyelles, 2013; Murphy et al., 2014). Informal learning environments are "characterised by fluid geographical boundaries and malleable, socially negotiated time frames" (Kearney et al., 2012, "Conclusion", para. 2). Learning is "interwoven with everyday activities that take place in everyday locations", such as workplaces, outdoors and places of leisure (Sharples et al., 2005, as cited in Brown & Mbati, 2015, p. 122). Students may use a variety of apps for informal learning which makes it challenging to determine which apps students use and how they use them for academic purposes (Chen & DeNoyelles, 2013), leading to lower research within informal learning settings (Wright & Parchoma, 2011). From research and design perspectives, "mobile learning in informal settings is challenging because students are 'on the move' across different modes of space (both physical and virtual) and time" (Looi et al., 2010, p. 8).

A concept related to the use of social media and informal learning is a Personal Learning Environment (PLE). Learners can develop and manage their own learning environment through the use of apps and social media (Brown & Mbati, 2015; Maina & García-González, 2016). A PLE is a collection of tools used by a learner to meet their needs as part of their normal work and study routines. Learners make use of different devices, applications and services (Wilson et al., 2006, as cited in Martindale & Dowdy, 2016). PLEs demonstrate that people learn informally through the use of a variety of networks and sources, both online and offline (Martindale & Dowdy, 2016).

Another consideration is the separation between personal and academic use. Some students perceive that their personal devices are to be used for personal reasons and not for learning (Murphy et al., 2014). Many students prefer to keep a boundary between their personal and academic lives in their use of technology (Dahlstrom et al., 2013). Although students use technologies (such as social networks) regularly as part of their day-to-day lives, this is driven by personal and social demands and does not mean that they want to use the same technologies for educational use (Bates, 2015; Dahlstrom, 2012). These students will use emerging technologies for learning where educators "make a good case for it and when students can see that the use of digital media will directly help them in their studies" (Bates, 2015, p. 447). The use of social media and devices for both learning and social purposes means a blurring of boundaries between formal and informal learning (Gikas & Grant, 2013; Sharples et al., 2014, 2009).

The blurring of boundaries means that formal learning activities can be extended outside of traditional education (Schroeder, 2013) and educators can help learners move between informal and formal learning. For example, taking photographs and sharing them with others is a popular and easy activity to extend informal interest into more formal learning (Kukulska-Hulme, 2010). Devices can be used to document off-screen learner activity such as photographs of a nature study or an audio or video recording of an oral or gestural performance (Cope & Kalantzis, 2009, p. 8). A focus for educational institutions should be meaningful engagement within a range of formal and informal learning practices via mobile applications (Lai et al., 2013).

3.4.5 Educator Use of Technologies and Professional Development

The potential for digital technologies to support "learning opportunities depends on the skills used to design learning activities that align pedagogy and technology for the benefit of learners" (Gros, 2016b, p. 4). Most students do not believe that educators harness the potential of mobile devices to deepen learning (Brooks, 2016). Educators more commonly use the VLE to "push out" information such as curricula and resources, rather than to promote interaction through discussion forums and collaborative assessments (Dahlstrom et al., 2015). Some educators are more willing to interact with students using the variety of online tools available, while others are more reticent (Andrews & Tynan, 2012). Educator attitudes and the lack of professional development have inhibited the adoption of emerging technologies. As educators face considerable time constraints, finding time to keep up to date with technological trends can be difficult (Johal, 2012, as cited in Green et al., 2016). Students are unlikely to have encountered pedagogical approaches that use mobile devices (such as tablets) for learning in a meaningful way. Educator reluctance to engage with mobile technologies, combined with limited student experience, results in "a lack of student motivation to question whether tablet technology could be used in a more constructive way" (van Oostveen et al., 2011, as cited in Green et al., 2016, p. 52).

The challenge of appropriate staff development is an ongoing one (Andrews & Tynan, 2012). Educators need to be empowered with the relevant skills to utilise the affordances of mobile technologies to engage and support students (Makoe, 2012; Rajasingham, 2011). Educators need to overcome their reservations about harnessing student technologies for academics. This can be accomplished by engaging in skilful, thoughtful and effective uses of technology that are grounded in empirical research (Brooks, 2016). The strongest motivator for educators to integrate technology into their courses is a clear indication or evidence that students would benefit from its use (Dahlstrom, 2015; Dahlstrom et al., 2015). Other motivators are time to design or redesign courses integrating new technologies and confidence that the technology would work out as planned (Dahlstrom, 2015). Students expect their educators to make use of technologies in the learning process, but little training is provided for educators on the use of these technologies in courses. Understanding the practices of students can guide informed professional development (Chen & DeNoyelles, 2013). Universities should offer professional development to help educators learn and integrate mobile technologies into their curricula. Helping educators incorporate strategic, pedagogically sound uses of technology into their teaching and learning practice can facilitate a sense of student connectedness and engagement. Students tend to be more positive of educator use of technology when educators themselves are able to choose which technologies to implement (Dahlstrom, 2015). Appropriate training and support for educators is important to acquire the necessary competencies to ensure broad implementation (Ferran-Ferrer et al., 2014). Educators can seek assistance from instructional designers to design or redesign courses and participate in technology-oriented professional development opportunities (Brooks, 2016).

Although students use devices for personal use, they have a limited understanding of how these technologies may support learning and are dependent on guidance from educators (Ellis & Goodyear, 2010; Gikas & Grant, 2013; Margaryan et al., 2011). Students will "respond positively to changes in teaching and learning strategies that include the use of new technologies that are well conceived, well explained and properly embedded in courses" (Jones and Shao, 2011, as cited in Bates, 2015, p. 264). Thus, there is a need to continue to support educators "in becoming more proficient and/or inspiring in their own uses of technology" (Selwyn, 2016, p. 1019). Universities and educators need to engage with how emerging technologies add value to the educational experience (Guhr & Gair, 2013 in Green et al., 2016). Advocacy for the greater use of technology "in teaching and learning is ineffectual without the context of how it could result in better learning outcomes, why it could result in a less effortful teaching or learning experience" and if it would result in better student engagement (Dahlstrom, 2015). Educators should use sound pedagogical practices to support their mobile learning practices, designing activities to support a meaningful learning purpose or outcome (Chen & DeNoyelles, 2013; Reid & Pechenkina, 2016; Sharples et al., 2009).

3.4.6 Institutional Support

When educators do want to embrace mobile learning, they often face infrastructure and institutional support challenges (Chen et al., 2015). Determining how best to incorporate technology into academics requires a partnership between students, educators and the university (Dahlstrom et al., 2013). There is a need for university policies and the appropriate pedagogical and technology support for staff and students in their adoption of emerging mobile technologies (Chen et al., 2015; Nguyen et al., 2015). Policies, at national and local levels, can impact mobile learning (Vosloo, 2012). Institutions need to ensure that academic staff have adequate training in the emerging technologies and educational practices "necessary for the development of the knowledge and skills required in a digital age" and provide the necessary learning technology support (Bates, 2015, p. 415).

The perspective of mobile learning as an extension of e-learning aims to provide mobile access to course materials and VLEs (Rius et al., 2014; Schroeder, 2013; Zawacki-Richter et al., 2015). Students make use of the institutional VLE and value it as important to the student experience, particularly seeking a mobile-friendly, personalised and engaging VLE experience (Dahlstrom & Bichsel, 2014). Institutions are recommended to be mobile-ready and create systems for guiding students and educators to incorporate mobile devices into curricula and pedagogy (Dahlstrom & DiFilipo, 2013). Mobile versions of the VLE should not just duplicate the functions of the web version, but take advantage of the features of mobile devices (Han & Han, 2014). Several studies have investigated the use of a mobile VLE in ODL universities (Han & Han, 2014; Shin & Kang, 2015) or deployed cloud-based VLEs to support mobile device access (Wang et al., 2014).

Some of the strategies available to universities to promote mobile learning are to increase the use of text and instant messaging, deploy web-based apps for student support and initiate discussions around the changing codes of acceptable use (JISC, 2012, as cited in Traxler, 2016). Another institutional strategy is the use of Universal Design for Learning (UDL) so that students are "provided with multiple ways of accessing information" and "multiple ways of demonstrating what they have learned" (Fidaldo & Thormann, 2017, p. 140). To facilitate multiple devices and mobile learning, learning materials should be provided in a variety of formats, for example, documents in pdf, html, doc or epub formats as well as audio and video formats (Bates, 2015; Farley et al., 2015; Ferran-Ferrer et al., 2014; López & Silva, 2014). Text, audio and video formats can be created from an XML file to provide different formats (Ferran-Ferrer et al., 2014). The same course content can be provided in various formats such as text, voiceover presentations, videos or screencasts. Videos and other visuals can be used to support text materials, while alternative assessment formats can be used to promote better learning. However, the use of alternative formats of materials does increase the preparation time and assignment evaluation time for educators (Thormann, 2013, as cited in Fidaldo & Thormann, 2017).

Technologies can continually monitor learning activity so that movements and conversations are stored and assessed as part of learning records (Sharples et al., 2009). Universities collect detailed information about student use of institutional systems (Dahlstrom et al., 2015). Although the use of learning analytics is not widely implemented at many institutions yet, most students are interested in personalised learning opportunities, alerts and recommendations. With personalisation, data privacy concerns need to be considered. The educational environment can be enriched with contextual information; however, this comes with the possibilities for greater surveillance and oversight of students, especially when the information is linked to other educational systems. Students may have concerns about their privacy (Farley et al., 2015; Traxler, 2010). Privacy and security risks related to mobile learning applications include the access of GPS or location-based services to disclose a learner's location through undocumented features or software exploitation and the interception and misuse of learner information (Shuib et al., 2015).

The abundance of tools available means that educators and students need to make informed choices about which technologies to use in which contexts (Conole, 2014). Institutions need to support students and educators to make use of mobile devices for academic purposes (Ferran-Ferrer et al., 2014). Institutions can compile a list of familiar and frequently used academic apps for educators and help them incorporate these apps into their courses (Chen & DeNoyelles, 2013; Ferran-Ferrer et al., 2014).

3.4.7 Bring Your Own Device (BYOD)

Personal devices present challenges to the institutional practices and procedures associated with ICT. Historically, institutions have provided the ICT needed for learning. This affected the applications and privileges that educators and students could access. This is challenged when personal technologies are used to access institutional learning resources and services (Traxler, 2010). Universities can introduce prescribed device programmes to provide staff and students with devices or help them better utilise the devices they already have through Bring Your Own Device (BYOD) policies. Most universities make use of a combination of approaches (Reid & Pechenkina, 2016; Walker et al., 2016). The increasing level of personal ownership of internet-capable devices has led to the need for BYOD policies (Dahlstrom & DiFilipo, 2013; Sharples et al., 2014). To overcome many of the resource issues associated with sustainable mobile learning, educational institutions encouraged learners to bring their own devices (Traxler, 2016). BYOD ties into the notion of seamless learning as learning occurs in multiple places and at multiple times (Reid & Pechenkina, 2016; Sharples et al., 2013). The goal for educational institutions is to provide "seamless operation" for each learner, "regardless of device or operating system" (Brown & Mbati, 2015, p. 126). BYOD is seen as a cost effective alternative to institutions providing technologies (Murphy et al., 2014). However, cost savings for institutions can be elusive as upgrades to infrastructure can balance the cost savings from not providing institutional technologies (Dahlstrom & DiFilipo, 2013). An advantage for students is that they are likely to be more familiar with and competent in using their own devices (Brown & Mbati, 2015; Shim et al., 2013, as cited in Murphy et al., 2014). While BYOD aims to remove the need for university computer labs (Kobus et al., 2013), some studies have found that a proportion of students still make use of university-provided computers on campus, despite their use of personal devices (Henderson et al., 2015).

The financial considerations of not having to provide students with devices is just one aspect to BYOD. User devices cannot be separated from the associated services such as social networking, instant messaging, cloud and other services. Thus, associated with BYOD are BYOT or BYOS that refer to use of technologies or services (Traxler, 2016) or even Bring Your Own Everything (BYOE), where students and staff bring their own "devices, software, apps and cloud-based technology to create a personal computing environment" (Dahlstrom & DiFilipo, 2013, p. 4). Students are equipped not only with their own technologies, but with their personal learning environments and social networks (Sharples et al., 2014).

Although the focus of the literature is the ownership of mobile devices, the willingness of students to bring these devices to university is an equally important issue for the implementation of BYOD strategies (Kobus et al., 2013). Many students choose to bring their own devices to university and favour portable ones such as smartphones and tablets, which provides opportunities and challenges for educators (Chen & DeNoyelles, 2013; Green et al., 2016; Sharples, 2013). However, Kobus et al. (2013) found that many students did not bring their laptops to universities every day because they were cumbersome to carry or made use of university-provided computers. The most common uses for bringing laptops to universities were fit-for-use (for group work), better functionality than university computers and better for quick usage.

There are a number of challenges for institutions regarding BYOD. For example, BYOD strategies may be unfavourable for lower socio-economic students who have less access to technologies (Kobus et al., 2013). However, the majority of challenges seem to be one step away from teaching and learning and relate more to security, support and technological infrastructure issues (Dahlstrom & DiFilipo, 2013). The first challenge is a safe and reliable infrastructure to deal with the numbers of devices, their diversity and unpredictability (Traxler, 2016). IT Departments need to maintain the security of institutional networks and enable Wi-Fi access to a range of possible different devices with different operating systems (Brown & Mbati, 2015; Farley et al., 2015; Newman & Beetham, 2017). A solid security focus can meet most BYOD challenges, with risk management and user awareness being key focus areas (Dahlstrom & DiFilipo, 2013). Usability challenges include ensuring that devices can connect to the network and resources can be accessed from a range of devices "so that web pages display correctly on different-sized screens, and interactive forms work on different platforms" (Sharples et al., 2014, p. 17). BYOD affects technology support and internet access policies (Farley et al., 2015). Resources are needed for learner advice and support. The second challenge is to ensure educational quality, so that, irrespective of ownership, all students have an adequate educational experience. There are also political and ethical issues to ensure inclusion and equality of access (Traxler, 2016).

Related to BYOD, university campus networks need to accommodate different types of devices and operating systems, as well as growing numbers of devices per student. 61% of students try to connect at least two devices to a university network at the same time. Students have an increasingly "always connected" mentality, which is a result of increased device ownership and increased availability of Wi-Fi in commercial places. While mobile data plans can be used in the absence of Wi-Fi, data plans can be expensive (Dahlstrom et al., 2015). The ease of access and reliability of Wi-Fi networks as well as the network performance are important issues for students (Brooks, 2016).

3.4.8 Mobile Devices, Agency and Learning

Almost every student owns more than one mobile device. Not only do students own them, but they spend considerable time, effort and resources choosing, customising and using them. The devices express a part of the owner's values, affiliations, identity and individuality. They "are both pervasive and ubiquitous, both conspicuous and unobtrusive, both noteworthy and taken-for-granted in the lives" of most students (Traxler, 2010, p. 149). The personal nature of mobile devices and the close relationship to the personal self has been emphasised in the literature with terms such as mobile devices being extensions of the body, "embodied" or "prosthetic" (Traxler, 2010). Savin-Badin (2015, as cited in Barden & Bygroves, 2017) refers to people carrying, wearing or holding a constantly connected device as "digital tethering".

The use of technologies such as instant messaging, video sharing, photo sharing and social network tools are integrated into student lifestyles. Mobile phones are used not only for making calls, but also for taking pictures and uploading them to shared spaces, and accessing the web on the move. The use of mobile technologies facilitates "communication, collaboration, sharing and learning in informal settings with their peers, friends and family, unbounded by time and location" (Looi et al., 2010, p. 2). Mobile technologies have changed how students communicate, gather information, and allocate time and attention to learning activities (Chen et al., 2015; López & Silva, 2014). The use of mobile technologies is changing the way people live and learn, for example, social, business and educational boundaries are blurring (Ally & Prieto-Blázquez, 2014). More significantly, the use of computers, mobile technologies and internet services are changing “what we know and how we know it, and hence what we learn and how we can learn it” (Traxler, 2010, p. 153). Anyone “with a smartphone and a network can generate, store, share and discuss images, ideas, information and opinions”, via the cloud and the services it provides (Traxler, 2016, “Looking forward”, para. 8). People can pursue interests specific to them, their location or their community. The devices themselves are important, as are the systems, networks and infrastructures that support them. As greater numbers of students own mobile devices and access information, they will “gain greater confidence, agency and familiarity with the technology exemplified by mobile devices and with the knowledge mediated by them” (Traxler, 2010, p. 154). The notion of human agency refers to the capability of individuals to make choices and act on those choices through the interaction between brain activities and socio-cultural contexts (Bandura 2001, as cited in Sha et al., 2012). The personalisation of learning, through learner choice, has strong implications for agency and autonomous learning (Kearney et al., 2012). Learner autonomy occurs when learners make decisions about how they will engage to meet their needs and address their own situations (Nortcliffe & Middleton, 2013).

Different tools and technologies are adopted by different communities and cultures in different ways and at different rates (Sharples et al., 2009; Traxler, 2010). Technologies that enable learners to perform “new activities may change the way learners perceive and practice old activities and may give rise to additional unpredicted patterns of learning” (Sharples et al., 2009, p. 240). Emerging technologies raise questions concerning the implications for educational institutions where content and expertise is easily accessible online (Conole, 2014). Student devices challenge the role of educators and educational institutions, especially their role as gatekeepers and custodians of knowledge (Traxler, 2010). The challenge to education systems is the shift in “control, authority and agency, represented not by the technologies themselves, but by the social changes around them” (Traxler, 2016, “Looking forward”, para. 10). Mobile learning gives learners the opportunity to “adopt an active stance in relation to the process of learning and to develop their initiative, digital competence, knowledge production and communication” (Kukulska-Hulme, 2010, p. 9). Learners taking control of their own learning processes and experiences is characterised as heutagogy or self-directed learning (Anderson, 2016; Blaschke & Hase, 2016). It “applies a holistic approach to developing learner capabilities, with learning as an active and proactive process”, where learners are “the major agent in their learning, which occurs as a result of personal experiences” (Hase & Kenyon, 2007, as cited in Gros, 2016b, p. 13). Students need to be supported to “become more adept at understanding their own learning needs and gain confidence and skill in managing their own learning” (Ellis & Goodyear, 2010, p. 50). Heutagogy expands the role of human agency in the learning process, where the learner is at the centre of the process and can learn in an autonomous and self-determined manner (Blaschke & Hase, 2016).

The pervasiveness of mobile technologies accelerates the move towards learner-centred education (Kukulska-Hulme, 2010). The portability and versatility of these technologies "has significant potential in promoting a pedagogical shift from didactic teacher-centred to participatory student-centred learning", where educators are facilitators and partners rather than the sole knowledge experts (Looi et al., 2010). Educators need to shift from "being providers of knowledge and resources" to directing "technology-enabled networked learners" (Sharples et al., 2014, p. 17). The perspective of learner-centred strategies enables learners to take more "control of their own learning and better understand how and why they learn" (Schroeder, 2013, p. 108). Developing a learner-centred approach requires knowing the students and helping them to develop the skills needed to use available tools, such as how to search for and evaluate information, how to work together online and how to solve problems (Schroeder, 2013). As an example of the general life skills that students need to develop, the Framework for 21st Century Learning describes the skills, knowledge and expertise students must master to succeed in work and life (Partnership for 21st Century Skills, 2009, as cited in Kukulska-Hulme, 2010, p. 6):

> *Learning and Innovation (creativity, critical thinking, problem solving, communication and collaboration); Information, Media and Technology (information, media and technology strategies); and Life and Career (flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility).*

A number of learner skills, attributes and competencies emerge from this consideration of skills needed for the 21^{st} century. Students are required to be active, inquiring and analytical. They need to be equipped with research and inquiry skills and to be able to exercise independent critical judgement. Students are seen as co-creators and producers of knowledge, who should be able to communicate and cross language or cultural boundaries. Importantly, they need to be motivated and equipped to continue learning over a lifetime. Many educators aspire to use emerging technologies in ways that will enable the development of these competencies, skills and attributes. One approach is to "look at how students are already using their personal mobile devices for life and learning, to see if there is any kind of match between the nature of these mobile device uses and the characteristics that educators" wish to promote (Kukulska-Hulme, 2010, p. 6). A focus on the development of 21^{st} century skills means that educators need to review their pedagogical roles (Gómez-Rey, Barbera, & Fernández-Navarro, 2017).

Mobile devices in the hands of so many students presents challenges and opportunities for the provision of learning and support (Traxler, 2010), such as the opportunity to diversify and expand the teaching and learning environment (Dahlstrom & DiFilipo, 2013). The introduction of emerging technologies requires a change in the pedagogies used and the design of the learning environment. Pedagogical methods and activities need to be redesigned to take advantage of the affordances of m-learning (Brown & Mbati, 2015; Lucke & Rensing, 2014). Educators need to work together to develop emerging educational models and practices that cater for future learners using different and emerging mobile technologies (Ally & Prieto-Blázquez, 2014).

3.5 From a Digital Device to Multiple Devices

This research will look at students' use of multiple devices for learning. The aim of this section is to explore the proliferation of mobile or handheld devices and the implications of the widespread usage of a growing and evolving set of mobile devices. However, the adoption of mobile devices has not replaced the use of fixed devices. Therefore, the use of multiple devices by computer users or consumers on a general level is explored.

3.5.1 Mobile / Handheld Devices

Mobile devices include smartphones, game consoles, digital cameras, media players, netbooks and handheld computers (Traxler, 2010). Mobile devices also include personal digital assistants, basic mobile phones, tablets and wearable devices. They can connect wirelessly, thus ensuring mobility and flexibility. They can be stand-alone, have intermittent access or constantly connected to a network (Zawacki-Richter et al., 2009). Mobile technologies have unique capabilities that include connectivity, cameras, sensors and GPS (Chen et al., 2015). Some researchers refer to later generation mobile devices as "smart" devices (Nortcliffe & Middleton, 2013). Cameras and microphones can be used to collect images, audio and video, while built-in noise, light and temperature sensors can be used to collect data as well (Sharples et al., 2014). It is difficult to imagine everyday life without mobile technologies as the market has increased to near saturation, with new communities, expectations and behaviours (Traxler, 2016).

Mobile devices are diverse and transient, coming in different sizes and shapes, and these change over time (Traxler, 2010). Devices are fragmented with different operating systems, screen sizes and features (Rius et al., 2014). Some devices may not support particular features required by a mobile learning application, such as storage space, camera or screen resolution, screen size and touch screen properties. The differences between capabilities means that learning applications need to be able to support different hardware configurations (Shuib et al., 2015) and ensure that resources are accessible from different devices (European Commission, 2013). Mobile devices typically have a smaller screen size and "an interface that is not well suited to entering large quantities of data" (Rius et al., 2014, p. 195). Table 3.3 distinguishes between the most common types of mobile devices currently available.

Table 3.3: Common Mobile Device Types

Device	Description
Laptop	• Laptops or notebooks have a physical keyboard and larger screen displays and pointing devices to facilitate user interaction. They also tend to have larger storage capacity and run more sophisticated "desktop" applications (Cheung, 2012).
Tablet	• Tablet computers combine the features of smartphones (although not typically telephony) and laptops, with screen sizes in between smartphones and laptops (Chen & DeNoyelles, 2013; Cheung, 2012; Ellaway et al., 2014). • Tablets have virtual keyboards, but a separate keyboard can be bought for typing (Green et al., 2016).
Smartphone	• Smartphones provide the core range of basic mobile phone functions, but with the computing capability to allow additional software tools (or apps) to be installed. They also have extended multimedia capabilities (Ellaway et al., 2014). • Smartphones have smaller displays, but are smaller, lighter and usually have longer battery lives than larger devices (Cheung, 2012).
Basic mobile	• Basic mobile or feature phones provide a fixed range of applications, including basic telephony, texting and personal information management, with some phones providing basic internet services such as email or web browsing (Ellaway et al., 2014).
e-Reader	• An e-book reader (or e-reader) is designed for reading electronic books (e-books). It is typically smaller, lighter and cheaper than a laptop computer and uses black-and-white e-ink technology instead of an LCD or backlit screen (Nie, Armellini, Witthaus, & Barklamb, 2011).
Wearable technology	• Wearable technologies include fitness devices, headsets and smartwatches (Brooks, 2016; Dahlstrom et al., 2015).

Due to ongoing changes in devices, it is becoming more difficult to distinguish between different devices. Recent mobile devices have greater functionality and connectivity than previous devices (Murphy et al., 2014). There is blurring in the tasks supported by smartphones and tablets, particularly as smartphone screens have become larger (Garg, 2015). For example, touchscreen laptops and docking keyboards for tablets blur the lines between laptops and tablets (or "laplets"), while large-screen smartphones approach the size of tablets (or "phablets") (Dahlstrom et al., 2015). It is expected that mobile technologies will continue to become more popular, personal, robust, cheap and social (Cope & Kalantzis, 2009; Traxler, 2016). Mobile devices will look different in the future, with technologies having virtual input and output capabilities. Another future prediction is the growth of the Internet of Things (IoT) where physical objects are "embedded with electronics, software, sensors and connectivity to enable objects to collect and exchange data" (International Telecommunication Union as cited in Dahlstrom et al., 2015).

An important point for educators and researchers to bear in mind is that mobile devices are designed and developed for different purposes, however, they are not designed for learning. Educational technology has always been "parasitic", co-opting desktop computers, then laptops and mobile devices for learning. None of these technologies were intended for educational use and so they continually challenge educators to develop appropriate educational applications (Traxler, 2010). As mobile learning frequently takes place on devices not designed for educational purposes, usability remains a challenge

(Sharples, 2013). A key point for educators to remember is that mobile devices may not be suited for learning, they will be different and they will change over time (Traxler, 2010).

There is some uncertainty whether laptops are mobile devices, with some researchers identifying them as such, while others view laptops as not mobile enough (Brown & Mbati, 2015; Traxler, 2009). Many researchers prefer to refer to mobile devices as handheld devices because they can be operated in the hand, enabling greater mobility (Brown & Mbati, 2015). Cross et al. (2015, p. 3) prefer to use the term handheld "because some handheld devices evidently remain geographically fixed". This study will make use of the term handheld devices going forward to refer to tablets, smartphones, basic mobile phones and e-readers, while referring to desktops and laptops as fixed devices.

3.5.2 Multiple Device Use by Consumers or General Users

The number of digital devices that people own is growing. Users "incorporate multiple devices into their lives, including desktop computers, laptops, mobile phones, digital cameras and media players" (Dearman & Pierce, 2008, p. 767). Google (2012) found that consumers spent their time using a range of devices in a day, including smartphones, tablets, laptops/computers and televisions. Users "engage in activities that span devices, rather than just using different devices for different tasks", thus using multiple devices to support tasks (Dearman & Pierce, 2008, p. 767). Users do not use their devices in the same ways, they assign different roles to devices, either by personal choice or by constraint. People use multiple devices to improve their access to information and computation, but this requires management across different devices, each with unique affordances and limitations (Dearman & Pierce, 2008). Devices offer flexibility; however, they can cause the blurring of boundaries, leading to perceptions of heavier workloads and greater stress. Some people use multiple devices as a way to create a boundary between work and home. Yet, the management of home-work boundaries is complicated with the use of BYOD, where use is often determined by factors outside the control of the individual (Fleck, Cox, & Robison, 2015).

Users reported using multiple devices because different devices have different forms and affordances. The physical design (display size and orientation) and the modes of interaction (keyboard, mouse, finger etc.) influence the suitability of a device for a specific activity. The use of a specific device is driven by context: the time available, the goal to accomplish, the location and state of mind (Google, 2012). Because handheld devices are portable, they allow users to choose the setting to perform their tasks. Specific devices are also chosen based on how quickly they can complete a task (Dearman & Pierce, 2008). Computers are mainly used for productivity and being informed, smartphones are mainly used to keep connected, while tablets are mainly used for entertainment (Google, 2012).

Consumers made use of multiple screens, either sequentially (moving from one device to another at different times to accomplish a task) or simultaneously (using more than one device at a time for a related or unrelated activity). Smartphones are the most frequently used devices during simultaneous usage, while most simultaneous usage involved multi-tasking (Google, 2012). There are three reasons why users work with multiple devices: i) multi-tasking is required for complex tasks; ii) a secondary task is allocated to a secondary device such as needing additional screen space to look at information; or iii) tasks are transferred across devices because of hardware or software needs (Dearman & Pierce, 2008). The first two reasons result in simultaneous usage, while the third reason results in sequential usage. In order to manage information across multiple devices, users make use of different mechanisms such as portable media (USB memory stick), emailing files to themselves or cloud services. Cloud services were becoming more prevalent, but current automatic synchronisation was not trusted. In addition to files, users also wanted to share interaction histories such as browser and chat logs (Dearman & Pierce, 2008).

3.6 Use of Different Devices for Study

The aim of this section is to explore how different devices are used for study purposes. The differences between learning interactions with fixed devices and handheld devices are highlighted. Then the use of specific devices for specific learning activities are considered. Fixed technologies, such as desktops and laptops, are considered first. This is followed by an exploration of handheld devices, such as tablets and phones. The use of multiple devices for study is then explored.

3.6.1 Learning Interactions: Fixed versus Handheld Technologies

The patterns of use (the various ways in which people interact with technologies) differ when comparing sedentary desktop technologies with personal handheld technologies, in terms of mobility and contexts of use (Kukulska-Hulme, 2010; Traxler, 2010). Interacting with a desktop computer takes place in dedicated times and places where the student is focused for a substantial and probably premeditated period. Interacting with handheld technologies is different and is woven into the different times and places of students' lives (Traxler, 2009, 2010).

The emergence of the tablet computer has meant that handheld devices can be seen as more than just "readers" (Cross et al., 2015). For many tasks and in many cases, handheld devices are a possible replacement for laptop or desktop computers. Students can use their handheld devices to undertake "increasingly sophisticated learning activities previously only possible with computers" (Murphy et al., 2014, p. 342). However, most educators feel that handheld devices will be only be some of the devices used for learning rather than replacing desktops and laptops (Zawacki-Richter et al., 2009). Handheld devices are used for a range of study tasks. Much of the learning activity undertaken on handheld devices is migrated activity from fixed devices. Yet, alongside migrated tasks, handheld devices enhance the study experience by undertaking activities the student would otherwise not have done (Cross et al., 2015). While they may not be a replacement for all computer-related tasks, handhelds do offer new interactions (Ferran-Ferrer et al., 2014; Rius et al., 2014).

Connected handheld devices enable students to access and store all sorts of knowledge wherever they are and almost instantly, with very little effort. Different types of information are easily accessible on mobile phones: text, images, audio and video. Handheld devices deliver this information chunked, structured and connected in different ways from other educational delivery mechanisms such as the lecture, the book and the web (Traxler, 2009, 2010). Knowledge is affected by how it is stored, transmitted or consumed. With handheld devices, small pieces of learning (such as short videos) can be easily presented but their relationships to others may be difficult to understand, thereby fragmenting what students learn (Sølvberg & Rismark, 2012; Traxler, 2010). The fragmentation of learning experiences is a common concern for educators as mobile learning is highly susceptible to interruptions (Tossell et al., 2015).

3.6.2 Use of Desktops for Study

Until relatively recently, desktop computers were the main digital devices used to support learning activities (Murphy et al., 2014). In the past, universities provided desktop computers in laboratories for students. However, student use of university-provided desktops in laboratories now comprises only a small part of study-related computer use (Kobus et al., 2013). For students who use university-provisioned desktops on campus, the most common reasons for use were to access print services, to use as a laptop substitute and to access library resources (Dahlstrom et al., 2013). As noted previously, students' use of desktops usually occurs in dedicated times and places for substantial periods of time (Traxler, 2010). Desktops are typically used for accessing or reading course materials, online searches, emailing and accessing the VLE (Murphy et al., 2014). They can also be used to prepare assignments.

3.6.3 Use of Laptops for Study

Laptops or notebooks tend to replace stationary desktop computers (Zawacki-Richter et al., 2015). Laptops are the quintessential academic tool for undergraduates. The larger screens and keyboards of laptops make them more usable for students than the portability offered by tablets and mobile phones (Dahlstrom, 2012). Research on the efficacy of using laptops in classrooms in higher education has produced mixed results. Studies have identified clear benefits to using laptops in class such as keeping students engaged and on-task, however, researchers have also observed off-task use. Kay & Lauricella (2016) divide laptop use in higher education into academic use (note-taking, web-based research, communication, organising, using software and web-based interactive tools) and non-academic use (personal emails, web surfing, instant messaging, playing games, watching web-based media and social media). Several factors can influence the use and effectiveness of laptop use in the classroom including the teaching and learning strategies, classroom management, student motivation and engagement, and the type of course content. There is a shortage of studies that examine student use of laptops outside of class, for example educators could describe and disseminate patterns of behaviour or use that might be helpful to students (Kay & Lauricella, 2016). This study will explore how ODL students make use of laptops (together with other devices) for study and identify any patterns of behaviour.

3.6.4 Use of Handheld Devices (General) for Study

The most popular activities that students use their handheld devices for are to communicate with other students, to check grades, look up information and access the VLE. 78% of students considered it important to be able to access the VLE from a handheld device (Dahlstrom & Bichsel, 2014). Students can use their mobile phones, smartphones and media players to create, collect and access useful educational resources and to communicate with educators and students wherever they are located (Ally & Prieto-Blázquez, 2014; Gikas & Grant, 2013; Kukulska-Hulme, 2010). Students can also make best use of their time wherever they are (Kukulska-Hulme, 2010), for example, while commuting, on a trip or while waiting, thus extending traditional study times and locations (Ferran-Ferrer et al., 2014). Handheld devices, together with social media, allow for instant sharing of different types of media (Brown & Mbati, 2015; Schroeder, 2013). The following sections discuss the use of specific mobile devices: tablets, mobile phones and e-readers. Some researchers have also looked into the educational affordances of wearable technologies (Bower & Sturman, 2015).

3.6.5 Use of Tablets for Study

Tablets are useful devices for consumption (such as sourcing information and communicating) (Dahlstrom, 2012) or content presentation (interactive self-learning modules, e-books) (Zawacki-Richter et al., 2015). They are useful for reading digital books or online content and reviewing multimedia presentations, note-taking and annotation as well as recording lectures. Common learning activities undertaken by students using tablets include email, using the internet, accessing course materials (via the VLE), reading required texts and communicating with group members via social media (Green et al., 2016). Students found tablets to be useful to increase flexibility and productivity because of their small size, ease of use and the availability of apps (Nguyen et al., 2015). Tablets are popular with students because of a long battery life, they are lightweight and highly portable in a bag or backpack. They are also relatively low cost compared to larger devices. The portability of tablets means that they can be used instead of paper notebooks, yet still provide most of the functionality of a laptop (van Ostveen et al., 2011, as cited in Green et al., 2016). They are also useful for field and laboratory work, where they can replace expensive equipment (Green et al., 2016). For example, medical students used tablets for communication and during previously wasted time in clinical environments (Byrne-Davis et al., 2015).

However, there are some challenges associated with the use of tablets for learning. Tablets are less useful for the production or creation of academic work (Dahlstrom, 2012; Green et al., 2016). On-screen keyboards lack responsiveness and occupy a substantial portion of display space. Additionally, tablets can serve as a distraction in class (Wakefield & Smith, 2012, as cited in Green et al., 2016). There is a lack of "pedagogical guidelines on how best to use this device to improve academic processes and achievements" (Nguyen et al., 2015, p. 197). Furthermore, students vary in their perception and use of tablets (Byrne-Davis et al., 2015). Some students do not buy tablets because they prefer using their laptops or do not perceive tablets to offer additional functionality to laptops and smartphones (Green et al., 2016). Most students who own a tablet also own a laptop, suggesting that tablets do not replace laptops but have an "additive" value (Dahlstrom, 2012).

3.6.6 Use of Mobile Phones for Study

Mobile phones include smartphones or basic mobile phones. Smartphones can be used "for collaborative activities such as sharing information and communicating through social media" (Murphy et al., 2014, p. 342). Many institutions make use of text messages as a regular communication tool to provide administrative support and motivational messages (Brown & Mbati, 2015), while smartphones can also be used for synchronous communication (Zawacki-Richter et al., 2015). Multiple choice tests can be used with basic mobile phones to ensure regular engagement with the material, while more advanced feature phones allow for more audio-visual materials in learning activities (Brown & Mbati, 2015). Students can use their mobile phones to video conference or make use of text messaging or instant messaging to communicate one-on-one or in groups (Schroeder, 2013).

Students use their smartphones mainly for informal learning and to access course resources, while perceiving their smartphones as a distractor in classes (Tossell et al., 2015). Some of the barriers that students cited to using a smartphone as an academic tool were inadequate battery life, slow network connections, device usability issues and costs of data services (Dahlstrom et al., 2013).

3.6.7 Use of e-Readers for Study

The main functionality of e-readers is to read learning materials (or e-books). Students can use e-readers in different locations to access all essential course readings. Students are also able to read materials whenever an opportunity arises (make use of spare time). This means that students are less dependent on printed materials (Nie et al., 2011). Students can also create bookmarks, search and annotate e-books (Reid & Pechenkina, 2016).

3.6.8 Learning with Multiple Devices

Learners can learn from multiple devices and sources, rather than using only one device (Ally & Prieto-Blázquez, 2014), which can complicate the design of learning and the provision of support (Chen & DeNoyelles, 2013). Students own different devices, such as laptops and mobile phones, and move across them based on the type of task (Green et al., 2016; Sharples et al., 2009). Students have high ownership rates of laptops and smartphones and slightly lower ownership rates of tablets; many students own both a laptop and smartphone (Kobus et al., 2013).

As students have multiple devices, not all educational designs should migrate to handheld devices. The combined usage of computers, tablets and mobile phones provides more possibilities for learning. Each device leverages certain activities, for example, mobile phones "to check", tablets "to immerse" and computers "to manage" (Ferran-Ferrer et al., 2014, p. 183). A distinction can be made between physical context (location) and intentional context (purpose) (Hess, 2012, as cited in Ferran-Ferrer et al., 2014). The move from a locational context towards an intentional context requires the redesign of learning experiences across and between devices to better support student objectives (Ferran-Ferrer et al., 2014). The use of devices for learning depends on the features of the device and the nature of the learning activity (Cheung, 2012). The advantages and disadvantages of different devices require the application of effective pedagogical strategies to use those technologies. For example, laptops are useful for students collaborating on a shared file (Schroeder, 2013) and writing assignments is easier with a larger screen, dedicated keyboard and pointing device (Cheung, 2012). Tablets are useful for reading e-books because they can be held in the hand and the touch screen can be used to easily flip pages. Smartphones are useful for activities requiring students to take and share photos (Cheung, 2012; Schroeder, 2013).

When designing learning applications, there are many considerations for learners using a variety of devices (Lentz & Carson, 2012). A key step in multi-device learning is having a responsive system design. Levin (2014, as cited in Garg, 2015) defines three types of experiences designed for multi-devices:

- *Consistent*: a consistent experience is when content and core features are replicated across device types. However, some adjustments are made for screen size and interaction methods.
- *Continuous*: a continuous experience can continue between devices, either continuing the same action or progressing along a sequence of actions.
- *Complementary*: a complementary experience occurs when devices complement each other to create a new type of experience.

Research concerning the use of multiple devices for learning is scarce and tends to be within face-to-face universities and focuses mainly on the use of handheld devices. Barden & Bygroves (2017) provide a case study of a single undergraduate's use of his mobile phone, tablet and laptop to produce an assignment. However, a limitation of this study is that it only looks at the habits of a particular student. In an Australian study at two universities (n=1658), laptops and smartphones were found to be commonly used, yet tablets were not considered to be central academic tools for the majority of students (Henderson et al., 2015). Students were asked to specify the most useful digital tools for their university studies. The most common practices were the use of the VLE as a repository for resources and information, followed by library websites and databases for research and word processors for taking notes or writing assignments. Student engagement with digital technologies was found to relate to a perspective of logistics (use surrounding assignments, grades and attendance) or a perspective of learning (use relating to the transmission mode of learning). Thus, digital technologies enabled students to pursue learning in a more convenient, but not novel, way. The researchers found that students' adoption of digital technologies to be varied and inconsistent and the use of technology was more constrained than the narrative implied by the use of technology to enhance or transform education (Henderson et al., 2015).

In a study of the provision of two mobile devices (either laptop and tablet or laptop and smartphone) to 240 undergraduate students in a medical education setting, context and learner autonomy were found to be important factors. Learners used multiple devices for different purposes and adopted strategic approaches to learning using these devices (Ellaway et al., 2014). An expectation that university-issued devices would be regularly and enthusiastically used to replace more traditional study media was not reflected in practice. Learners' approaches to and the extent of use of mobile devices were heterogeneous. However, a limitation of this study is that students were prescribed some devices (without being able to opt-out) and had to integrate (or not) the usage thereof with their own devices.

Reid & Pechenkina (2016) investigated student experiences where students made use of a prescribed tablet, together with existing devices (n=22). Students were found to use an assortment of devices (desktops, laptops, tablets and smartphones) simultaneously in a variety of ways to enable their learning. The use of available devices was shaped by their immediate needs as well as their technological habits. Different devices were used to supplement learning activities, rather than duplicate activities. Students chose specific devices for specific learning activities. Tablets and smartphones were useful for searching for information online and answering a short quiz, while larger devices were useful for typing and submitting assignments (Reid & Pechenkina, 2016). A limitation of this study is that students were loaned a tablet (although they could choose to participate) and had to integrate (or not) the usage thereof with their own devices. Another limitation is that only a few students (n=22) out of the cohort could participate in the study due to the costs of prescribing devices.

3.7 Previous Studies of Device Access and Use in ODL Universities

The aim of this section is to describe previous studies of device access and use in ODL or dual-mode universities. These studies were selected because of their similarity to this study. Two general studies of device access and usage at ODL universities are described and then three further studies that focus on the changes in study habits brought about by the use of handheld devices are explored.

3.7.1 General Technology Access and Use Surveys in ODL Universities

In 2011, the University of South Africa (Unisa) undertook a survey of student access to and effective utilisation of technology for learning. The aim of the survey was to inform effective learner support (Liebenberg et al., 2012). 22 216 participants participated in the online survey. A variation was found between those students who took the survey online and those who completed a paper version. All online students indicated they had regular access to a computer for study purposes, even if not personally owned, while 52% of paper-based respondents had access to computers. Students mostly accessed the internet from home, the homes of others, at work, at internet cafes or at university computer laboratories. 91% of online students indicated they had regular access to the internet, compared to 46% of paper-based respondents. 82% of online students indicated they had a mobile phone with internet access, compared to 55% of paper-based respondents. The cost of mobile network access was an issue. While students might access the internet via their mobile devices for personal activities and be willing to pay for this use, they may be less likely to afford using their devices for learning activities. Access is only one aspect to internet usage. Other factors such as the quality of the devices and bandwidth should be considered. Even students who live in large metropolitan areas can struggle with internet access, mainly because of the costs involved and not necessarily because of infrastructure and location. The use of mobile phones was found to reduce the need for public internet access facilities such as internet cafes, and yet increase the demand for public Wi-Fi. Not all students have digital literacy skills and levels of digital literacy vary (Liebenberg et al., 2012). A limitation of this this study is that the results may no longer be applicable due to when the study was done. However, it will provide useful comparative data for the results of this research study undertaken at Unisa.

Kumar et al. (2011) undertook a survey of the use of mobile phones to support postgraduate distance learners at the Indira Gandhi National Open University in India. They found that mobile phones were used to support learner-learner and learner-educator interaction through text messages. Many of the messages were for information exchange related to schedules and deadlines. Due to the age of this study and the limited focus on text messages, the results may no longer be applicable.

3.7.2 Handheld Device Access and Use at ODL Universities

The majority of student use of technology research focuses on traditional campus-based universities, usually in western countries, while very few studies consider ODL contexts (Cross et al., 2015). Three such studies are reviewed in this section. Cross et al. (2015) describe a survey of handheld devices used by undergraduate students (n=518) undertaken at the Open University in the United Kingdom in 2013. The study had three aims: i) to consider different patterns of ownership, adoption and use; ii) to determine how study habits and learning experiences are changing; and iii) consider the relationship between purchase reason and device usage for study. The survey focused on eBook readers, tablets and smartphones. The results indicated that 50% of students owned or accessed tablets, while 37% of students owned or accessed e-readers. 50% of students with access to handheld devices used them at least once a week to access study materials. The most common study tasks performed with handheld devices were preparing assignments and reading learning materials, although tasks varied between devices. Common locations for using handheld devices included home as well as at work and on public transport. 61% of students reported that their study habits had changed as a result of using a handheld device (Cross et al., 2015).

Cross et al. (2016) later synthesised the findings from three student surveys of handheld devices between 2013 and 2016. The aim of the study was to: i) investigate the influence of geographic reach of handheld devices used for study; and ii) determine the changes in how students use handheld devices for study. In terms of ownership, tablet ownership increased slightly from 50% to 58% over the period, e-reader ownership dropped from 37% to 25%, while smartphone ownership increased from 64% to 77%. Other devices owned include internet connected TVs and game consoles. Tablets and smartphones were used increasingly for accessing and reading materials. A strong association was found between the geographic reach of study (number of locations used) and range of tasks performed using handheld devices. Students who use devices ubiquitously across multiple spaces do not simply migrate existing devices onto their handheld devices but undergo changes in how, when and where they study. One of the limitations of these studies is that the focus was on handheld devices and so students' use of desktops and laptops was not considered. Furthermore, the studies only considered how devices were used separately and not together.

Farley et al. (2015) describe a study of student ownership of mobile devices at a regional dual-mode Australian university (University of Southern Queensland). A survey (n=749) was conducted in 2013 with on-campus and distance students and followed up with focus group interviews. The aim of the study was to determine “how university students perceive mobile learning, the types of informal learning they undertake, the mobile technologies they own or access and their mobile learning preferences” (Farley et al., 2015, p. 2). The findings indicated that almost all students had access to smartphones (93%) and laptops (93%), while students also had access to a variety of other devices: desktops, tablets, MP3 players, basic mobile phones, eBook readers and netbooks. Of these devices, the most common devices used to support studies were: laptops (90%), tablets (78%), desktops (76%) and smartphones (73%). Students use these devices in different locations (home, university, work etc.) and for a range of activities (scheduling, administration, collaboration, information recording and information consumption). However, no examples were found of educators actively enabling or facilitating mobile learning in their courses. The study also found 87% of students were in favour of using mobile devices to support their learning (Farley et al., 2015). The researchers provided a set of recommendations for supporting learners using mobile devices, although these recommendations drew from broader studies rather than just the results reported. The results of a similar exploratory study (n=100) undertaken by the researchers at the same university were reported in Murphy et al. (2014). The results indicated that students rarely use a feature phone for learning activities, while laptops are the most widely used devices for learning. Smartphones were found to be used for communication and tablet usage was found to be in-between laptop and smartphone usage.

Cheung (2012) conducted a survey of students at the Open University of Hong Kong in 2011 to determine the ownership and usage of mobile devices (n=518). The results found that 56% of students owned two or more mobile devices, with 83% of students using smartphones. Tablets were not yet widely used for learning. The most common uses of smartphones for learning were emailing, chatting and social networking. For tablets, the most common activities were emailing, chatting and social communicating, browsing the internet and reading e-books. Students often read e-books offline. For laptops and notebooks, the most common uses were email, reading e-books, chatting and doing assignments (Cheung, 2012). The limitations of this study are that the focus was mostly on handheld devices and that the results may no longer be applicable due to when the study was undertaken.

Although all very useful, a limitation of the studies reviewed in this section is that they only considered how devices were used for study purposes separately, and not together. Furthermore, in most instances (with the exception of Farley et al., 2015), the researchers did not expand upon the learning support implications for students making use of different devices. Furthermore, each study considered a different (and sometimes limited) set of learning tasks. This research study will explore these key aspects.

3.8 Key Concepts for this Study

The previous sections have discussed the key trends and issues in the review of the literature. Figure 3.4 shows a map of the key concepts for this study arising from the literature and the theoretical framework. These will be further explored in the design and the findings of this study. This study takes place in the context of seamless learning, where ODL students can move between different settings to perform their learning activites, supported by the use of multiple devices. ODL learners are likely to be diverse, but many ODL learners need to balance work and family responsibilities with study requirements. They are likely to have access to different types of digital devices (fixed or handheld) and use these devices differently (either separately or together) to perform learning activities in different locations. The use of devices is also influenced by the associated applications, services and connectivity. Finally, the use of multi-devices for learning means students require specific learning support. The study will explore the devices ODL students have access to and how they are used for learning (performing specific activities) in different locations. The study will also explore how devices are used separately or together, and what support needs ODL students have.

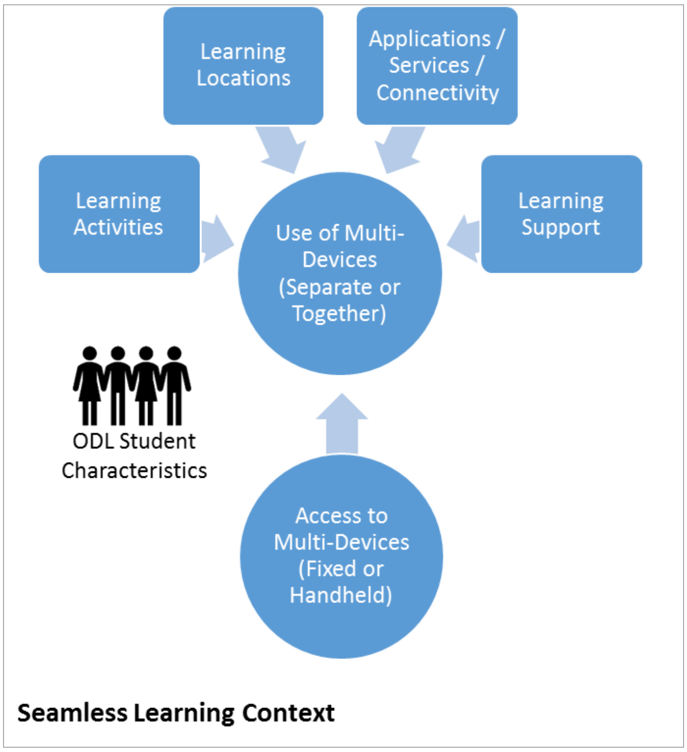

Figure 3.4: Key Concepts from the Theoretical Framework and Literature Review

3.9 Summary

This chapter has explored the use of devices within the context of ODL, where the integration of emerging technologies into distance education pedagogies has tended to face the same barriers. ODL students tend to be diverse, mobile, connected and resourceful. Several trends and issues in mobile learning were explored. A key reflection is that the research area of mobile learning is a growing field as more and more students and educators seek to make use of the potential of mobile learning. The literature has shown that students engage with mobile learning using their own devices, often informally or to quickly access resources in formal environments. However, mobile learning still faces low adoption in higher education. One challenge is that educators lag a bit behind, with many excited by the potential of mobile learning, yet also reluctant to engage. This implies that educators need to move beyond their traditional methods and explore alternative pedagogies. This is a challenging proposition for many educators, already facing high workloads and lacking the skills and knowledge to implement innovative learning initiatives (Farley et al., 2015). Other m-learning opportunities and challenges relate to BYOD, skills development, institutional support and increasing student agency.

The literature has shown that students have access to a variety of devices, although access does not imply effective use for learning. The access to devices is an important consideration, but the use of these technologies for learning is a greater area of contemplation. Related to the devices are the associated applications and services. Students also use these devices in different locations and require support. A deeper understanding of how students use their devices to support learning could lead to more successful and sustainable mobile learning initiatives in higher education (Murphy et al., 2014).

There has been a shift from the use of a digital device for learning to the use of multiple devices for learning. Not only do students make use of their handheld devices (such as tablets, e-readers and mobile phones) for learning, but they make use of fixed devices (desktops and laptops) as well. Students own multiple devices and they use these devices in different ways. There is need for further research into the widespread use and of adoption of handheld devices by students.

Although a few studies have been conducted in ODL or dual mode universities that have explored student access to and use of different mobile devices, these studies have not focused on how students use their multiple devices together nor on the support needs of students. There is little research available that describes how students make use of multiple devices to support their learning. There is a need to research and develop flexible pedagogies, learning designs and resources that allow students to take control and adapt their learning to the specific mix of technologies and locations in which they study (Cross et al., 2016). The key aspects from the literature review and theoretical framework were highlighted in a conceptual diagram.

The following chapters will explore how to address some of the gaps in the literature through the design and results of this study and explore how ODL students make use of multiple devices for learning and how ODL universities can support them. The next chapter specifies the design of the study and the approach followed.

Chapter 4

Research Methodology

This chapter introduces the research methodology and processes followed in this study (Section 4.1) and provides an overview of the research design (Section 4.2). The research setting and sampling process is explained (Section 4.3), the processes for data collection are described (Section 4.4) and the data analysis processes are then specified (Section 4.5). This is followed by a short review of the study limitations (Section 4.6). Ethical considerations related to the research study are discussed (Section 4.7) and the validity, reliability and credibility of the research is considered (Section 4.8). Finally, a short summary of the research design (Section 4.9) closes the chapter.

4.1 Introduction

The research methodology chapter provides a description of the research design and methods used in this research. A rationale is provided for the chosen mixed methods design, based on the gaps identified in the literature, as discussed in the Literature Review chapter (Chapter 3). The research approach explains how the research was undertaken using a general case study approach and a grounded theory approach (for the qualitative data). The research setting is discussed with the cases of two Open and Distance Learning (ODL) universities and the sampling processes are detailed. The data collection instruments for the quantitative and qualitative phases are explained and the data collection processes are specified. The analysis processes are provided together with the reason for using these methods for both the quantitative and qualitative phases. The limitations of the research design are reviewed. The ethical considerations are discussed and then issues relating to validity, reliability and credibility are considered. A short summary is provided at the end of the chapter.

4.2 Research Design

The research paradigm in which this research study is situated is within the pragmatic worldview. Pragmatists are concerned with “what works” and solutions to problems, recognising that research occurs in social and other contexts. Pragmatism is often used as a philosophical underpinning for mixed methods studies (Creswell, 2009). This is because researchers are able to use quantitative and qualitative approaches to derive knowledge about the problem. The advantages of following a pragmatic approach in this study is that the researcher can apply mixed methods that draw on both quantitative and qualitative assumptions. The researcher is also able to select the methods and procedures that best meet the needs and purposes of the study (Creswell, 2009). Thus, the researcher makes use of quantitative and qualitative data to be able to provide the best understanding of the research problem.

Although this study has descriptive and explanatory purposes, the primary purpose is exploratory. Exploratory research aims to satisfy the desire for a better understanding of a topic and develop methods to be employed in subsequent studies (Babbie, 2013). The research is considered exploratory because, although there is a rich tradition of exploring the affordances and potential of emerging technologies within higher education, there is very little research that considers how students make use of different devices together and how this influences their learning and support needs. In this context, the setting is ODL universities. This research makes use of a mixed methods research design to answer the research questions. The approach was selected as this exploratory study uses a combination of quantitative and qualitative approaches to derive theory from data collected in a social setting (Babbie, 2013; Creswell, 2009; Khan, 2014). Quantitative research is an approach for “testing objective theories by examining the relationships between variables”, while qualitative research is an approach “for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2009, p. 4). The research follows a sequential explanatory strategy where the quantitative data is first collected and then the qualitative data is collected afterwards to build on the quantitative results and explain and interpret relationships. The study uses multiple data sources to draw on both the strengths of quantitative and qualitative research and minimise the weaknesses in using only one approach (Creswell, 2009; Creswell & Clark, 2011). This enables a triangulation of data and the comparison of several data sets to avoid any potential biases (Babbie, 2013). The study is therefore able to take a holistic and comprehensive approach to the research topic (Corbin & Strauss, 2015). Most of the research that investigates students' use of technology applies a quantitative methodology (Brooks, 2016; Cross et al., 2015). However, this study will follow a similar method used by a study that investigated students' use of devices in a dual-mode university, where a quantitative survey was followed by the collection of qualitative data (focus groups) (Farley et al., 2015).

This investigation proposes the use of a case study approach along with a grounded theory approach (for the qualitative data) as an inductive research paradigm, where the research moves from specific observations to the development of general principles (Babbie, 2013). This is because this research seeks to describe and explain how students learn using multiple devices and explore the experiences of students in two different ODL universities.

4.2.1 Case Study Approach

A case study is an empirical enquiry that investigates a contemporary phenomenon in-depth and within its real-life context (Yin, 2009). In this research, two case studies of two different ODL universities are used to provide a greater understanding of student learning behaviours at each university under examination, in detail and in context. The case study approach employs a variety of data collection methods over a period of time (Creswell, 2009). The first objective of a case study is to understand each case, and then move on to study its functioning and how it relates to other cases. Within multiple-case study research, the single case is of interest because it belongs to a specific collection of cases. To understand this collection better, some of the individual cases are investigated. The similarities and differences between the cases are studied in order to understand the collection better. A multiple-case approach provides the opportunity for a more robust and reliable study (Stake, 2006).

4.2.2 Grounded Theory Approach

For the qualitative phase of this research study, a grounded theory approach is followed. In this approach, the theory is constructed from concepts derived during the data collection process and not chosen before data collection. Another important aspect of grounded theory is that the data collection and analysis phases are interrelated and ongoing. Researchers can examine topics from many different angles and develop comprehensive explanations (Corbin & Strauss, 2015). A grounded theory approach does not just describe the qualitative research, but provides a structure that explains why and how things happen. The research questions and literature review in this study lead towards conceptual thinking and theory building, rather than empirical testing of theory. However, the approach still allows for the existence of some theory and ideas when approaching the research problem (Gray, 2009, as cited in Khan, 2014). Grounded theory seeks to obtain multiple viewpoints using different observational techniques. It also ensures methods and findings are continually refined (Corbin & Strauss, 2015). A grounded theory approach has been used in a previous quantitative study to analyse open-ended questions regarding students' use and perceptions of technologies in an ODL setting (Cross et al., 2015).

4.3 Research Setting and Sampling

The primary method of sampling used is non-probability purposive sampling to select the case studies (Babbie, 2013; Khan, 2014). Cases were selected on the basis of research interests and access. The selection of the ODL universities as cases has been informed by their representativeness of online or distance students in each country as well as their experience in providing online learning. It has also been informed by the researcher's access to university staff and online students, and familiarity with university programmes and structures. Two ODL universities have been selected, each one operating in different socio-economic conditions, with different histories, missions and student numbers. Each is in a different country to better understand the influence of any cultural or geographic contexts (Cheung & Hew, 2009; Liamputtong, 2010). The case studies are:

- Universitat Oberta de Catalunya (UOC), Spain
- The University of South Africa (Unisa), South Africa

4.3.1 Population Sample

The population sample within each of these cases consists of registered undergraduate students in the academic year 2015/2016. The decision was taken to focus on undergraduate students, rather than on postgraduate students as the nature of postgraduate learning is different. The data was collected in the period April – December 2016. Although each case is sampled according to its specific context, the general sampling process followed was:

- Confirming research agreements with university staff in charge of research and obtaining ethical clearance.

- Requesting a random sample of undergraduate students, from the directors of research, across different disciplines (stratified sampling by discipline/faculty, followed by random sample selection).
- Sending questionnaires to a sample list of 5000 students per case. An expected 10% sample rate results in around 500 student respondents for each case, or around 1000 questionnaire respondents in total.
- Selecting 20 students per case (random sampling from self-nominated questionnaire respondents) for individual interviews (40 interviews in total).

This sampling approach was selected to align to the research questions of the study so that the sample is representative of the population under study. The samples were refined as the investigation progressed in accordance with the research design. Table 4.1 summarises the sample population.

Table 4.1: Research Participants

	Group Participants	**Site Population**	**Sample Size**	**Expected Response Rate**	**Age Profile**
Group 1	UOC Undergraduate Students	25 788 (in 2016)	5 000	500 (10% response rate)	18 and above
Group 2	UNISA Undergraduate Students	298 770 (total under and postgrad 2016)	50 000	500 (1% response rate)	18 and above

4.3.2 Sampling Methods

The same sampling method was used at UOC and UNISA. At the UOC (Group 1 participants) a request was made to the eLearn Centre for a sample of 5000 undergraduate students (stratified sampling by department, followed by random sample selection). The inclusion criteria for the sample was that students had to be registered UOC undergraduate students in the year 2015/2016 with a valid email address. The sample of 5000 students were invited to participate in the online survey via email. The email was sent by the eLearn Centre. For the online questionnaires, it was expected that the respondents would take 15-20 minutes to complete the questionnaires. The questionnaires were accessed and completed online. The researcher expected to receive 500 responses (10% response rate) aligned to similar online surveys undertaken at UOC. The aim of this sample method was to obtain a large sample (above 400 respondents) that is representative of the total population.

After completing the questionnaire, students were invited to register their willingness to participate in an online interview. A random sample of 60 students to interview was selected from this group to interview 20 students. An email invitation was sent to the participants to arrange a date and time for the online interview.

At UNISA (Group 2 participants) a request was made to the ICT Directorate for an initial sample of 5000 undergraduate students (stratified sampling by college, followed by random sample selection). The inclusion criteria for the sample was that students had to be registered UNISA undergraduate students in the year 2016 with a valid email address. The sample of 5000 students were invited to participate in the online survey via email. The email was sent by the ICT Directorate. The researcher expected to receive 500 responses (10% response rate), similar to the online survey undertaken at UOC. However, the initial response rate yielded only 53 respondents (1% response rate). In discussion with the Information Services Manager in the Directorate Information & Analysis (personal communication), a response rate of 1% is considered normal for online questionnaires at UNISA. Therefore, permission was obtained to increase the sample size to 50 000 to receive an expected response rate of 500 responses (1% response rate).

After completing the questionnaire, students were invited to register their willingness to participate in an online interview. A random sample of 60 students to interview was selected from this group to email 20 students. An email invitation was sent to the participants to arrange a date and time for the online or telephonic interview. One follow-up reminder was sent if no response was received. The qualitative nature of these interviews means that only small sample was required.

4.4 Data Collection

The data was collected from students at the participating ODL universities. In alignment with the chosen research methods, multiple methods were used to collect the data:

- *Online Questionnaires*: The questionnaire includes a mix of open and closed questions regarding device usage, student motivations and learning activities performed in online learning. Questionnaires are the best way to gather data from a large sample. Online questionnaires are a low cost and efficient way to distribute questionnaires and gather responses (Babbie, 2013).
- *Semi-structured Interviews*: Interviews are an excellent method for exploring experiences (Babbie, 2013). Interviews are used to derive qualitative data around interpretations and insights of student perceptions and habits.

As a supporting method of data collection, the researcher obtained and reviewed background documentation relevant to teaching and learning approaches or the use of technology in learning from the participating university websites or teaching and learning staff. This provided contextual information for each case.

These methods were selected being the most appropriate methods to obtain the data needed to answer the research questions. It follows the case study approach by collecting detailed information using a variety of data collection methods in multiple stages over a sustained time period (Creswell, 2009). The approach was feasible to carry out the data collection and the methods were refined as the study progressed. The resulting datasets are relevant and sufficient for analysis.

4.4.1 Quantitative Data Instruments

Quantitative data was collected via an online questionnaire sent to the student participants at UOC and UNISA. The data collected in the online questionnaire can be divided into different sections:

- *Demographic/personal information*: related to age category, gender, discipline, employment status, national status, length of study, location type and language of study. The reason for the collection of personal information is to identify learner characteristics.
- *The use of digital devices for learning*: related to the types of digital devices, age of devices, how devices are used for learning, locations used for studying and learning activities performed.
- *The use of multiple devices for learning*: benefits and challenges of using multiple devices, time spent studying, how multiple devices are used together, and online tools used.
- *Attitudes towards technology*: agreement or disagreement regarding attitudes towards using mobile and digital devices and learning.
- *Support required for learning (using technology)*: examples of how learning is designed to make use of digital devices and how student learning is supported.

The questionnaire was developed specifically for this study by the researcher. However, it was informed by a literature review and the use of specific instruments designed by other authors. Table 4.2 shows the sections of the survey where questions were used or adapted from other researchers. It consisted of 5 sections and 48 questions in total. The survey was developed in Netquest Survey Manager specifically to be delivered as an online survey. An advantage of using this tool is that questions could be branched and items could be displayed or hidden, depending on the selections made in previous questions. Most of the questions were multiple choice or multiple response questions, however, a few open-ended questions were included. After the results of the UOC survey were analysed, one change was made for the survey for Unisa, based on the UOC results. The option of a USB flash drive was added to the question about the tools used to store or access resources across devices. Appendix A contains the email invitation sent to students with the link to the survey (in English). Appendix B contains the survey (in English).

Table 4.2: Survey Sections

Section	Questions	Studies Influencing the Design
Section A: Demographics	Age Gender Subject Area/Discipline Study Status Employment Status National Status Years of Study Area Language	Cross et al. (2015), Dahlstrom & Bichsel (2014), Farley et al. (2015).
Section B: Use of Digital Devices in Studies	Access to Digital Devices Reasons for Purchase Age of Digital Devices Frequency of Use for Study Locations of Study Learning Activities Level of Expertise Perceived Importance Device Operating System and Screen Size Other Digital Devices	Chen & deNoyelles (2013), Chen et al. (2015), Cheung (2012), Cross et al. (2015), Dahlstrom & Bichsel (2014), Dahlstrom et al. (2015), Farley et al. (2015), Murphy et al. (2014).
Section C: Use of Multiple Devices	Benefits of Multi-devices Challenges of Multi-devices Online Study Time Device Choice Influencers Tools to Access/Store Resources Useful Applications Sequential Device Use Simultaneous Device Use	Cross et al. (2015), Google (2012).
Section D: Attitudes towards Technologies and Devices	Use of Digital Devices in Studies Value of Mobile Learning Perceived Future Learning	Farley et al. (2015), Murphy et al. (2014).
Section E: Learning Support Needs	Design of Courses LMS Responsiveness/Mobile-friendly Academic Support Needs Technological Support Needs	Dahlstrom et al. (2015), Farley et al. (2015).

4.4.2 Qualitative Data Instruments

As the research followed a sequential explanatory strategy, the qualitative data was collected via interviews to build on the quantitative results and explain and interpret the relationships. A student interview protocol was developed. The aim of the student interview was to confirm and elaborate on the information collected in the survey. The researcher sought additional information about the use of multiple devices for learning and types of study behaviours and to gather student interpretations and insights around their learning habits. The interview protocol consisted of 13 questions that covered:

- The digital devices to which students have access
- How students make use of different devices for learning
- The locations / contexts where devices are used for learning

- The influences of why specific devices are chosen
- Examples of sequential and simultaneous device usage
- How students deal with academic and technical issues/problems
- The most important tools or technologies needed for learning
- How study habits have changed due to the influence of devices

One additional question was added to the interview protocol for the Unisa interviews, due to the results of the survey. A question was added about internet access experiences (this was not formally included in the UOC interview protocol). Due to the students being at a distance in both university cases, interviews needed to be conducted online (via Skype or Google Hangouts) or telephonically, depending on interviewee preference. The benefit of using videoconferencing is that it closely resembles face-to-face communication including verbal and non-verbal signals (Salmons, 2012). The researcher elected to make use of semi-structured interviews. Semi-structured interviews provide a balance between the standard questions in a structured interview with the spontaneity and flexibility of an unstructured interview (Corbin & Strauss, 2015; Salmons, 2012). The researcher prepared questions in advance and then generated follow-up questions during the interview. The same open-ended questions would be asked to ensure a consistency in interviews, but the sequence of the questions could vary based on responses to provide a more natural conversational style (Salmons, 2012). Additional follow-up questions and probes could be used to elicit the desired information from interviewees. After the questions on the list have been covered, participants are free to add anything they feel is relevant to the topic (Corbin & Strauss, 2015).

For the UOC case, research fieldworkers were used to translate the student interview questions from English into Catalan and Spanish. The researcher fieldworker agreement is contained in Appendix C. The research fieldworkers also conducted the interviews (in Catalan or Spanish) and transcribed the interviews. After the transcription process, the research field workers translated the interviews into English. The translation process followed is described in Section 4.4.4.

For the UNISA case, the researcher conducted the student interviews and transcribed the data himself. Appendix D contains the student information sheet and consent form (in English). Prospective participants were asked to complete the consent form before the interview. Appendix E contains the student interview protocol (in English).

4.4.3 Procedures and Timeline

Figure 4.1 provides a visual overview of the processes involved in the data collection and analysis. The data collection process comprised three parts. The first was the pilot study undertaken to test the research instruments and verify the types of data to be collected. The researcher designed the research instruments (survey and interview protocol). For UOC, two research fieldworkers translated the student questionnaires from English into Catalan and Spanish (the main languages of instruction at UOC). Two separate individuals were then asked to review each translation for accuracy. Further information is provided about the translation processes in the next section (Section 4.4.4). For the UNISA case, the data was collected by the researcher only. Convenience sampling was used to send the survey to a pilot group of 70 UOC students (both undergraduate and postgraduate) in January 2016. The respondents had 2 weeks to complete the survey in either Spanish or Catalan and one reminder was sent. 33 respondents completed the survey. From this group, 3 respondents were selected for follow-up face-to-face semi-structured interviews, and 2 interviews were then conducted and transcribed.

The second part of the data collection involved collecting data from the UOC case. The data from the pilot study was analysed and several amendments were made to the research instruments to improve their clarity. A random stratified sample was obtained of 5 000 UOC undergraduates who were invited via email to participate in the research in April 2016. The survey was open for 4 weeks and one email reminder was sent. 488 responses were received (398 in Catalan and 90 in Spanish). An initial data (descriptive) analysis was performed. 121 respondents indicated a willingness to be interviewed by providing their email addresses. A random sample of 60 respondents were emailed to schedule online interviews in either Catalan or Spanish during June or July 2016. Five online semi-structured interviews were conducted in Catalan and five interviews were conducted in Spanish during this period by the research fieldworkers. Due to the low response rate to the interview invitation, this invitation was sent out again in September 2016 (after the summer holiday) yielding an additional eight interviews over September-October 2016, for a total of 18 interviews. These interviews were audio recorded. The research fieldworkers then transcribed and translated these interviews.

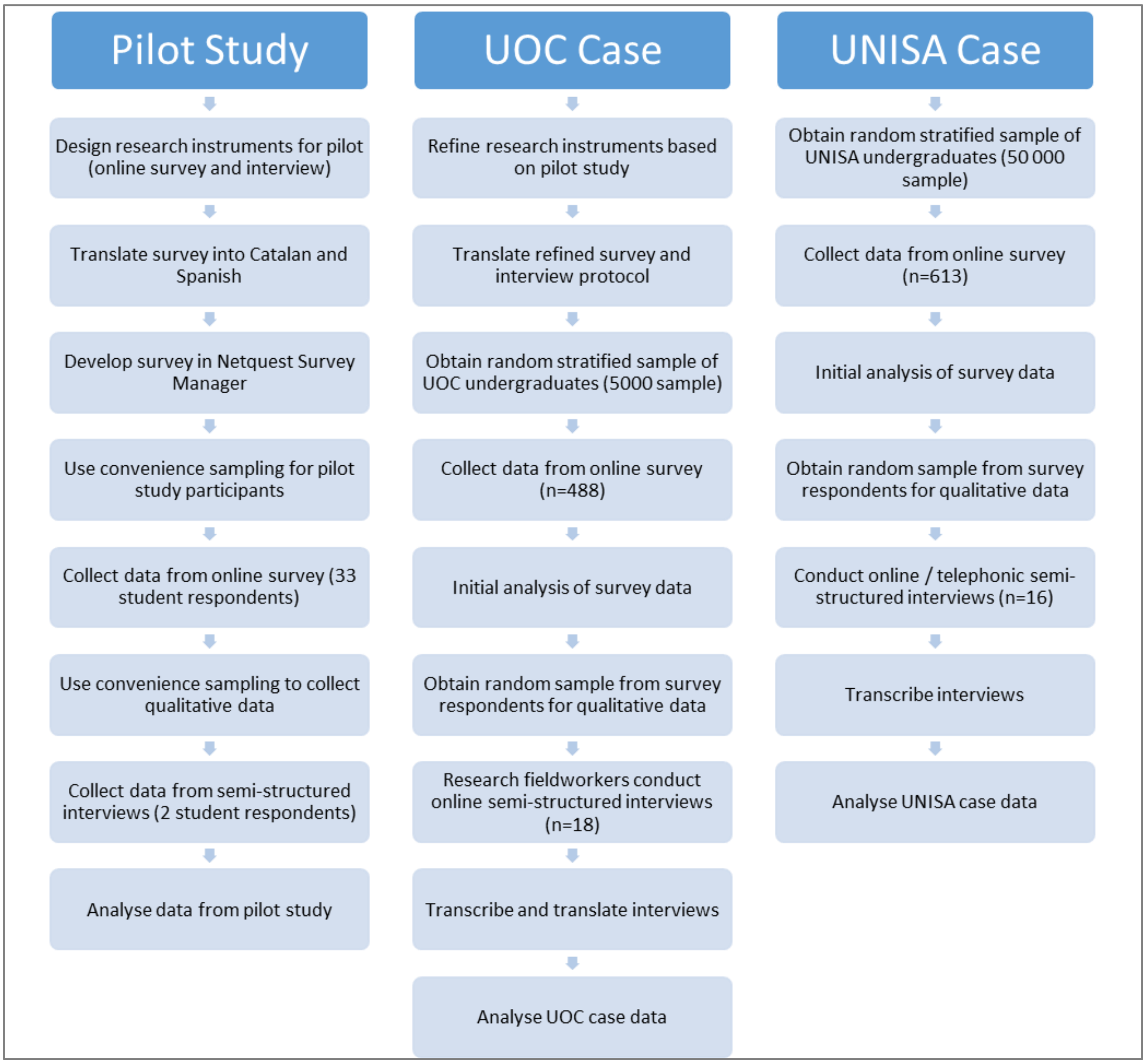

Figure 4.1: Overview of Data Collection Methods and Processes

The third part of the data collection involved collecting data from the UNISA case. A random stratified sample was obtained of 5 000 UNISA undergraduates who were invited via email to participate in the research in August 2016. The survey was open for 3 weeks and one email reminder was sent. Only 53 responses were received so the researcher obtained permission to send out the survey again to an additional sample of 45 000. However, this survey could only be distributed again in November 2016, after the examination period. A further 560 responses were received for a total of 613 responses. An initial data (descriptive) analysis was performed after the first sample and again after the combined sample. 204 respondents indicated a willingness to be interviewed by providing their email addresses. A random sample of 60 respondents were emailed to schedule online or telephonic interviews during September 2016 (for the first sample) or during November-December 2016 (for the second sample). 16 online/telephonic semi-structured interviews were conducted. All interviews were audio recorded and supplemented with hand written notes taken during the interview. The researcher then transcribed these interviews.

4.4.4 Translation Processes

For the UOC case, translation was required for both the quantitative and qualitative phases. This was because the researcher was not familiar with the languages used by the majority of students (Catalan and Spanish). For the quantitative phase, the researcher made use of two bilingual research fieldworkers to translate the questionnaire from English into Catalan and Spanish. The quality of the translation was assured by following a translation, review and approval process (Harkness, Pennell, & Schoua-Glusberg, 2004). Each fieldworker translated the questionnaire into one of the languages, two independent researchers then reviewed or amended the translations. Any translation queries were discussed and confirmed with the researcher.

Within qualitative research, the role and influence of language is critical in the research processes and the resulting data and interpretation (Liamputtong, 2010). The translators and the act of translation form part of the knowledge production process (Temple & Young, 2004). Rather than using an interpreter, two bilingual (bicultural) research assistants or fieldworkers were used in this study, one native Spanish speaker and one native Catalan speaker. These fieldworkers volunteered to be part of the qualitative phase of the study and had already assisted the researcher by translating the quantitative questionnaire into Catalan and Spanish. The fieldworkers were both PhD students at UOC so were familiar with the university, the student experience, as well as the research objectives of the study. The fieldworkers first assisted by translating the interview protocol into Catalan and Spanish. The fieldworkers then participated in training with the researcher before conducting the interviews and translating the transcriptions, an important component when using fieldworkers (Liamputtong, 2010). It is also important for the fieldworkers to receive support from the researchers throughout the study. For this reason, the researcher was present for all the interviews and held regular meetings with the fieldworkers to discuss any challenges in the interview or translation processes. The process for interview transcription and translation is shown below. This process was adapted from Lopez et al. (2008, as cited in Liamputtong, 2010):

1. The interviewer/translator transcribes the interview verbatim in the local language (Catalan or Spanish).
2. The translator first reads through the transcript in the local language and makes any notes or comments to refer to or check.
3. The translator translates the transcript into English. The focus of the translation is the intended meaning of the participant, rather than a word-for-word translation.

4. If any problems or questions occur during translation: these are discussed with the translation team and collectively a decision is made. This decision is recorded for future use.
5. For the first interview, the translator sends the translation and the original transcript to another reviewer/translator to check. The reviewer checks it against the original transcript and makes sure the translation is correct and makes sense. If any problems or questions arise: these are discussed with the translator and collectively a decision is made. This decision is recorded for future use.
6. For the remaining interviews, the translator him/herself checks the translation against the original transcript to make sure it is correct and makes sense.
7. The translator submits the revised translation to the main researcher.
8. The main researcher reviews the translation and if he/she is unclear on any meaning: these are discussed with the translator and collectively a decision is made. This decision is recorded for future use.

This approach emphasises the collaborative nature of translation, where the interviewer/translator is seen as a cultural co-researcher as they are involved in more than just the translation of the interviews, but also the design of the research instrument as well as the data collection (Liamputtong, 2010; Temple & Young, 2004). Another benefit is that a verbatim transcript exists in the participant's native language. The translation into English then allows the accurate meaning of the participant's experience to be properly conveyed in the English language. This also makes the translated text more readable and easier to understand. However, the risk of losing information or misinterpreting information is acknowledged. This approach is appropriate and meaningful as the researcher is able to use the qualitative data collected in the local language more accurately. The steps to check for problems and make collective decisions assure the adequacy and accuracy of translation (Liamputtong, 2010).

4.5 Data Analysis

4.5.1 Quantitative Analysis

The analysis procedure began with the organisation of the data obtained. A statistical analysis tool (IBM SPSS Statistics Version 24) was used to analyse the quantitative data from the questionnaire used for each case. Each case was analysed separately and a comparison of the cases was done afterwards. The approach for the analysis started with the descriptive statistics followed by inferential statistics. As this study was exploratory, the main focus was on the descriptive analysis. Descriptive statistics provide a way to describe the quantitative data in manageable forms, while inferential statistics assist the researcher to draw conclusions from their observations (Babbie, 2013). These steps were followed by using previous studies as a guide, specifically Cross et al. (2015) and Farley et al. (2015). For the descriptive analysis, the researcher began with univariate analysis, which is the analysis of a single variable for the purpose of description (Babbie, 2013). The univariate data is summarised in the results chapters, including the frequency distributions, means and standard deviations. Descriptive analysis provides an understanding of circumstances and patterns in a population of interest (Loeb et al., 2017). The researcher wanted to determine which devices students have access to and how these devices are used for study purposes.

One of the aims of the research was to determine whether there are associations between different variables and whether students make use of specific devices to perform specific learning activities in different locations. After the univariate analysis, the researcher undertook bivariate analysis, which is the analysis of two variables simultaneously, for the purpose of determining the empirical relationship between them. For the bivariate analysis, the researcher made use of chi square testing and correlations analysis. Chi square (X^2) is a frequently used test of significance, based on the null hypothesis, where the assumption is that there is no relationship between two variables. For the observed distribution of values in two separate variables, an expected distribution is determined as if there was no relationship between the two variables. The result is a set of expected frequencies for all the cells in a contingency table. This expected distribution is compared to the actual distribution of cases in the sample data, and the probability is determined that the difference is due to the sampling error alone (Babbie, 2013). Correlation analysis tests whether an empirical relationship exists between two variables where changes in one are associated with changes in the other. However, correlation itself does not constitute causality (Babbie, 2013). Appropriate measures of association (correlations) and corresponding significance tests were calculated, depending on the level of measurement: Spearman's rho (r_s) was used between pairs of ordinal variables and the phi-coefficient (r_ϕ) was used between pairs of dichotomous and ordinal variables and pairs of dichotomous variables (Howell, 2009; Meneses, Fàbregues, Rodríguez-Gómez, & Ion, 2012). Coefficients of the tests of association range from -1 to 1. The cut-off for weak relationships was set at $r = 0.20$ (Evans, 1996).

For each device, respondents could select from fifteen options to indicate the learning activities performed. Principal Components Analysis (PCA) was then used to explore whether there was a structure to this set of variables (Field, 2013). Finally, multivariate analysis was conducted that analysed the simultaneous relationships among several variables. For the multivariate analysis, the researcher made use of multiple regression analysis, specifically linear regression analysis. Multiple regression analysis "seeks the equation representing the impact of two or more independent variables on a single dependent variable", while linear regression analysis seeks the equation for the straight line that best describes the relationship between two or more variables (Babbie, 2013, p. 467). Using regressions analysis, the researcher sought to determine whether specific variables can be identified as predictors of how frequently students make use of specific devices for learning.

4.5.2 Qualitative Analysis

The qualitative analysis procedure followed the suggested procedures for grounded theory research (Corbin & Strauss, 2015; Khan, 2014). Data from the questionnaires were used to inform the gathering and analysis of the qualitative data to explain and interpret the relationships. The investigation made use of Computer-assisted Qualitative Data Analysis Software (CAQDAS) (QRS International's Nvivo Version 11 Pro) to store and organise data, compare codes and produce visual representations of the qualitative data. The researcher was guided by previous researchers using Nvivo for grounded theory studies (Bringer, Johnston, & Brackenridge, 2004; Hutchison, Johnston, & Breckon, 2010). As with the quantitative data, the interviews for each case were first analysed separately before comparing the results from both cases. The interview data was transcribed for both UOC and UNISA. For UOC, as previously discussed, the data was also translated into English.

Qualitative analysis using grounded theory is performed by means of constant comparisons where data is broken down into manageable pieces with each piece compared for similarities and differences (Corbin & Strauss, 2015). Other analysis tools include asking questions of the data and the categorisation of data into codes. Coding is the process of transforming raw data into a standardised format for processing and analysis to bring meaning to information (Babbie, 2013; Creswell, 2009). A three-stage iterative coding process was followed (Corbin & Strauss, 2015):

1. An initial or open coding took place that details the interview data. Data that are conceptually similar are grouped together under the same conceptual heading. These form the lower-concepts. The focus then moves to selecting the most relevant or frequent codes.
2. An iterative process was followed to generate the conceptual categories. Through further analysis, concepts are grouped together to form categories or themes. Each category is further developed by defining its properties and dimensions.
3. Finally, the specific properties of categories and how they relate were analysed to emerge with theoretical patterns. The different categories are integrated around a core category. The core category describes the major theme of the study. The core category together with the other categories provide the structure of the theory, while the properties and dimensions of each category provide the details within the structure

During data collection, field notes were made after each interview to record any ideas and insights. During the data analysis, memos were used to keep track of the properties and dimensions of categories and to note ideas for relationships between categories. Additionally, cross-case analysis was used to compare the results of the different cases under study. The analysis of the different datasets led to the development of conceptual thinking and theory development. These data analysis procedures align with the selected methods of case studies and grounded theory.

4.6 Research Design Limitations

There are several limitations in the design of the study that need to be highlighted. In terms of the approach selected, the use of a case study approach may result in limitations due to the choices of cases and whether the findings can be generalised (Yin, 2009). Initially, three case studies were envisioned for this study, however, only two cases are explored as a third case could not be obtained in a feasible manner.

A potential limitation is the use of a grounded theory approach for the qualitative part of the study. Typically, the use of a grounded theory approach implies that there is no prior theoretical framework (Corbin & Strauss, 2015). However, in this study, several important theoretical concepts and the initial quantitative results were used as a starting point to provide insights and direction. This means that there is a potential bias in the interpretations. Nonetheless, the concepts under consideration evolved with the study and the researcher remained open to the development of new concepts or expanding existing ones during the qualitative analysis. This means that the study did not follow a theoretical sampling method. Other limitations in using a grounded theory approach are the challenges in determining when the theory is fully developed and the time consuming and precise nature of data analysis may lead to potential emerging data themes not being discovered (Babbie, 2013; Khan, 2014).

In terms of data collection, a potential limitation is the self-reported nature of the data that may have been open to respondent bias and misrepresentation. Furthermore, the use of self-reported student information means that the results can show the uses of technologies for learning and the value thereof, but cannot demonstrate any enhancements in student learning performance (Kirkwood & Price, 2013). A further limitation is in the use of online surveys for the quantitative data. A previous survey at Unisa (Liebenberg et al., 2012) found differences in the use of technologies reported by respondents who completed the paper-based survey and those who completed the online survey. However, only online surveys were distributed in this study for consistency in data collection across both studies. Two additional data collection methods that were planned for this study (electronic diaries and learning analytics) had to be discarded. In the case of UOC, only one student responded to an invitation to complete a daily log over a period of a week. The aim was to use electronic diaries as reflective student "self-reports" to compare with other data sources to analyse activities, timing and habits (Clulow & Brace-Govan, 2003). Additionally, learning analytics information stored by the UOC VLE did not include information about devices, therefore this supportive method of data triangulation was discarded as well.

4.7 Ethical Considerations

Researchers must consider ethical issues in the data collection and analysis processes (Khan, 2014). Ethical considerations need to be applied to the research participants, the research methods and the researchers themselves (Corbin & Strauss, 2015). The researcher obtained ethical clearance from the UOC Ethics Committee to conduct the research at the UOC. For the UNISA case, a two-step approval process was required. The researcher first obtained ethical clearance from the UNISA Research and Innovation Ethics Review Committee (2016/URIERC/006_RS). The researcher then obtained research permission from the UNISA Research Permission Sub-committee (2016/RPSC/034). The research was thus conducted in accordance with the relevant institutional research and ethical processes.

The research involved human participants directly, largely through uncontroversial and non-sensitive topics undertaken through an online questionnaire and interview. Due to the nature of the research, this is a low risk study as the participants are adults (undergraduate students) and are not considered to be a vulnerable research population. For the online questionnaire, all responses were anonymous, unless the student provided an email address to express their interest in participating in an interview.

An important consideration is the confidentiality of participant information. The quantitative information was collected online and the survey link was sent and returned anonymously. Although the questionnaires were anonymous, personal information was collected regarding age, gender and other demographic data to understand if these are influencing factors on students' digital device use for study. Other personal information was collected relating to university status (student status, year of study) as well as ownership or use of personal digital devices for learning (via questionnaire and interview). For participants who consented to interviews, their email addresses were collected to facilitate organising interviews. Personal identifiers (name, email address) were removed from the qualitative data before analysis. Pseudonyms are used (together with an age category and gender) when specific examples of participant utterances are described in the results.

Informed consent is an important aspect of ethical data collection. All participants were informed about the research and voluntarily gave their consent to participate. For the survey, the researcher provided information about the research in the email communication to participants and again in the online survey introduction. Participants were required to provide their consent to participate before accessing the survey questions. For the interviews, all participants were provided with an informed consent form to read and sign before the commencement of the interview. Participants were provided with the contact details of the researcher to be able to ask any questions during or after the data collection process.

Another important consideration is the security of participant information. Only the researcher and the supervisor of the researcher have access to the data records. Both require a unique username and password to access the data stored in the survey manager tool or the data analysis tools. For the administration of the online questionnaire, the software uses SSL (secure sockets layer) encryption so that when the data is transmitted the network, it is protected against malicious attacks. The data will be retained for 5 years after the end of the research study (in accordance with UOC and Unisa research and ethical processes and relevant legislation). Thereafter the data will be deleted.

4.8 Validity, Reliability and Credibility

It is important to evaluate the quality of a research study. For quantitative data, researchers look at the validity and the reliability of the data and results. For qualitative data, researchers look at the credibility and authenticity of the data and results.

4.8.1 Validity and Reliability of Quantitative Data

Validity within quantitative research is concerned whether "a measure accurately reflects the concept it is intended to measure" (Babbie, 2013, p. 191). Both internal and external validity need to be considered. As this research study is not experimental, internal validity threats are low. Selection of participants is an important aspect. The researcher made use of a random selection of participants in each case so that participant characteristics had the probability of being equally distributed. In terms of participant drop out, a large sample was collected from two different sites and the data collection took place over a short time period to minimise drop out (Creswell, 2009). The interaction of setting and treatment is the first consideration for external validity. The researcher collected data in two different university settings so that the findings can be generalised to other settings. The interaction of history and treatment is the second consideration for external validity. In each case data was collected over a semester. The interaction of selection and treatment is the third consideration for external validity (Creswell, 2009). The sample was carefully defined and results will be generalised only for ODL universities.

The quantitative data gathering instrument (questionnaire) was designed specifically for this research. However, the design of the instrument was influenced by the instruments used by other researchers and a review of the literature. To establish validity, the instrument was piloted within a sample group of students at the UOC and it was also sent to a group of expert researchers for review. Five experts responded to this invitation and provided feedback on the questionnaire. This testing was important to improve questions, format and scales. For the questionnaire versions in Catalan and Spain at the UOC, pilot participants were also invited to suggest any improvements to the language used. The pilot test and expert reviews measured face validity (that the quality of an indicator seems to be a reasonable measure of some variable) and content validity (that a measure covers the range of meanings about a concept). Reliability within quantitative research is a measure of quality "that suggests that the same data would have been collected each time in repeated observations of the same phenomenon" (Babbie, 2013, p. 188). To ensure reliability, the questions should be relevant and the respondents willing and competent to respond. The reliability of the instrument was established by multiple uses and in the consistency of instrument administration. For any research publications, the data collection instruments should be appended (Creswell, 2009), as they are in this thesis.

4.8.2 Credibility and Authenticity of Qualitative Data

When interview questions are designed, it is important to assess the extent to which the questions asked and the answers received reflect the content under study (Babbie, 2013). As a measure of authenticity, the semi-structured interview in this study was piloted for future data collection. Two pilot interviews were conducted with student participants at UOC to check the instrument used. The questions were refined to ensure that they are the right questions to ask to be able to answer the research questions. Further checks include checking that the transcripts of interviews do not contain any transcription errors and that the definition of codes and the meaning of codes do not change over time (Creswell, 2009).

A condition for credibility is methodological consistency. The researcher made use of the grounded theory method and use the procedures defined by Corbin & Strauss (2015) and other authors, such as strategies for qualitative data analysis: constant comparison, asking questions and the use of open coding and memoing. Creswell (2009) advocates the use of triangulation by examining evidence from different sources to ensure accuracy. Different data sources were used to ensure dependability and transferability.

A key aspect of qualitative reliability is consistency (Gibbs, 2007, as cited in Creswell, 2009). For example, in the case of categorising raw interview data, another researcher could be asked to undertake the coding or categorisation process independently, for intercoder agreement. For this study, the research fieldworkers who undertook the interviews with UOC students were asked to review the categories and provide feedback. The supervisor of the researcher verified that the data analysis approach undertaken by the researcher was consistent. Another method for credibility is the use of external auditors to review the entire research project (Creswell, 2009). As this study forms part of a doctoral project, the thesis will be evaluated by a group of external experts.

To review the credibility of the research findings, Babbie (2013) suggests considering whether the conducted research addresses the original aims and purpose. In this research study, the aims and purpose were clearly defined in the initial research proposal and in the Introduction chapter (Chapter 1). The researcher attempted to follow through by assessing the findings against these aims. Researcher self-awareness and self-reflection is important for qualitative studies (Corbin & Strauss, 2015; Creswell, 2009). Corbin & Strauss (2015) suggest keeping a journal and writing memos about feelings and reactions during data collection and analysis to be aware of any biases and assumptions. The researcher made use of memos during the data collection and analysis process to write down any reactions and ideas. Another condition related to credibility is methodological awareness or training in qualitative research (Corbin & Strauss, 2015). For this study, the researcher developed their qualitative research skills through participating in a qualitative methods research course, reading about grounded theory and applying these learnings throughout the study.

To ensure the trustworthiness of the research, sensitivity to participants and data is required. In this study, the researcher attempted to be sensitive to participants by treating them with respect and honesty. Finally, to promote authenticity, the researcher needs to be open to new ideas and using strategies creatively and flexibly (Corbin & Strauss, 2015). The researcher followed the grounded theory approach during the qualitative analysis phase, yet remained flexible and open to other ideas in the analysis and reporting of the data.

4.9 Summary

This chapter has set out the research design and processes followed in this study. The study follows a mixed methods design that combines a case study and a grounded theory approach. The cases consist of two ODL universities (UOC and UNISA). The research participants at these universities consisted of samples of undergraduate students. For each university, quantitative and qualitative data was collected. First an electronic survey was sent to students, this was followed by online or telephone interviews conducted with a subset of interview participants. The quantitative data was analysed by starting with the descriptive (univariate) analysis, followed by correlations (bivariate analysis) and linear regressions (multivariate analysis). The qualitative data was analysed using a grounded theory approach with initial coding, more focussed coding and theoretical coding. This chapter also discussed the ethical considerations as well as issues related to validity, reliability and credibility. The next chapter will present the results of the first case study (UOC).

Chapter 5
UOC Case Results

This chapter introduces the results of the UOC case (Section 5.1) and provides an overview of the UOC teaching and learning model (Section 5.2). The learner demographic data is specified (Section 5.3). The data analysis processes are highlighted (Section 5.4) and the integrated quantitative and qualitative findings are presented for how students use different digital devices, in different locations to perform different learning activities (Section 5.5) and the quantitative and qualitative results are presented for demonstrating how students use multiple devices together (Section 5.6). Quantitative and qualitative results are then shown for how students use multiple devices obtain academic and technological support (Section 5.7). Finally, a short summary (Section 5.8) closes the chapter.

5.1 Introduction

This chapter presents the results of the UOC case by showing the results of the quantitative survey and the follow-up qualitative interviews. The first section highlights the teaching and learning model at UOC, while the next section provides the demographic data of the survey respondents and the representativeness of the sample. The following section highlights the data analysis processes followed. The results are categorised into three sections to address the three research questions in this study. The first research question explores the devices students use, the locations they study in and the learning activities undertaken. The research second question analyses how students make use of multiple devices together. The third research question analyses the academic and technological support that students need. For the each of research question sections, the quantitative results are first presented. The quantitative analysis starts with the descriptive and initial bivariate analysis (correlations) of the variables. Chi-square tests of independence were performed to determine significant associations between categorical variables. More advanced statistics, Principal Components Analysis (PCA) and multivariate (regressions) analysis were performed to categorise how students use devices and to be able to determine the frequency of device usage. The results of the qualitative interviews follow the quantitative data to provide a richer description of the results and explain the quantitative findings with examples. A short summary then concludes the chapter.

5.2 UOC Teaching and Learning Model

The educational model at UOC was designed to adapt to the progress of the internet and the knowledge society. The model creates a learning environment that combines a variety of learning resources with support from the teaching team and interaction with fellow students. The students and their learning activities are at the centre of the educational process (Figure 5.1). Continuous formative assessments provide constructive feedback to ensure continual improvement in the learning process, while summative assessments occur at the end of each semester. The model is oriented towards collective participation and knowledge building, and embraces the students' learning, social and working experiences. The UOC's VLE is known as the Virtual Campus and is the online learning environment where all these elements converge and become interrelated. The student is supported at all times by specialised educators who design, guide and assess the educational process: The professor designs the course and assures the quality, the course instructor guides and assesses the student's learning process in a course and the tutor guides the student in choosing a personalised academic pathway at the UOC (across courses) (UOC, 2017a).

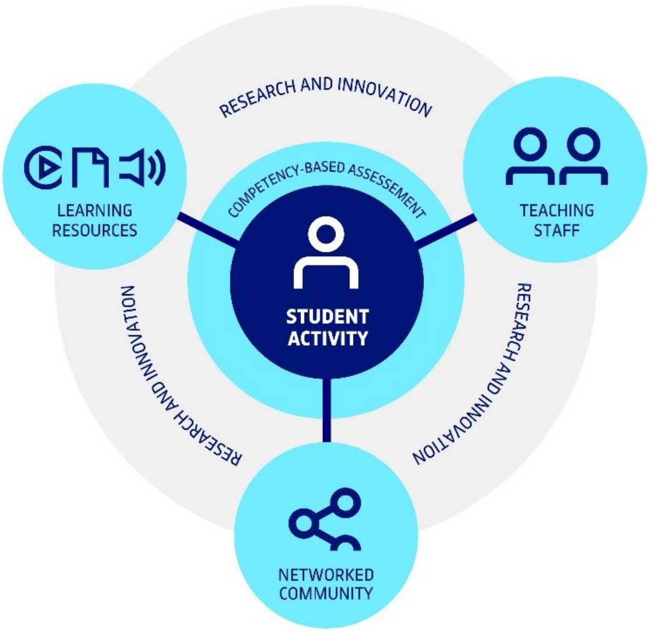

Figure 5.1: UOC Educational Model (Source: UOC, 2017a)

5.3 Demographic Profile

The aim of this section is to identify the characteristics of the sample students as well as the representativeness of the sample. 488 undergraduate students at UOC completed the survey. Seven demographic classifications were looked at: age, gender, discipline, employment status, national status, year of study, and language status. This demographic data was also used to determine any significant relationships.

Table 5.1 shows the demographic distributions for age, gender, discipline, employment status, national status, year of study, and language status (n=488). The sampling error was calculated to be 4.44% (n=488, with p=q=50.0%, confidence level=95.0%). The population of students (obtained from the university datamart) for 2015/2016 was N=25 788.

In terms of age, 63.5% of the respondents were between 26-35 years and 36-45 years. This is common in an online university, where there is a wide range of student ages, with a small proportion of “traditional” aged students. There was no gender bias, with a slight majority of females (53.5%) over males (46.5%). This matches the profile of UOC undergraduate students of 52.1% female and 47.9% male (according to UOC datamart information for 2015/2016). Students from a wide variety of disciplines participated in the survey (the UOC offers 22 bachelor degrees), the most common disciplines were Social Sciences (25.0%), Business or Economics (19.1%) and Engineering/Technology (15.4%). 87.3% of students were employed (either part-time or full-time). This is similar to the 80.0% of students who work and study according to UOC general information (UOC, 2017b). Almost all students were in Spain (92.4%). Students across different years of study participated. The majority of students' home language and language of study was the same (69.7%).

Table 5.1: Demographic Profile

Demographic	**Values**	**Frequency**	**Percentage**
Age	25 and under	78	16.0
	26-35 years	160	32.8
	36-45 years	150	30.7
	46-55 years	91	18.6
	56 and over	9	1.8
Gender	Female	261	53.5
	Male	227	46.5
Discipline	Arts, Humanities or Languages	48	9.8
	Business or Economics	93	19.1
	Education	23	4.7
	Engineering or Technology	75	15.4
	Environmental or Life Sciences	2	0.4
	Information or Communication Sciences	51	10.5
	Law	66	13.5
	Social Sciences	122	25.0
	Healthcare	8	1.6
Employment Status	Not employed	62	12.7
	Employed part-time	93	19.1
	Employed full-time	333	68.2
National Status	Local student	451	92.4
	International student	37	7.6
Year of Study	Less than 1 year	156	32.0
	1-2 years	71	14.5
	2-3 years	70	14.3
	3-4 years	75	15.4
	More than 4 years	116	23.8
Language Status	Same home and study language	340	69.7
	Different home and study language	148	30.3

In comparison to demographic information (age, discipline and gender) obtained for the registered UOC undergraduates for the year 2015/2016 (N=27 588), the sample accurately reflected the population under study and can be considered representative.

5.4 Data Analysis Processes

The analysis processes are described in the Research Methodology chapter (Section 4.5). As discussed in that chapter, the aim of this study was to be exploratory and the focus was mainly on descriptive analysis, however there is some focus on more advanced statistics. In order to answer the first two research questions, the quantitative data was analysed using univariate analysis, followed by bivariate analysis (correlations). Chi-square tests of independence were performed and finally, multivariate analysis (multiple regressions) was performed. A note on the results of the correlations analysis: The cut-off for weak relationships was set at $r = 0.20$ (Evans, 1996). None of the correlations between devices and the other variables are close to perfect or very strong ($r > 0.80$). This indicates that device usage for study has complex uses and practices that may have different determining factors and explanations. The qualitative data was then analysed using a grounded theory approach to explain and supplement the quantitative findings.

5.5 Devices, Learning Locations and Learning Activities

The aim of this section is to provide a summary of findings that are able to address the first research question (*Which digital devices, and for which purposes and locations, are ODL university students using to perform their learning activities?*). This section focuses on device access and frequency of use, as well as the locations where studies are undertaken and the learning activities performed.

5.5.1 Descriptive Analysis

5.5.1.1 Device Access

Table 5.2 shows student's access to digital devices (percentages). Students were asked which digital devices have access to or they own (0 = I do not have access, 1 = I use someone else's, 2 = I have my own) from a list of six common devices (desktop, laptop, tablet, smartphone, basic mobile and e-reader). Access to devices was determined by combining "I use someone else's" with "I have my own". The sample means show that a smartphone with a mean of 1.84 (with a standard deviation (SD) of 0.54) is the most common device that is accessed. The second most accessed device is the laptop with a mean of 1.79 (SD of 0.57). Desktops and tablets are also common. However, access to e-readers and basic mobiles is low, the least most accessed device is the basic mobile with a mean of 0.29 (SD of 0.70).

Table 5.2: Access to Digital Devices (Percentages)

Device	M	SD	I do not have access	I use someone else's	I have my own
Desktop	1.35	0.86	25.4	13.7	60.9
Laptop	1.79	0.57	8.0	4.9	87.1
Tablet	1.29	0.91	30.9	9.2	59.8
Smartphone	1.84	0.54	7.8	0.6	91.6
Basic Mobile	0.29	0.70	84.8	1.2	13.9
e-Reader	0.59	0.89	68.0	4.5	27.5

n=488

Figure 5.2 visually represents the ownership and access for each device. It shows that students own the majority of the devices they use, with very few students sharing devices (accessing the devices of others). The device most likely to be shared is the desktop (13.7% of respondent's use someone else's). Similar to Table 5.2, when combining personal ownership and access, the percentages show that the most commonly accessed devices are smartphones (92.2%) and laptops (92.0%). This is followed by desktops (74.6%) and tablets (69.1%). e-Readers (32.0%) and basic mobile phones (15.2%) are less commonly accessed.

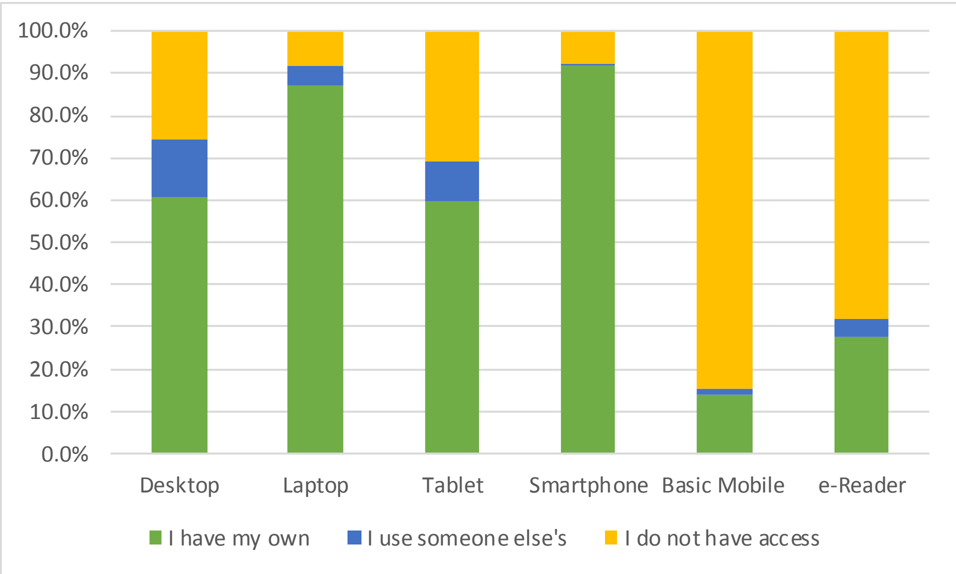

Figure 5.2: Ownership/Access of Digital Devices (Percentages)

Students have access to multiple devices: 99.6% of students had access to two or more devices, while 89.3% of students had access to three or more devices. Figure 5.3 shows the distribution of how many devices students have access to. Most students had access to between three (29.5%) and four (37.3%) devices, with a mean of 3.75 (SD of 1.01). The most common sets of devices students had access to were: a desktop, laptop, tablet and smartphone (25.2%), a desktop, laptop, tablet, smartphone and e-reader (13.7%), a desktop, laptop and smartphone (11.1%), and a laptop, tablet and smartphone (11%).

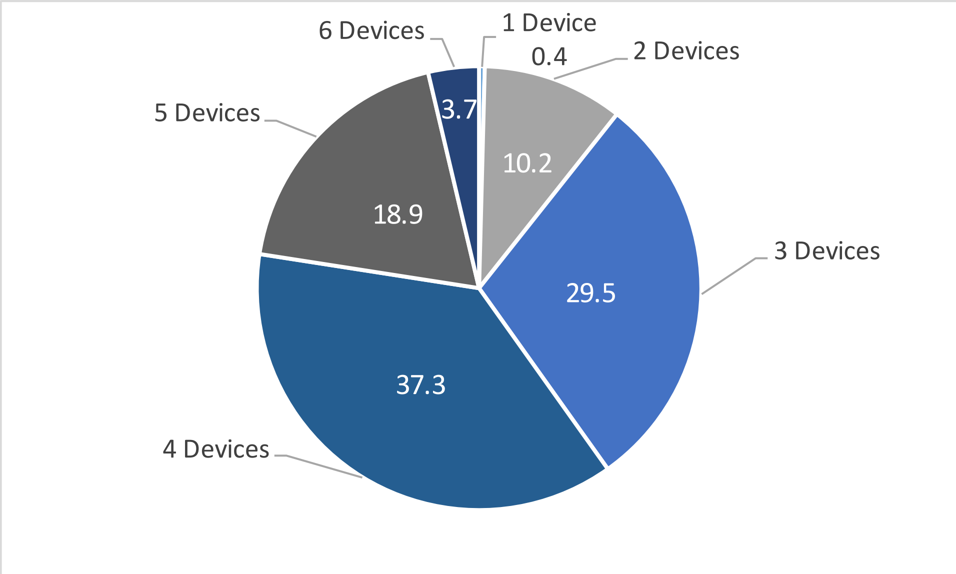

Figure 5.3: Number of Devices Accessed (Percentages)

The following sections describe the analysis of relationships (correlations) between access to a particular device and demographic variables as well as access to other devices.

5.5.1.1.1 Device Access and Demographic Variables

Table 5.3 shows the relationships (correlations) between device access and the different demographic variables, except for Discipline. Correlations analysis could not be performed because Discipline is a nominal variable. The only significant relationship (above $r_s = 0.20$) found between age group and device access was that older students (45 and above) were slightly less likely to have access to smartphones ($r_s = -0.23$, $p < 0.01$). No significant relationships (above $r_s = 0.20$) above were found between access to any of the devices and the other demographic variables (gender, employment status, national status, year of study and language status).

Table 5.3: Correlations between Device Access and Demographic Variables

Device Access	**M**	**SD**	**Age Group**	**Gender**	**Employ-ment Status**	**National Status**	**Year of Study**	**Language Status**
Desktop Access	1.35	0.86	0.11*	0.14**	0.05	-0.15**	0.08	0.04
Laptop Access	1.79	0.57	-0.11*	-0.05	-0.05	0.02	0.00	0.00
Tablet Access	1.29	0.91	0.12**	-0.01	0.07	-0.04	0.05	0.01
Smartphone Access	1.84	0.54	-0.23**	0.01	0.02	0.01	0.06	0.01
Basic Mobile Access	0.29	0.70	0.10*	0.06	0.01	-0.01	-0.02	-0.01
e-Reader Access	0.59	0.89	0.04	0.01	-0.03	-0.02	-0.02	0.04

* p < 0.05, ** p < 0.01
n=488

5.5.1.1.2 Device Access (Across Devices)

Tables 5.4 shows the relationships (correlations) between access to different devices. Students with access to smartphones were slightly less likely to have access to basic mobiles (r_s = -0.39, p < 0.01). Students who had access to laptops were slightly less likely to have access to desktops (r_s = -0.23, p < 0.01). No significant relationships (above r_s = 0.20) were found between access to any of the other devices.

Table 5.4: Correlations between Access to Different Devices

Device Access	M	SD	Desktop Access	Laptop Access	Tablet Access	Smart-phone Access	Basic Mobile Access	e-Reader Access
Desktop Access	1.35	0.86	-					
Laptop Access	1.79	0.57	-0.23**	-				
Tablet Access	1.29	0.91	0.09*	0.03	-			
Smartphone Access	1.84	0.54	-0.04	0.18**	0.17**	-		
Basic Mobile Access	0.29	0.70	0.09*	-0.01	0.00	-0.39**	-	
e-Reader Access	0.59	0.89	0.00	0.07	0.03	0.08	0.07	-

* p < 0.05, ** p < 0.01
n=488

It is clear that students have access to multiple digital devices. However, as discussed in the Literature Review chapter (Chapter 3), access to devices does not automatically imply their use for academic purposes. The next section looks at how frequently students make use of these devices for their studies.

5.5.1.2 Device Use for Study

Table 5.5 shows students' frequency of using different devices for study (percentages). Students were asked, based on the devices they had access to, to indicate how often they used these devices for study purposes (0 = Never, 1 = Monthly, 2 = Weekly, 3 = Daily). Frequency of device usage for study was determined by combining "Monthly", "Weekly" and "Daily" uses. The sample means show that a laptop with a mean of 2.59 (SD of 0.73) is the device that is most frequently used for studies. The second most frequently used device for studies is the desktop with a mean of 2.26 (SD of 1.02), followed by the smartphone with a mean of 2.12 (SD of 1.17). This indicates that laptops, desktops and smartphones are frequently used either weekly or daily for study. The least frequently used devices for study were the basic mobile with a mean of 1.29 (SD of 1.31) and the e-reader with a mean of 1.08 (SD of 1.02).

Table 5.5: Frequency of Device Use for Study (Percentages)

Device	n	M	SD	Never	Monthly	Weekly	Daily
Desktop	350	2.26	1.02	11.1	9.1	22.3	57.4
Laptop	449	2.59	0.73	2.7	6.2	20.7	70.4
Tablet	337	1.88	1.05	13.4	21.4	28.8	36.5
Smartphone	450	2.12	1.17	17.8	10.0	14.9	57.3
Basic Mobile	69	1.29	1.31	44.9	10.1	15.9	29.0
e-Reader	150	1.08	1.02	36.7	30.0	22.0	11.3

n = Excludes students without access to devices

Figure 5.4 visually represents the frequency of usage for study of each device. For those students who have access to specific devices, 70.4% use a laptop daily for study, 57.4% use a desktop and 57.3% use a smartphone. As 87.3% of students work part-time or full-time and study, it is expected that many do not study every day. If a combination of daily and weekly study usage is considered, 91.1% of students use a laptop, 79.7% use a desktop, 72.2% use a smartphone, 65.3% use a tablet, 44.9% use a basic mobile phone and 33.3% use an e-reader.

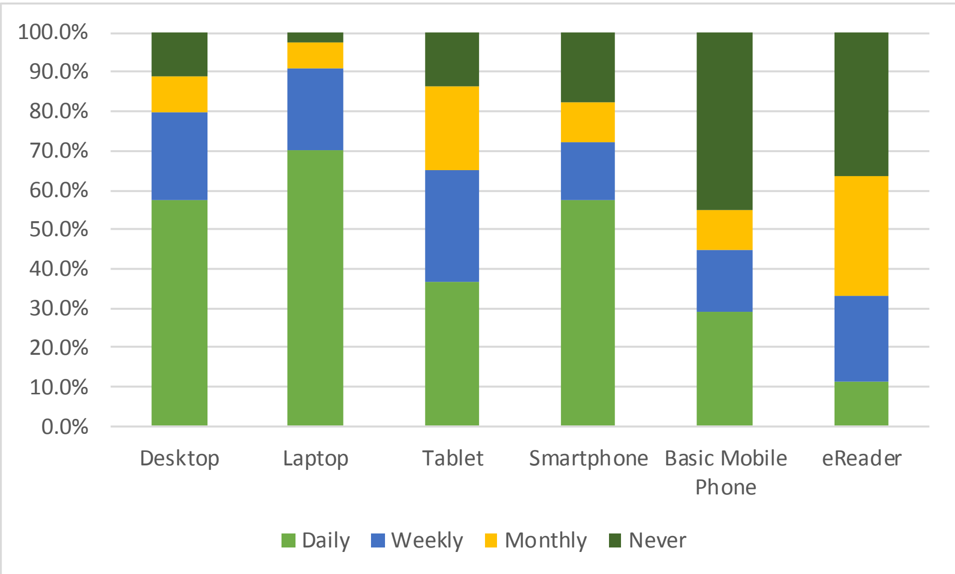

Figure 5.4: Frequency of Usage of Devices for Study (Percentages)

Students use multiple devices for study: 95.3% of students use two or more devices, while 71.9% use three or more. Figure 5.5 shows the frequency of how many devices students use for study purposes. Most students use between three (34.6%) and four (27.3%) devices, with a mean of 3.16 (SD of 1.07). The most common device sets that students use for study were the desktop, laptop, tablet and smartphone (19.5%), followed by laptop, tablet and smartphone (12.3%) and desktop, laptop and smartphone (10.9%).

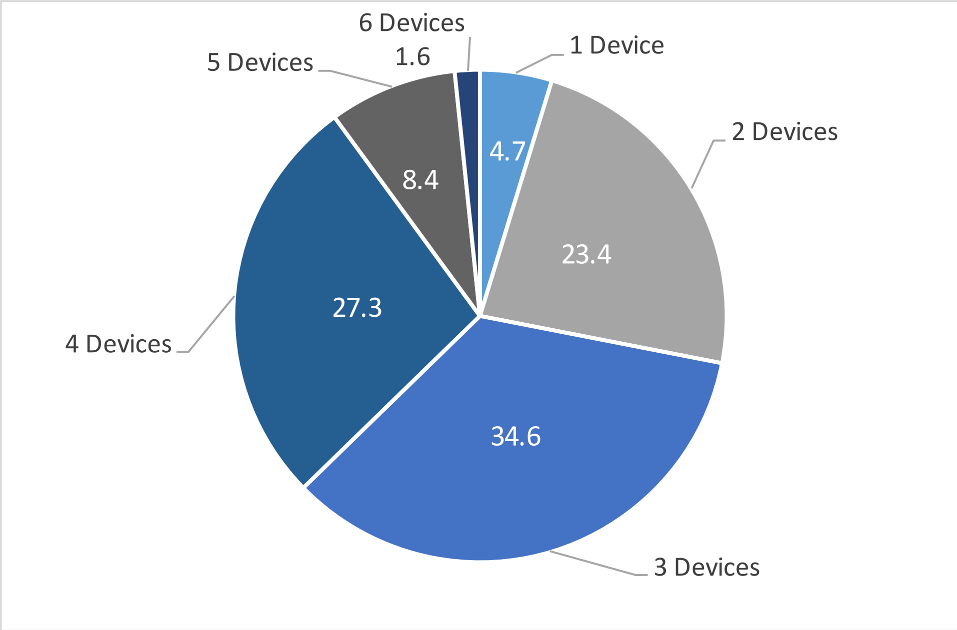

Figure 5.5: Number of Devices Used for Study (Percentages)

Survey respondents were asked to provide examples of any other digital devices that they used for study purposes (other than the six listed above). There were no major findings. A few students (n=5) mentioned the use of a smart TV to watch videos, while a few (n=4) mentioned making use of dual screens or an extra monitor when using their laptop or desktop to perform learning activities.

The following sections describe the analysis of relationships (correlations) between the frequency of use of a particular device and demographic variables as well as other related variables (device access, purchase reason, level of expertise and importance to academic success). Due to the low numbers of basic mobiles (n=38) and e-readers (n=94) that are used for study purposes, these devices were excluded from further analysis.

5.5.1.2.1 Device Use and Demographic Variables

Table 5.6 shows the relationships (correlations) between device use frequency and the different demographic variables, except for Discipline. Older students were slightly more likely to make use of desktops and tablets more frequently for studies ($r_s = 0.29$, $p < 0.01$ and $r_s = 0.22$, $p < 0.01$, respectively). There were no significant relationships (above $r_s = 0.20$) between age group and frequency of use for the other devices. Male students were slightly more likely to use the desktop more frequently for studies ($r = 0.22$, $p < 0.01$). There were no significant relationships (above $r_s = 0.20$) between gender and frequency of use for the other devices. There were no significant relationships (above $r_s = 0.20$) between frequency of use for any of the devices and employment status, national status, year of study or language status.

Table 5.6: Correlations between Device Frequency and Demographic Variables

Device Frequency	n	M	SD	Age Group	Gender	Employ-ment Status	National Status	Year of Study	Language Status
Desktop Frequency	350	2.26	1.02	0.29**	0.22**	0.12*	0.04	0.10	-0.03
Laptop Frequency	449	2.59	0.73	-0.05	-0.06	-0.08	0.12*	-0.07	-0.03
Tablet Frequency	337	1.88	1.05	0.22**	0.15**	0.06	0.09	0.06	-0.05
Smartphone Frequency	450	2.12	1.17	-0.09	0.02	-0.09	0.10*	-0.09	-0.08

* p < 0.05, ** p < 0.01
n = Excludes students without access to device*s*

5.5.1.2.2 Device Use and Device Access

Table 5.7 shows the relationships (correlations) between device usage frequency and access to devices. Students who have greater access to a desktop were slightly more likely to use the desktop more frequently for study ($r_s = 0.38$, $p < 0.01$). Students who have greater access to a tablet were slightly more likely to use the tablet more frequently for study ($r_s = 0.31$, $p < 0.01$). Students who have greater access to a laptop were slightly more likely to use the laptop more frequently for study ($r_s = 0.29$, $p < 0.01$). There was no significant relationship between smartphone use frequency and access to a smartphone.

Tables 5.7 also shows the relationships (correlations) between the use of a device for study and frequency of use of other devices. Students who frequently use smartphones were also likely to slightly more frequently use tablets ($r_s = 0.35$, $p < 0.01$). Students who frequently use desktops were slightly less likely to frequently use laptops ($r_s = -0.34$, $p < 0.01$).

Table 5.7: Correlations between Device Access and Device Frequency Variables

Device Frequency	n	M	SD	Desktop Access	Laptop Access	Tablet Access	Smart-phone Access	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency
Desktop Frequency	350	2.26	1.02	0.38**	-0.20**	0.02	-0.04	-			
Laptop Frequency	449	2.59	0.73	-0.27**	0.29**	-0.05	-0.06	-0.34**	-		
Tablet Frequency	337	1.88	1.05	-0.07	0.01	0.31**	-0.07	0.18**	0.03	-	
Smartphone Frequency	450	2.12	1.17	-0.08	0.09	-0.08	0.06	0.14**	0.16**	0.35**	-

* p < 0.05, ** p < 0.01
n = Excludes students without access to devices

5.5.1.2.3 Device Use and Purchase Reason

Table 5.8 shows the proportion of students owning devices by reason for purchase (percentages). Student who indicated that they owned specific devices were asked to indicate the reason for purchase (0 = Purchased for university study, 1 = Purchased for another purpose). The sample means show that a laptop with a mean of 0.45 (SD of 0.50) was the most common device that is purchased for study reasons.

The laptop is the only device where more students (55.5%) purchased the device for study purposes than for other reasons. The second most purchased device for study was the desktop with a mean of 0.67 (SD of 0.47). The devices that are purchased the least for studies are the smartphone with a mean of 0.96 (SD of 0.19) and the basic mobile with a mean of 0.97 (SD of 0.18).

Table 5.8: Proportion of Students Owning Devices by Reason for Purchase (Percentages)

Device	n	M	SD	Purchased for university study	Purchased for another purpose
Desktop	285	0.67	0.47	33.0	67.0
Laptop	420	0.45	0.50	55.5	44.5
Tablet	287	0.80	0.40	19.5	80.5
Smartphone	435	0.96	0.19	3.9	96.1
Basic Mobile	64	0.97	0.18	3.1	96.9
e-Reader	130	0.85	0.36	14.6	85.4

n = Excludes students who do not own devices

Table 5.9 shows the relationships (correlations) between the reason for device purchase and device use frequency. Students who purchased tablets for study were slightly more likely to use them more frequently for study (r = -0.27, $p < 0.01$). There were no relationships between purchase reason and device usage frequency for the other devices. For relationships between devices purchased for study, students who purchased desktops for study were slightly likely to purchase laptops for study (r = 0.30, $p < 0.01$). Students who purchased tablets for study were slightly likely to purchase smartphones for study (r = 0.21, $p < 0.01$).

Table 5.9: Correlations between Device Frequency and Purchase Reason Variables

	n	M	SD	Purchase Desktop	Purchase Laptop	Purchase Tablet	Purchase Smartphone
Purchase Desktop	285	0.67	0.47	-			
Purchase Laptop	420	0.45	0.50	0.30**	-		
Purchase Tablet	287	0.80	0.40	0.15*	0.10	-	
Purchase Smartphone	435	0.96	0.19	0.16**	0.18**	0.21**	-
Desktop Frequency	350	2.26	1.02	-0.16**	0.17**	-0.04	-0.05
Laptop Frequency	449	2.59	0.73	0.10	-0.09*	-0.05	-0.02
Tablet Frequency	337	1.88	1.05	0.03	0.12*	-0.27**	-0.04
Smartphone Frequency	450	2.12	1.17	0.03	-0.01	0.00	-0.08

* p < 0.05, ** p < 0.01
n = Purchase: excludes students who do not own devices, Frequency: excludes students without access to devices

5.5.1.2.4 Device Use and Level of Expertise

Table 5.10 shows the frequency of device usage for study by level of expertise (percentages). Students were asked to indicate their level of expertise with the devices they use for studies using a Likert scale (0 = Very low, 1 = Low, 2 = Neutral, 3 = High, 4 = Very high). The sample means show that students have the highest level of expertise with a desktop with a mean of 3.54 (SD of 0.73) and a laptop with a mean of 3.53 (SD of 0.63). Thus, students have high or very high levels of expertise in using these devices for study, while have neutral or high levels of expertise for the other devices. Students had the lowest level of expertise with the e-reader with a mean of 2.52 (SD of 1.19).

Table 5.10: Frequency of Device Use by Level of Expertise (Percentages)

Device	**n**	**M**	**SD**	**Very Low**	**Low**	**Neutral**	**High**	**Very High**
Desktop	307	3.54	0.73	0.3	2.0	6.2	26.4	65.1
Laptop	438	3.53	0.63	0.0	0.2	6.4	33.6	59.8
Tablet	291	2.89	0.97	0.3	9.3	22.7	36.4	31.3
Smartphone	367	2.65	1.18	4.6	14.7	20.4	31.3	28.9
Basic Mobile	36	2.61	1.38	11.1	13.9	11.1	30.6	33.3
e-Reader	93	2.52	1.19	6.5	12.9	29.0	25.8	25.8

n = Excludes students without access to devices, some values missing

Table 5.11 shows the relationships (correlations) between level of expertise and device frequency for study. There is a positive relationship between level of expertise and device frequency, the greater the level of expertise, the more likely students used the device frequently. Students who have greater expertise in using the tablet, desktop, laptop or smartphone were slightly more likely to use that device more frequently for study ($r_s = 0.31$, $r_s = 0.24$, $r_s = 0.24$ and $r_s = 0.20$, respectively, $p < 0.01$ in all cases).

For relationships between levels of expertise in different devices, students who had higher expertise in using tablets were more likely to have higher expertise in using smartphones ($r_s = 0.61$, $p < 0.01$). Students who had expertise in using laptops were more likely to have expertise in using desktops, tablets and smartphones ($r_s = 0.41$, $r_s = 0.33$ and $r_s = 0.24$, respectively, $p < 0.01$ in all cases).

Table 5.11: Correlations between Device Frequency and Expertise Variables

	n	M	SD	Desktop Expertise	Laptop Expertise	Tablet Expertise	Smartphone Expertise
Desktop Expertise	307	3.54	0.73	-			
Laptop Expertise	438	3.53	0.63	0.41**	-		
Tablet Expertise	291	2.89	0.97	0.13	0.33**	-	
Smartphone Expertise	367	2.65	1.18	0.09	0.24**	0.61**	-
Desktop Frequency	350	2.26	1.02	0.24**	-0.14*	0.09	0.14*
Laptop Frequency	449	2.59	0.73	-0.07	0.24**	0.08	0.08
Tablet Frequency	337	1.88	1.05	0.13	0.07	0.31**	0.04
Smartphone Frequency	450	2.12	1.17	0.08	0.08	0.17**	0.20**

* p < 0.05, ** p < 0.01

n = Excludes students without access to devices, some values missing

5.5.1.2.5 Device Use and Importance to Academic Success

Table 5.12 shows the frequency of device usage for study by importance to academic success (percentages). Students were asked to indicate the importance of the devices they use for studies for academic success using a Likert scale (0 = Very low, 1 = Low, 2 = Neutral, 3 = High, 4 = Very high). The sample means show that students consider the laptop with a mean of 3.67 (SD of 0.69) to be the most important device for academic success. This is followed by the desktop with a mean of 3.43 (SD of 0.95). Students view these devices as having a high or very high importance for study, while view tablets and smartphones as having a neutral or high importance for study. Students view basic mobiles and e-readers as having low or neutral importance for study. Students consider the basic mobile with a mean of 1.51 (SD of 1.39) to be the least important device for academic success.

Table 5.12: Frequency of Device Use by Level of Importance (Percentages)

Device	n	M	SD	Very Low	Low	Neutral	High	Very High
Desktop	308	3.43	0.95	2.9	1.6	10.1	20.5	64.9
Laptop	439	3.67	0.69	0.5	1.4	5.5	16.6	76.1
Tablet	290	2.43	1.13	7.2	10.3	34.1	28.6	19.7
Smartphone	372	2.22	1.19	11.6	11.6	36.0	25.0	15.9
Basic Mobile	37	1.51	1.39	32.4	18.9	27.0	8.1	13.5
e-Reader	95	1.52	1.18	26.3	21.1	32.6	14.7	5.3

n = Excludes students without access to devices, some values missing

Figure 5.6 visually represents that, in general, the combined daily and weekly use of a specific device for study is related to its specified importance for academic study. However, tablets are considered more important than smartphones, yet smartphones are used more often for study. Laptops are considered to be the most important devices for academic success (when using a combination of high and very high importance) (92.7%), followed by desktops (85.4%), tablets (48.3%), smartphones (40.9%), basic mobiles (21.6%) and e-readers (20.0%).

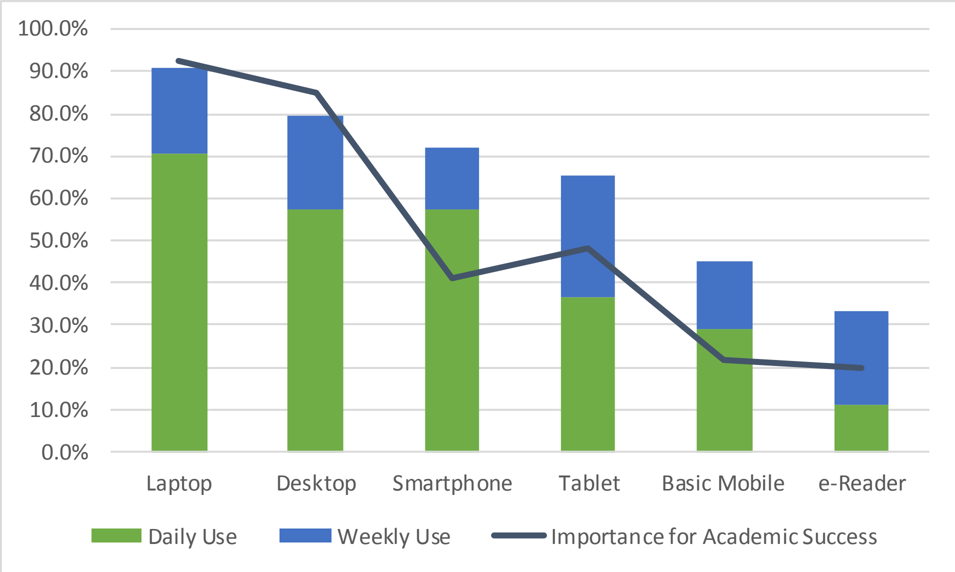

Figure 5.6: Daily/Weekly Use of Devices for Study Compared to Importance (Percentages)

Table 5.13 shows the relationships (correlations) between importance for academic success and device frequency for study. There is a positive relationship between perceived importance and device frequency. Students who consider the tablet, laptop and desktop to be important for academic success were more likely to use those devices more frequently for study (r_s = 0.54, r_s = 0.52 and r_s = 0.44, respectively, $p < 0.01$ in all cases). Students who consider the smartphone to be important for academic success were slightly more likely to use it more frequently for study (r_s = 0.28, $p < 0.01$). For relationships between levels of importance in different devices, students who considered tablets to be important were slightly more likely to consider smartphones to be important (r_s = 0.37, $p < 0.01$).

Table 5.13: Correlations between Device Frequency and Importance Variables

	n	M	SD	Desktop Importance	Laptop Importance	Tablet Importance	Smartphone Importance
Desktop Importance	308	3.43	0.95	-			
Laptop Importance	439	3.67	0.69	-0.08	-		
Tablet Importance	290	2.43	1.13	-0.03	0.07	-	
Smartphone Importance	372	2.22	1.19	-0.03	0.16**	0.37**	-
Desktop Frequency	350	2.26	1.02	0.44**	-0.28**	0.10	0.09
Laptop Frequency	449	2.59	0.73	-0.29**	0.52**	0.02	0.11*
Tablet Frequency	337	1.88	1.05	0.10	0.07	0.54**	0.10
Smartphone Frequency	450	2.12	1.17	0.06	0.13**	0.14*	0.28**

* $p < 0.05$, ** $p < 0.01$
n = Excludes students without access to devices, some values missing

Table 5.14 shows the correlations between device expertise and importance for academic success. Students who place greater importance in using the smartphone, tablet, desktop or smartphone are more likely to have greater expertise in the use of these devices ($r_s = 0.49$, $r_s = 0.46$, $r_s = 0.45$ and $r_s = 0.41$, respectively, $p < 0.01$ in all cases).

Table 5.14: Correlations between Device Expertise and Importance Variables

	n	M	SD	Desktop Expertise	Laptop Expertise	Tablet Expertise	Smartphone Expertise
Desktop Importance	308	3.43	0.95	0.45**	-0.07	-0.06	-0.02
Laptop Importance	439	3.67	0.69	-0.02	0.41**	0.01	0.08
Tablet Importance	290	2.43	1.13	-0.08	-0.01	0.46**	0.17**
Smartphone Importance	372	2.22	1.19	-0.03	0.06	0.27**	0.49**

* p < 0.05, ** p < 0.01
n = Excludes students without access to devices, some values missing

5.5.1.3 Learning Locations

Students were asked to select, for the devices they use for study, in which locations they use these devices for study. These locations were selected based on previous similar studies in distance and dual mode universities (Cross et al., 2015; Murphy et al., 2014). Table 5.15 shows the locations where the different devices are used for study. Unsurprisingly, the most common location for studying was at home for all devices. Desktops are mainly used for studies at home (83.7%), followed by at work (38.1%). Laptops are used for learning mainly at home (93.8%), but sometimes also in public locations with Wi-Fi such as restaurants or libraries (31.5%) and the homes of friends or family (27.4%). Tablets are also mainly used at home for learning (89.8%), but also in public locations with Wi-Fi such as restaurants or libraries (31.2%), homes of family or friends (25.3%) and in-transit (21.8%). Given that smartphones are more portable and are usually on-person, they are used for learning across the most number of locations, such as home (79.7%), in-transit (66.9%), work (56.3%), homes of family/friends (49.7%) and public locations with Wi-Fi (49.7%). Similarly, basic mobile phones are mainly used at home (76.5%), work (35.3%) and in-transit (29.4%). e-Readers are also mainly used for study at home (81.8%) and in-transit (45.5%).

Table 5.15: Learning Locations by Device (Percentages)

	Desktop	Laptop	Tablet	Smartphone	Basic Mobile	e-Reader
	n=307	n=435	n=285	n=350	n=34	n=88
Home	83.7	93.8	89.8	79.7	76.5	81.8
Work	38.1	26.7	20.4	56.3	35.3	10.2
Home of Family/Friends	5.9	27.4	25.3	49.7	23.5	26.1
University Centre	3.6	11.5	7.7	20.6	8.8	5.7
Public Location with Wi-Fi	3.9	31.5	31.2	49.7	11.8	13.6
In-transit	N/A	6.7	21.8	66.9	29.4	45.5
Other	2.9	12.2	13.7	34.6	20.6	17.0

n = Excludes students who do not use devices

Students could select "Other" to indicate studying in another location. However, due to the question type, this could not be expanded upon in the survey. In follow-up interviews with a sub-set of students, interviewees mentioned travelling for work or studying while on holiday.

The geographic reach of each device was determined by adding up the number of locations in which the device was used (between 0 and 7) (based on the example of Cross et al., 2016). Table 5.16 shows the geographic reach of desktops, laptops, tablets and smartphones (percentages). The sample means show that smartphones are used in the most locations with a mean of 3.57 (SD of 1.97). This was followed by laptops with a mean of 2.10 (SD of 1.22) and tablets with a mean of 2.10 (SD of 1.43). Desktops were used in the fewest places with a mean of 1.38 (SD of 0.65).

Table 5.16: Geographic Reach of Devices (Percentages)

	n	**M**	**SD**	**1 location**	**2 locations**	**3 locations**	**4 locations**	**5 locations**	**6 locations**	**7 locations**
Geographic Reach – Desktop	307	1.38	0.65	69.4	24.8	4.6	1.0	0.3	0.0	0.0
Geographic Reach – Laptop	435	2.10	1.22	41.4	27.8	17.5	8.0	3.9	1.1	0.2
Geographic Reach – Tablet	285	2.10	1.43	51.2	17.5	13.3	9.5	5.3	2.8	0.4
Geographic Reach – Smartphone	350	3.57	1.97	20.9	14.6	16.0	13.7	14.0	11.4	9.4

n = Excludes students who do not use devices

The following sections analyse the relationships between locations and the frequency use of each device (desktop, laptop, tablet and smartphone) and then the geographic reach.

5.5.1.3.1 Desktop Frequency and Learning Locations

Table 5.17 shows the means and standard deviations for using desktops for study in different locations (0 = No, 1 = Yes). The sample means show that desktop use at home with a mean of 0.53 (SD of 0.50) was the most common location for studying using a desktop. The second most common location for study was at work with a mean of 0.24 (SD of 0.43). The other locations all had a mean of 0.04 or less which indicates almost no usage. The option of In-transit as a location for desktop use was discarded as it was not applicable. Table 5.17 also shows the relationships (correlations) between desktop frequency and locations of use for study. Students using the desktop more frequently were more likely to use the desktop at home ($r = 0.58$, $p < 0.01$) and slightly more likely to use the desktop at work ($r = 0.24$, $p < 0.01$). There were no significant relationships between desktop use frequency and the other locations.

In terms of relationships (correlations) between locations of desktop use for study, students who use a desktop in a public location were likely to also use a desktop at a university regional centre (*r* = 0.42, p < 0.01).

Table 5.17: Correlations between Desktop Frequency and Location Variables

	n	M	SD	Desktop Frequency	Desktop - Home	Desktop - Work	Desktop - Home of Others	Desktop - University Centre	Desktop - Public Location	Desktop – Other
Desktop - Home	488	0.53	0.50	0.58**	-					
Desktop - Work	488	0.24	0.43	0.24**	0.11*	-				
Desktop - Home of Others	488	0.04	0.19	-0.03	-0.01	0.15**	-			
Desktop - University Centre	488	0.02	0.15	0.03	0.09	0.08	-0.03	-		
Desktop - Public Location	488	0.02	0.16	0.04	0.15**	0.07	0.11*	0.42**	-	
Desktop – Other	488	0.02	0.13	0.01	0.07	0.07	0.14**	0.08	0.18**	-

* p < 0.05, ** p < 0.01

5.5.1.3.2 Laptop Frequency and Learning Locations

Table 5.18 shows the means and standard deviations for using laptops for study in different locations (0 = No, 1 = Yes). The sample means show that laptop use at home with a mean of 0.84 (SD of 0.37) was the most common location for study using a laptop. The second most common location for study was in a public location with a mean of 0.28 (SD of 0.45). Table 5.18 also shows the relationship (correlations) between laptop frequency and locations of use for study. Students using the laptop more frequently were more likely to use the laptop at home (*r* = 0.50, p < 0.01). There were no significant relationships between laptop use frequency and the other locations.

In terms of relationships (correlations) between locations of laptop use for study, students who use a laptop in a public location were slightly likely to also use a laptop at a university regional centre, the homes of others and in-transit (*r* = 0.35, *r* = 0.28 and *r* = 0.25, respectively, p < 0.01 in all cases). Students who use a laptop at a university regional centre were slightly likely to also use a laptop in the homes of others and in-transit (*r* = 0.23 and *r* = 0.23, respectively, p < 0.01 in both cases).

Table 5.18: Correlations between Laptop Frequency and Location Variables

	N	M	SD	Laptop Frequency	Laptop - Home	Laptop - Work	Laptop - Home of Others	Laptop - University Centre	Laptop - Public Location	Laptop – Transit	Laptop – Other
Laptop - Home	488	0.84	0.37	0.50**	-						
Laptop - Work	488	0.24	0.43	0.08	0.10*	-					
Laptop - Home of Others	488	0.24	0.43	0.00	0.07	0.12**	-				
Laptop - University Centre	488	0.10	0.30	0.06	0.04	0.18**	0.23**	-			
Laptop - Public Location	488	0.28	0.45	0.08	0.17**	0.14**	0.28**	0.35**	-		
Laptop – Transit	488	0.06	0.24	0.00	0.04	0.15**	0.18**	0.23**	0.25**	-	
Laptop – Other	488	0.11	0.31	-0.01	0.01	0.07	0.06	0.06	0.16**	0.19**	-

* p < 0.05, ** p < 0.01

5.5.1.3.3 Tablet Frequency and Learning Locations

Table 5.19 shows the means and standard deviations for using tablets for study in different locations (0 = No, 1 = Yes). The sample means show that tablet use at home with a mean of 0.52 (SD of 0.50) was the most common location for studying using a tablet. The second most common location for study was in a public location with a mean of 0.18 (SD of 0.39). Table 5.19 also shows the relationship (correlations) between tablet frequency and tablet locations of use for study. Students using the tablet more frequently were more likely to use the tablet at home (r = 0.51, p < 0.01). Students using the tablet more frequently were also slightly more likely to use the tablet at work, in-transit, in public locations and the homes of others (r = 0.28, r = 0.28, r = 0.26 and r = 0.24, respectively, p < 0.01 in all cases).

In terms of relationships (correlations) between locations of tablet use for study, students who use a tablet in a public location were slightly likely to also use a tablet in the homes of others, in-transit, at a university regional centre, at home, at other locations and at work (r = 0.52, r = 0.44, r = 0.36, r = 0.33, r = 0.33 and r = 0.30, respectively, p < 0.01 in all cases). Students who use a tablet in transit were slightly likely to also use a tablet in other locations, in the homes of others, at a university regional centre, at work and at home (r = 0.34, r = 0.33, r = 0.30, r = 0.26 and r = 0.20, respectively, p < 0.01 in all cases). Students who use a tablet in the homes of others were slightly likely to also use a tablet at a university regional centre, in other locations, at home and at work (r = 0.30, r = 0.30, r = 0.29 and r = 0.28, respectively, p < 0.01 in all cases). Students who use a tablet at a university regional centre were slightly likely to also use a tablet in other locations (r = 0.23, p < 0.01). Students who use a tablet at work were slightly likely to also use a tablet at home and in other locations (r = 0.21 and r = 0.20, respectively, p < 0.01 in both cases).

Table 5.19: Correlations between Tablet Frequency and Location Variables

	n	M	SD	Tablet Frequency	Tablet - Home	Tablet - Work	Tablet - Home of Others	Tablet - University Centre	Tablet - Public Location	Tablet – Transit	Tablet – Other
Tablet - Home	488	0.52	0.50	0.51**	-						
Tablet - Work	488	0.12	0.32	0.28**	0.21**	-					
Tablet - Home of Others	488	0.15	0.36	0.24**	0.29**	0.28**	-				
Tablet - University Centre	488	0.05	0.21	0.17**	0.19**	0.16**	0.30**	-			
Tablet - Public Location	488	0.18	0.39	0.26**	0.33**	0.30**	0.52**	0.36**	-		
Tablet – Transit	488	0.13	0.33	0.28**	0.20**	0.26**	0.33**	0.30**	0.44**	-	
Tablet – Other	488	0.08	0.27	0.16**	0.18**	0.20**	0.30**	0.23**	0.33**	0.34**	-

* p < 0.05, ** p < 0.01

5.5.1.3.4 Smartphone Frequency and Learning Locations

Table 5.20 shows the means and standard deviations for using smartphones for study in different locations (0 = No, 1 = Yes). The sample means show that smartphone use at home with a mean of 0.57 (SD of 0.50) was the most common location for studying using a smartphone. The second most common location for study was in-transit with a mean of 0.48 (SD of 0.50). Table 5.20 also shows the relationship (correlations) between smartphone frequency and locations of use for study. Students using the smartphone more frequently were likely to use the smartphone at home, work and in-transit (r = 0.62, r = 0.42 and r = 0.41, respectively, p < 0.01 in all cases). Students using the smartphone more frequently were also slightly more likely to use the smartphone in the homes of others, in public locations, in other locations and at university regional centres (r = 0.37, r = 0.35, r = 0.30 and r = 0.22, respectively, p < 0.01 in all cases).

In terms of relationships (correlations) between locations of smartphone use for study, students who use a smartphone in a public location were likely to also use a smartphone in the homes of others, in-transit, at a university regional centre, at home, at other locations and at work (r = 0.63, r = 0.55, r = 0.47, r = 0.46, r = 0.45 and r = 0.36, respectively, p < 0.01 in all cases). Students who use a smartphone in-transit were likely to also use a smartphone in the homes of others, at home, in other locations, at work and at a university regional centre (r = 0.54, r = 0.43, r = 0.42, r = 0.40 and r = 0.38, respectively, p < 0.01 in all cases). Students who use a smartphone at home were likely to also use a smartphone at work, in the homes of others, in other locations and a university regional centre (r = 0.48, r = 0.48, r = 0.36 and r = 0.33, respectively, p < 0.01 in all cases). Students who use a smartphone at the homes of others were likely to also use a smartphone in other locations, at work and at university regional centres (r = 0.48, r = 0.41 and r = 0.39, respectively, p < 0.01 in all cases). Students who use a smartphone in other locations were slightly likely to also use a smartphone at a university regional centre and at work (r = 0.38 and r = 0.34, respectively, p < 0.01 in both cases). Students who use a smartphone at work were slightly likely to also use a smartphone at a university regional centre (r = 0.24, p < 0.01).

Table 5.20: Correlations between Smartphone Frequency and Location Variables

	n	M	SD	Smartphone Frequency	Smart-phone - Home	Smart-phone - Work	Smart-phone - Home of Others	Smartphone - University Centre	Smart-phone - Public Location	Smart-phone – Transit	Smart-phone – Other
Smartphone - Home	488	0.57	0.50	0.62**	-						
Smartphone - Work	488	0.40	0.49	0.42**	0.48**	-					
Smartphone - Home of Others	488	0.36	0.48	0.37**	0.48**	0.41**	-				
Smartphone - University Centre	488	0.15	0.36	0.22**	0.33**	0.24**	0.39**	-			
Smartphone - Public Location	488	0.36	0.48	0.35**	0.46**	0.36**	0.63**	0.47**	-		
Smartphone – Transit	488	0.48	0.50	0.41**	0.43**	0.40**	0.54**	0.38**	0.55**	-	
Smartphone – Other	488	0.25	0.43	0.30**	0.36**	0.34**	0.48**	0.38**	0.45**	0.42**	-

* p < 0.05, ** p < 0.01

5.5.1.3.5 Geographic Reach and Device Frequency

Table 5.21 shows the relationships (correlations) between geographic reach and frequency of device use for study. Students who used a tablet or smartphone in more places were slightly more likely to use it more frequently for study (r_s = 0.27 and r_s = 0.20, respectively, p < 0.01 in both cases). There were no significant relationships (above r_s = 0.20) between geographic reach and frequency of use of desktops and laptops.

In terms of relationships (correlations) between geographic reach between different devices, students who use a smartphone in a wide number of places were likely to use a laptop or tablet in a wide number of places (r_s = 0.49 and r_s = 0.38, respectively, p < 0.01 in all cases). Students who use a tablet in a wide number of places were slightly likely to use a laptop in a wide number of places (r_s = 0.38, p < 0.01).

Table 5.21: Correlations between Geographic Reach and Device Frequency Variables

	n	M	SD	Geographic Reach – Desktop	Geographic Reach – Laptop	Geographic Reach – Tablet	Geographic Reach – Smartphone
Geographic Reach – Desktop	307	1.38	0.65	-			
Geographic Reach – Laptop	435	2.10	1.22	0.17**	-		
Geographic Reach – Tablet	285	2.10	1.43	0.03	0.38**	-	
Geographic Reach – Smartphone	350	3.57	1.97	0.10	0.49**	0.38**	-
Desktop Frequency	350	2.26	1.02	0.14*	-0.12*	-0.02	-0.18**
Laptop Frequency	449	2.59	0.73	-0.02	0.02	0.00	0.13*
Tablet Frequency	337	1.88	1.05	-0.03	-0.03	0.27**	0.04
Smartphone Frequency	450	2.12	1.17	0.03	0.03	0.03	0.20**

* p < 0.05, ** p < 0.01
n = Excludes students who do not have access to devices, some values missing

5.5.1.4 Learning Activities

Students were asked to select, for the devices they use for study, which learning activities (from a list of 15 learning activities) they perform using these devices. The list of learning activities was adapted from Cheung (2012), Cross et al. (2015) and Murphy et al. (2014). Table 5.22 shows the learning activities performed on different devices. Students tend to use a central device such as a laptop or desktop to perform the majority of learning activities. Laptops are the most commonly used devices for learning across all learning activities. For tablets, the most common learning activities are reading materials (80.0%), checking news and announcements (76.7%) and searching for information (73.1%). For smartphones, the most popular learning activities are checking news and announcements (77.8%) and searching for information (66.3%) and communicating with other students (57.5%). The other devices are used more for specific learning activities, highlighting the functionality of devices. For example, basic mobile phones are mainly used to communicate with students (72.7%) and check information (54.5%), while e-readers are used to read materials (97.8%).

Table 5.22: Learning Activities by Device (Percentages)

	Desktop	**Laptop**	**Tablet**	**Smartphone**	**Basic Mobile**	**e-Reader**
	n=272	n=414	n=245	n=320	n=11	n=46
Communicate with educator	84.1	88.6	33.9	36.6	9.1	0.0
Communicate with students	78.2	85.3	34.3	57.5	72.7	0.0
Read materials	80.4	86.5	80.0	35.3	9.1	97.8
Listen to audio	63.5	72.5	40.8	34.4	9.1	2.2
Watch video	73.1	83.8	59.6	39.1	9.1	2.2
Participate in forums	78.6	87.7	32.7	28.8	9.1	4.3
Take test/quiz	74.5	83.3	17.6	7.8	0.0	2.2
Write assignment	83.8	91.1	13.9	5.3	0.0	0.0
Attend online meeting/ lecture	49.1	62.3	18.0	9.4	0.0	0.0
Search for information	90.8	96.9	73.1	66.3	18.2	6.5
Take exam	48.7	51.9	3.3	0.9	0.0	0.0
Use virtual library	70.5	76.8	24.1	12.5	0.0	2.2
Review assessment feedback	78.2	86.0	42.4	40.9	9.1	2.2
Plan/organise study time	65.3	73.2	33.5	37.2	0.0	0.0
Check news/announcements	77.1	80.0	76.7	77.8	54.5	8.7

n = Excludes students who do not use devices

Table 5.23 shows the means and standard deviations for the range of activities for desktops, laptops, tablets and smartphones. The range of activities was determined (based on the example of Cross et al., 2016) by adding up the number of learning activities for which this device was used (between 0 and 15). The sample means show that laptops are used for the most number of activities with a mean of 12.06 (SD of 3.45). This was followed by desktops with a mean of 10.96 (SD of 4.21) and tablets with a mean of 5.84 (SD of 3.46). Smartphones were used for the fewest number of activities with a mean of 4.90 (SD of 2.80).

Table 5.23: Means and Standard Deviations of Learning Activity Range by Device

	n	M	SD
Activity Range – Desktop	271	10.96	4.21
Activity Range – Laptop	414	12.06	3.45
Activity Range – Tablet	245	5.84	3.46
Activity Range – Smartphone	320	4.90	2.80

n = Excludes students who do not use devices

The following sections analyse the relationships between each learning activity and the frequency use of each device (desktop, laptop, tablet and smartphone) and then the range of activities.

5.5.1.4.1 Communicate with Educators by Device Frequency

Table 5.24 shows the means and standard deviations for different device use frequencies for the communicate with educators activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to communicate with educators with a mean of 0.75 (SD of 0.43). The next most frequently used device to communicate with educators was the desktop with a mean of 0.47 (SD of 0.50). Table 5.24 also shows the relationships (correlations) between specific device frequency and communicating with the educator. Students communicating with educators were considerably more likely to frequently use the desktop and the laptop ($r = 0.62$, and $r = 0.62$, $p < 0.01$ in both cases) and slightly more likely to frequently use the tablet and the smartphone ($r = 0.39$ and $r = 0.30$, $p < 0.01$ in both cases).

In terms of relationships (correlations) between communicating with educators and the different devices that are used to perform this task, students who communicate with an educator using a desktop were less likely to do so with a laptop also ($r = -0.51$, p < 0,01). Students who communicate with an educator using a laptop were slightly more likely to also do so with a smartphone ($r = 0.22$, $p < 0.01$).

Table 5.24: Correlations between Device Frequency and Communicate with Educator Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Communi-cate Educator – Desktop	Communi-cate Educator – Laptop	Commun-icate Educator – Tablet	Commun-icate Educator – Smart-phone
Communicate Educator – Desktop	488	0.47	0.50	0.62**	-0.43**	-0.08	-0.08	-			
Communicate Educator – Laptop	488	0.75	0.43	-0.37**	0.62**	0.05	0.09	-0.51**	-		
Communicate Educator – Tablet	488	0.17	0.38	0.01	0.06	0.39**	0.05	0.06	0.05	-	
Communicate Educator – Smartphone	488	0.24	0.43	-0.08	0.06	0.02	0.30**	0.04	0.06	0.22**	-

* p < 0.05, ** p < 0.01

5.5.1.4.2 Communicate with Students by Device Frequency

Table 5.25 shows the means and standard deviations for different device use frequencies for the communicate with students activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to communicate with students with a mean of 0.72 (SD of 0.45). The next most frequently used device to communicate with students was the desktop with a mean of 0.43 (SD of 0.50). Table 5.25 also shows the relationships (correlations) between specific device frequency and communicating with the student. Students communicating with students were considerably more likely to frequently use the desktop (r = 0.60, p < 0.01) and more likely to frequently use the laptop (r = 0.56, p < 0.01). Students communicating with students were slightly more likely to frequently use the smartphone and tablet (r = 0.39 and r = 0.37, p < 0.01 in both cases).

In terms of relationships (correlations) between communicating with students and the different devices that are used to perform this activity, students who communicate with other students using a desktop were less likely to do so with a laptop also (r = -0.42, p < 0.01). No significant relationships (above r = 0.20) were found between using the other devices to communicate with students.

Table 5.25: Correlations between Device Frequency and Communicate with Student Variables

	n	**M**	**SD**	**Desktop Frequency**	**Laptop Frequency**	**Tablet Frequency**	**Smart-phone Frequency**	**Communi-cate Student – Desktop**	**Communi-cate Student – Laptop**	**Commun-icate Student – Tablet**	**Commun-icate Student – Smart-phone**
Communicate Student – Desktop	488	0.43	0.50	0.60**	-0.41**	-0.02	-0.07	-			
Communicate Student – Laptop	488	0.72	0.45	-0.34**	0.56**	0.07	0.14*	-0.42**	-		
Communicate Student – Tablet	488	0.17	0.38	-0.04	0.10*	0.37**	0.05	0.06	0.10*	-	
Communicate Student – Smartphone	488	0.38	0.49	-0.07	0.10*	0.01	0.39**	-0.01	0.17**	0.19**	-

* p < 0.05, ** p < 0.01

5.5.1.4.3 Read Materials by Device Frequency

Table 5.26 shows the means and standard deviations for different device use frequencies for the read materials activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to read materials with a mean of 0.73 (SD of 0.44). The next most frequently used device to read materials was the desktop with a mean of 0.45 (SD of 0.50). Table 5.26 also shows the relationships (correlations) between specific device frequency and reading materials. Students reading materials were considerably more likely to frequently use the desktop (r = 0.60, p < 0.01), and more likely to frequently use the laptop and tablet (r = 0.53 and r = 0.47, p < 0.01 in both cases). Students reading materials were slightly more likely to frequently use the smartphone (r = 0.21, p < 0.01).

In terms of relationships (correlations) between reading materials and the different devices that are used to perform this activity, students who read materials using a desktop were slightly less likely to do so with a laptop (r = -0.24, p < 0.01). No significant relationships (above r = 0.20) were found between using the other devices to read materials.

Table 5.26: Correlations between Device Frequency and Read Materials Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Read – Desktop	Read – Laptop	Read – Tablet	Read – Smart-phone
Read – Desktop	488	0.45	0.50	0.60**	-0.39**	-0.08	-0.05	-			
Read – Laptop	488	0.73	0.44	-0.29**	0.53**	-0.04	0.08	-0.24**	-		
Read – Tablet	488	0.40	0.49	0.03	-0.03	0.47**	-0.03	-0.01	-0.04	-	
Read – Smartphone	488	0.23	0.42	-0.02	-0.06	0.02	0.21**	0.06	0.05	0.19**	-

* p < 0.05, ** p < 0.01

5.5.1.4.4 Listen to Audio by Device Frequency

Table 5.27 shows the means and standard deviations for different device use frequencies for the listen to audio activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to listen to audio with a mean of 0.61 (SD of 0.49). The next most frequently used device to listen to audio was the desktop with a mean of 0.35 (SD of 0.48). Table 5.27 also shows the relationships (correlations) between specific device frequency and listening to audio. Students listening to audio were more likely to frequently use the desktop and laptop (r = 0.51 and r = 0.45, p < 0.01 in both cases) and slightly more likely to frequently use the tablet and smartphone (r = 0.39 and r = 0.28, p < 0.01 in both cases).

In terms of relationships (correlations) between listening to audio and the different devices that are used to perform this activity, students who listen to audio using a tablet were also slightly likely to do so with a smartphone (r = 0.21, p < 0.01). No significant relationships (above r = 0.20) were found between using the other devices to listen to audio.

Table 5.27: Correlations between Device Frequency and Listen to Audio Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Listen – Desktop	Listen – Laptop	Listen – Tablet	Listen – Smart-phone
Listen – Desktop	488	0.35	0.48	0.51**	-0.36**	-0.01	-0.04	-			
Listen – Laptop	488	0.61	0.49	-0.33**	0.45**	-0.04	0.11*	-0.19**	-		
Listen – Tablet	488	0.20	0.40	0.06	0.02	0.39**	0.05	0.01	0.01	-	
Listen – Smartphone	488	0.23	0.42	-0.01	0.04	0.06	0.28**	0.00	0.01	0.21**	-

* p < 0.05, ** p < 0.01

5.5.1.4.5 Watch Video by Device Frequency

Table 5.28 shows the means and standard deviations for different device use frequencies for the watching video activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to watch video with a mean of 0.71 (SD of 0.45). The next most frequently used device to watch video was the desktop with a mean of 0.41 (SD of 0.49). Table 5.28 also shows the relationships (correlations) between specific device frequency and watching video. Students watching videos were more likely to frequently use the desktop, laptop and tablet (r = 0.58, r = 0.51 and r = 0.49, respectively, p < 0.01 in all cases) and slightly more likely to frequently use the smartphone (r = 0.32, p < 0.01).

In terms of relationships (correlations) between watching video and the different devices that are used to perform this activity, students who watch video using a desktop were less likely to also do so with a laptop (r = -0.37, p < 0.01). Students who watch video using a tablet were slightly likely to also do so with a smartphone (r = 0.21, p < 0.01).

Table 5.28: Correlations between Device Frequency and Watch Video Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Watch – Desktop	Watch – Laptop	Watch – Tablet	Watch – Smart-phone
Watch – Desktop	488	0.41	0.49	0.58**	-0.43**	0.01	-0.04	-			
Watch – Laptop	488	0.71	0.45	-0.38**	0.51**	-0.01	0.11*	-0.37**	-		
Watch – Tablet	488	0.30	0.46	0.03	0.01	0.49**	0.03	0.02	-0.01	-	
Watch – Smartphone	488	0.26	0.44	-0.02	0.07	0.03	0.32**	0.05	0.05	0.21**	-

* p < 0.05, ** p < 0.01

5.5.1.4.6 Participate in Forums by Device Frequency

Table 5.29 shows the means and standard deviations for different device use frequencies for the participate in forums activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to participate in forums with a mean of 0.74 (SD of 0.44). The next most frequently used device to participate in forums was the desktop with a mean of 0.44 (SD of 0.50). Table 5.29 also shows the relationships (correlations) between specific device frequency and participating in forums. Students participating in forums were more likely to frequently use the desktop and laptop (r = 0.58 and r = 0.53, p < 0.01 in both cases) and slightly more likely to frequently use the tablet and smartphone (r = 0.37 and r = 0.25, p < 0.01 in both cases).

In terms of relationships (correlations) between participating in forums and the different devices that are used to perform this activity, students who participate in forums using a desktop were less likely to also do so with a laptop (r = -0.35, p < 0.01). Students who participate in forums using a tablet were slightly likely to also do so with a smartphone (r = 0.27, p < 0.01).

Table 5.29: Correlations between Device Frequency and Participate in Forums Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Forums – Desktop	Forums – Laptop	Forums – Tablet	Forums – Smart-phone
Forums – Desktop	488	0.44	0.50	0.58**	-0.41**	-0.01	-0.05	-			
Forums – Laptop	488	0.74	0.44	-0.31**	0.53**	0.03	0.08	-0.35**	-		
Forums – Tablet	488	0.16	0.37	-0.04	0.07	0.37**	0.11*	0.00	0.07	-	
Forums – Smartphone	488	0.19	0.39	-0.12*	0.05	0.05	0.25**	0.02	0.08	0.27**	-

* p < 0.05, ** p < 0.01

5.5.1.4.7 Take a Test/Quiz by Device Frequency

Table 5.30 shows the means and standard deviations for different device use frequencies for the take a test/quiz activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to take a test with a mean of 0.71 (SD of 0.46). The next most frequently used device to take a test was the desktop with a mean of 0.41 (SD of 0.49). Table 5.30 also shows the relationships (correlations) between specific device frequency and taking a test. Students taking a test/quiz were more likely to frequently use the desktop and laptop (r = 0.56 and r = 0.50, p < 0.01 in both cases) and slightly more likely to frequently use the tablet (r = 0.20, p < 0.01).

In terms of relationships (correlations) between taking a test and the different devices that are used to perform this activity, students who take a test using a desktop were less likely to also do so with a laptop (r = -0.36, p < 0.01). No significant relationships (above r = 0.20) were found between using the other devices to take a test.

Table 5.30: Correlations between Device Frequency and Complete Test/Quiz Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Test – Desktop	Test – Laptop	Test – Tablet	Test – Smart-phone
Test – Desktop	488	0.41	0.49	0.56**	-0.41**	0.02	-0.06	-			
Test – Laptop	488	0.71	0.46	-0.36**	0.50**	0.04	0.09	-0.36**	-		
Test – Tablet	488	0.09	0.28	-0.09	-0.01	0.20**	0.01	-0.07	-0.02	-	
Test – Smartphone	488	0.05	0.22	-0.01	0.03	0.00	0.16**	-0.01	0.01	0.19**	-

* p < 0.05, ** p < 0.01

5.5.1.4.8 Write an Assignment by Device Frequency

Table 5.31 shows the means and standard deviations for different device use frequencies for the writing an assignment activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to write an assignment with a mean of 0.77 (SD of 0.42). The next most frequently used device to write an assignment was the desktop with a mean of 0.47 (SD of 0.50). Table 5.31 also shows the relationships (correlations) between specific device frequency and writing an assignment. Students writing an assignment were considerably more likely to frequently use the desktop (r = 0.61, p < 0.01) and more likely to frequently use the laptop (r = 0.55, p < 0.01). Students writing an assignment were slightly more likely to frequently use the tablet (r = 0.22, p < 0.01).

In terms of relationships (correlations) between writing an assignment and the different devices that are used to perform this activity, students who write an assignment using a desktop were less likely to also do so with a laptop (*r* = -0.43, p < 0.01). No significant relationships (above *r* = 0.20) were found between using the other devices to write an assignment.

Table 5.31: Correlations between Device Frequency and Write an Assignment Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Write – Desktop	Write – Laptop	Write – Tablet	Write – Smart-phone
Write – Desktop	488	0.47	0.50	0.61**	-0.40**	-0.02	-0.06	-			
Write – Laptop	488	0.77	0.42	-0.31**	0.55**	0.04	0.11*	-0.43**	-		
Write – Tablet	488	0.07	0.25	-0.01	0.03	0.22**	0.07	0.00	-0.02	-	
Write – Smartphone	488	0.03	0.18	-0.03	0.00	0.02	0.10*	0.02	-0.03	0.12**	-

* p < 0.05, ** p < 0.01

5.5.1.4.9 Participate in Online Meeting / Lecture by Device Frequency

Table 5.32 shows the means and standard deviations for different device use frequencies for the participate in an online meeting/lecture activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to participate in an online meeting with a mean of 0.53 (SD of 0.50). The next most frequently used device to participate in an online meeting was the desktop with a mean of 0.27 (SD of 0.45). Table 5.32 also shows the relationships (correlations) between specific device frequency and participating in an online meeting. Students participating in an online meeting were more likely to frequently use the desktop (*r* = 0.45, p < 0.01) and slightly more likely to frequently use the laptop and tablet (*r* = 0.39 and *r* = 0.25, p < 0.01 in both cases).

In terms of relationships (correlations) between participating in an online meeting and the different devices that are used to perform this activity, no significant relationships (above *r* = 0.20) were found between using other devices to participate in an online meeting.

Table 5.32: Correlations between Device Frequency and Online Meeting Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Meet – Desktop	Meet – Laptop	Meet – Tablet	Meet – Smart-phone
Meet – Desktop	488	0.27	0.45	0.45**	-0.30**	0.05	0.00	-			
Meet – Laptop	488	0.53	0.50	-0.22**	0.39**	0.00	0.16**	-0.14**	-		
Meet – Tablet	488	0.09	0.29	0.06	0.05	0.25**	-0.04	0.05	0.11*	-	
Meet – Smartphone	488	0.06	0.24	-0.04	0.07	-0.01	0.13*	0.00	0.12**	0.19**	-

* p < 0.05, ** p < 0.01

5.5.1.4.10 Search for Information by Device Frequency

Table 5.33 shows the means and standard deviations for different device use frequencies for the search for information activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to search for information with a mean of 0.82 (SD of 0.38). The next most frequently used device to search for information was the desktop with a mean of 0.50 (SD of 0.50). Table 5.33 also shows the relationships (correlations) between specific device frequency and searching for information. Students searching for information were considerably more likely to frequently use the desktop (r = 0.61, $p < 0.01$) and more likely to frequently use the laptop and tablet (r = 0.55 and r = 0.53, $p < 0.01$ in both cases). Students searching for information were slightly more likely to frequently use the smartphone (r = 0.36, $p < 0.01$).

In terms of relationships (correlations) between searching for information and the different devices that are used to perform this activity, students who search for information using a desktop were less likely to also do so with a laptop (r = -0.33, $p < 0.01$). No significant relationships (above r = 0.20) were found between using the other devices to search for information.

Table 5.33: Correlations between Device Frequency and Search for Information Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Search – Desktop	Search – Laptop	Search – Tablet	Search – Smart-phone
Search – Desktop	488	0.50	0.50	0.61**	-0.42**	-0.06	-0.08	-			
Search – Laptop	488	0.82	0.38	-0.29**	0.55**	0.07	0.14**	-0.33**	-		
Search – Tablet	488	0.37	0.48	0.06	-0.04	0.53**	-0.04	0.04	0.09	-	
Search – Smartphone	488	0.44	0.50	-0.08	0.06	-0.03	0.36**	0.03	0.11*	0.18**	-

* p < 0.05, ** p < 0.01

5.5.1.4.11 Take an Exam by Device Frequency

Table 5.34 shows the means and standard deviations for different device use frequencies for the take an exam activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to take an exam with a mean of 0.44 (SD of 0.50). The next most frequently used device to take an exam was the desktop with a mean of 0.27 (SD of 0.44). Table 5.34 also shows the relationships (correlations) between specific device frequency and taking an exam. Students taking an exam were more likely to frequently use the desktop (r = 0.43, $p < 0.01$) and slightly more likely to frequently use the laptop (r = 0.35, $p < 0.01$).

In terms of relationships (correlations) between taking an exam and the different devices that are used to perform this activity, students who take an exam using a tablet were slightly likely to also do so with a smartphone (r = 0.20, $p < 0.01$). No significant relationships were found between using the other devices to search for information.

Table 5.34: Correlations between Device Frequency and Take Exam Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Exam – Desktop	Exam – Laptop	Exam – Tablet	Exam – Smart-phone
Exam – Desktop	488	0.27	0.44	0.43**	-0.35**	0.08	-0.04	-			
Exam – Laptop	488	0.44	0.50	-0.24**	0.35**	0.06	0.11*	-0.06	-		
Exam – Tablet	488	0.02	0.13	0.07	0.07	0.09	-0.01	0.03	0.05	-	
Exam – Smartphone	488	0.01	0.08	-0.09	0.04	0.06	0.06	-0.05	0.04	0.20**	-

* p < 0.05, ** p < 0.01

5.5.1.4.12 Use Virtual Library by Device Frequency

Table 5.35 shows the means and standard deviations for different device use frequencies for the use the virtual library activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to use the virtual library with a mean of 0.65 (SD of 0.48). The next most frequently used device to use the virtual library was the desktop with a mean of 0.39 (SD of 0.49). Table 5.35 also shows the relationships (correlations) between specific device frequency and using the virtual library. Students using the virtual library were more likely to frequently use the desktop and laptop (r = 0.53 and r = 0.43, p < 0.01 in both cases) and slightly more likely to frequently use the tablet (r = 0.24, p < 0.01).

In terms of relationships (correlations) between using the virtual library and the different devices that are used to perform this activity, students who use the virtual library using a desktop were less likely to also do so with a laptop (r = -0.24, p < 0.01). No significant relationships (above r = 0.20) were found between using the other devices to use the virtual library.

Table 5.35: Correlations between Device Frequency and Use Virtual Library Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Library – Desktop	Library – Laptop	Library – Tablet	Library – Smart-phone
Library – Desktop	488	0.39	0.49	0.53**	-0.39**	0.01	-0.06	-			
Library – Laptop	488	0.65	0.48	-0.28**	0.43**	0.04	0.10*	-0.24**	-		
Library – Tablet	488	0.12	0.33	0.01	0.03	0.24**	0.08	0.09	0.09	-	
Library – Smartphone	488	0.08	0.27	-0.01	0.00	-0.07	0.18**	0.05	0.05	0.14**	-

* p < 0.05, ** p < 0.01

5.5.1.4.13 Review Assessment Feedback by Device Frequency

Table 5.36 shows the means and standard deviations for different device use frequencies for the review assessment feedback activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to review feedback with a mean of 0.73 (SD of 0.44). The next most frequently used device to review feedback was the desktop with a mean of 0.43 (SD of 0.50). Table 5.36 also shows the relationships (correlations) between specific device frequency and reviewing feedback. Students reviewing feedback were more likely to frequently use the desktop and laptop (r = 0.57 and r

= 0.56, p < 0.01 in both cases) and slightly more likely to frequently use the tablet and smartphone (*r* = 0.34 and *r* = 0.28, p < 0.01 in both cases).

In terms of relationships (correlations) between reviewing feedback and the different devices that are used to perform this task, students who review feedback using a desktop were less likely to also do so with a laptop (*r* = -0.34, p < 0.01). No significant relationships (above *r* = 0.20) were found between using the other devices to review feedback.

Table 5.36: Correlations between Device Frequency and Review Feedback Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Feedback – Desktop	Feedback – Laptop	Feedback – Tablet	Feedback – Smart-phone
Feedback – Desktop	488	0.43	0.50	0.57**	-0.37**	-0.08	-0.09	-			
Feedback – Laptop	488	0.73	0.44	-0.36**	0.56**	0.01	0.07	-0.34**	-		
Feedback – Tablet	488	0.21	0.41	-0.03	0.03	0.34**	-0.03	0.04	0.06	-	
Feedback – Smartphone	488	0.27	0.44	-0.11*	0.11*	-0.08	0.28**	-0.03	0.13**	0.13**	-

* p < 0.05, ** p < 0.01

5.5.1.4.14 Plan/Organise Study Time by Device Frequency

Table 5.37 shows the means and standard deviations for different device use frequencies for the plan/organise study time activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to plan studies with a mean of 0.62 (SD of 0.49). The next most frequently used device to plan studies was the desktop with a mean of 0.36 (SD of 0.48). Table 5.37 also shows the relationships (correlations) between specific device frequency and planning studies. Students planning studies were more likely to frequently use the desktop and laptop (*r* = 0.50 and *r* = 0.48, p < 0.01 in both cases) and slightly more likely to frequently use the tablet and smartphone (*r* = 0.35 and *r* = 0.29, p < 0.01 in both cases).

In terms of relationships (correlations) between planning studies and the different devices that are used to perform this task, students who plan studies using a desktop were less likely to also do so with a laptop (*r* = -0.25, p < 0.01). No significant relationships (above *r* = 0.20) were found between using the other devices to plan studies.

Table 5.37: Correlations between Device Frequency and Plan Study Time Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Plan – Desktop	Plan – Laptop	Plan – Tablet	Plan – Smart-phone
Plan – Desktop	488	0.36	0.48	0.50**	-0.36**	-0.04	-0.07	-			
Plan – Laptop	488	0.62	0.49	-0.36**	0.48**	0.05	0.11*	-0.25**	-		
Plan – Tablet	488	0.17	0.37	-0.02	0.03	0.35**	0.02	0.07	0.11*	-	
Plan – Smartphone	488	0.24	0.43	-0.03	0.04	-0.04	0.29**	0.01	0.08	0.13**	-

* p < 0.05, ** p < 0.01

5.5.1.4.15 Check News/Announcements by Device Frequency

Table 5.38 shows the means and standard deviations for different device use frequencies for the check news/announcements activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to check news with a mean of 0.68 (SD of 0.47). The next most frequently used device to check news was the desktop with a mean of 0.43 (SD of 0.50). Table 5.38 also shows the relationships (correlations) between specific device frequency and checking news. Students checking news were more likely to frequently use the desktop, tablet, laptop and smartphone (r = 0.53, r = 0.47, r = 0.43 and r = 0.42, p < 0.01 in all cases).

In terms of relationships (correlations) between checking news and the different devices that are used to perform this activity, no significant relationships (above r = 0.20) were found.

Table 5.38: Correlations between Device Frequency and Check News Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Check – Desktop	Check – Laptop	Check – Tablet	Check – Smart-phone
Check – Desktop	488	0.43	0.50	0.53**	-0.32**	-0.07	-0.08	-			
Check – Laptop	488	0.68	0.47	-0.27**	0.43**	-0.03	0.05	-0.10*	-		
Check – Tablet	488	0.39	0.49	0.05	-0.01	0.47**	-0.06	0.06	0.09	-	
Check – Smartphone	488	0.51	0.50	-0.12*	0.08	-0.03	0.42**	-0.03	0.14**	0.14**	-

* p < 0.05, ** p < 0.01

5.5.1.4.16 Range of Learning Activities

The range of learning activities per device was looked at in terms of relationships with device frequency, device importance and geographic reach. Table 5.39 shows the relationships (correlations) between the range of activities and frequency of device use for study. Students performing a wider range of learning activities were more likely to frequently use the desktop, laptop and tablet (r_s = 0.49, r_s = 0.42 and r_s = 0.41, respectively, p < 0.01 in all cases). Table 5.39 also shows the relationships (correlations) between the range of activities and expertise using each device. Students performing a wider range of learning activities were slightly more likely to have higher levels of expertise use the tablet and desktop (r_s = 0.24 and r_s = 0.21, p < 0.01 in both cases). Table 5.39 also shows the relationships (correlations) between the range of activities and the perceived importance for academic success. Students performing a wider range of learning activities were more likely to value the tablet and desktop as having greater importance (r_s = 0.47 and r_s = 0.44, p < 0.01 in both cases). Students performing a wider range of learning activities were slightly more likely to value the smartphone and laptop as having greater importance (r_s = 0.33 and r_s = 0.31, p < 0.01 in both cases).

Table 5.39 also shows the relationships (correlations) between geographic reach and range of activities for study. Students who performed a wide range of activities were likely to study in a wide range of locations using tablets (r_s = 0.28, p < 0.01). No significant relationships (above r_s = 0.20) were found between geographic reach and the activity range for the other devices.

Table 5.39: Correlations between Activity Range and Other Variables

	n	**M**	**SD**	**Device Frequency**	**Device Expertise**	**Device Importance**	**Geographic Reach**
Activity Range – Desktop	271	10.96	4.21	0.49**	0.21**	0.44**	0.16**
Activity Range – Laptop	414	12.06	3.45	0.42**	0.13**	0.31**	0.05
Activity Range – Tablet	245	5.84	3.46	0.41**	0.24**	0.47**	0.28**
Activity Range – Smartphone	320	4.90	2.80	0.19**	0.19**	0.33**	0.19**

* p < 0.05, ** p < 0.01
n = Excludes students who do not use devices

5.5.1.5 Learning Locations and Activities

The following sections show the relationships between learning locations and activities per device (for desktops, laptops, tablets and smartphones).

5.5.1.5.1 Learning Locations and Activities by Desktop

Table 5.40 shows the correlations between activities performed using a desktop and the locations where used. Students who use the desktop at home were considerably likely to carry out eight learning activities (p < 0.01 in all cases): communicating with educators, watching video, writing an assignment, searching for information, communicating with students, reading materials, participating in forums, taking a test (0.60 < r < 0.69). Students who use the desktop at home were likely to carry out the remaining seven activities (p < 0.01 in all cases): reviewing feedback, listening to audio, using the virtual library, checking news, planning studies, taking an exam (0.50 < r < 0.59) and participating in an online meeting (r = 0.49). Students who use the desktop at work were slightly likely to carry out thirteen learning activities (p < 0.01 in all cases): reading materials, searching for information, participating in forums, checking news, writing an assignment (0.30 < r < 0.39), communicating with educators, communicating with students, taking a test, reviewing feedback, listening to audio, watching video, using the virtual library and planning study time (0.20 < r < 0.29). No significant relationships were found (above r = 0.20) between using the desktop to perform activities in the homes of others, at university centres, in public locations and in other locations.

Table 5.40: Correlations between Desktop Learning Locations and Activities

	n	M	SD	Desktop – Home	Desktop – Work	Desktop - Home Others	Desktop - University Centre	Desktop - Public Location	Desktop - Other
Communicate Educator – Desktop	488	0.47	0.50	0.67**	0.29**	0.08	0.11*	0.14**	0.05
Communicate Students – Desktop	488	0.43	0.50	0.66**	0.29**	0.05	0.12*	0.15**	0.06
Read – Desktop	488	0.45	0.50	0.62**	0.36**	0.04	0.11*	0.12**	0.09*
Listen – Desktop	488	0.35	0.48	0.58**	0.24**	0.08	0.09*	0.13**	0.12**
Watch – Desktop	488	0.41	0.49	0.67**	0.24**	0.08	0.07	0.14**	0.07
Forums – Desktop	488	0.44	0.50	0.62**	0.34**	0.05	0.09*	0.13**	0.06
Test – Desktop	488	0.41	0.49	0.61**	0.28**	0.03	0.10*	0.14**	0.10*
Write – Desktop	488	0.47	0.50	0.67**	0.30**	0.04	0.11*	0.12**	0.12*
Meeting – Desktop	488	0.27	0.45	0.49**	0.13**	0.03	0.09*	0.17**	0.05
Search – Desktop	488	0.50	0.50	0.67**	0.36**	0.06	0.15**	0.13**	0.11*
Exam – Desktop	488	0.27	0.44	0.52**	0.19**	0.00	0.13**	0.19**	-0.01
Library – Desktop	488	0.39	0.49	0.58**	0.24**	0.04	0.11*	0.14**	0.05
Feedback – Desktop	488	0.43	0.50	0.59**	0.28**	0.07	0.09*	0.13**	0.10*
Plan – Desktop	488	0.36	0.48	0.56**	0.20**	0.03	0.06	0.07	0.09
News – Desktop	488	0.43	0.50	0.58**	0.33**	0.07	0.06	0.08	0.07

* p < 0.05, ** p < 0.01

5.5.1.5.2 Learning Locations and Activities by Laptop

Table 5.41 shows the correlations between activities performed using a laptop and the locations where used. Students who use the laptop at home were considerably likely to carry out one activity: searching for information (r = 0.65, p < 0.01). Students who use the laptop at home were also likely to carry out twelve activities (p < 0.01 in all cases): writing an assignment, communicating with educators, reading materials, watching video, reviewing feedback, participating in forums, communicating with students (0.50 < r < 0.59), taking a test, checking news, planning studies, listening to audio and using the virtual library (0.40 < r < 0.49). Students who use the laptop at home were also slightly likely to carry out two remaining activities (0.30 < r < 0.39, p < 0.01 in both cases): participating in an online meeting and taking an exam. No significant relationships were found (r > 0.20) between performing activities using a laptop and the other locations.

Table 5.41: Correlations between Laptop Learning Locations and Activities

	n	M	SD	Laptop – Home	Laptop – Work	Laptop - Home Others	Laptop - University Centre	Laptop - Public Location	Laptop - Transit	Laptop - Other
Communicate Educator – Laptop	488	0.75	0.43	0.57**	0.12**	0.14**	0.08	0.14**	0.00	0.02
Communicate Students – Laptop	488	0.72	0.45	0.52**	0.10*	0.12*	0.09	0.10*	0.00	0.02
Read – Laptop	488	0.73	0.44	0.56**	0.11*	0.09*	0.08	0.18**	0.07	0.06
Listen – Laptop	488	0.61	0.49	0.45**	0.08	0.10*	0.10*	0.10*	0.09*	0.02
Watch – Laptop	488	0.71	0.45	0.54**	0.11*	0.12*	0.10*	0.14**	0.06	0.02
Forums – Laptop	488	0.74	0.44	0.54**	0.15**	0.12*	0.07	0.13**	0.03	-0.01
Test – Laptop	488	0.71	0.46	0.49**	0.13**	0.08	0.05	0.09*	0.01	0.02
Write – Laptop	488	0.77	0.42	0.58**	0.17**	0.14**	0.07	0.14**	0.03	0.03
Meeting – Laptop	488	0.53	0.50	0.37**	0.10*	0.01	0.10*	0.09	0.05	-0.03
Search – Laptop	488	0.82	0.38	0.65**	0.16**	0.17**	0.10*	0.18**	0.00	0.06
Exam – Laptop	488	0.44	0.50	0.33**	0.09	0.12*	0.19**	0.08	-0.01	-0.07
Library – Laptop	488	0.65	0.48	0.44**	0.04	0.14**	0.09*	0.13**	-0.03	0.02
Feedback – Laptop	488	0.73	0.44	0.54**	0.09*	0.17**	0.10*	0.14**	0.06	0.02
Plan – Laptop	488	0.62	0.49	0.46**	0.08	0.13**	0.10*	0.09*	0.07	-0.01
News – Laptop	488	0.68	0.47	0.49**	0.13**	0.08	0.06	0.12**	0.02	-0.01

$* p < 0.05, ** p < 0.01$

5.5.1.5.3 Learning Locations and Activities by Tablet

Table 5.42 shows the correlations between activities performed using a tablet and the locations where used. Students who use the tablet at home were considerably likely to carry out two activities ($p < 0.01$ in both cases): checking news and searching for information ($0.60 < r < 0.69$). Students who use the tablet at home were also likely to carry out two activities ($p < 0.01$ in both cases): reading materials ($r = 0.59$) and watching video ($r = 0.48$). Students who use the tablet at home were also slightly likely to carry out ten activities ($p < 0.01$ in all cases): reviewing feedback, communicating with students, communicating with educators, listening to audio, participating in forums, planning studies ($0.30 < r < 0.39$), participating in an online meeting, taking a test, using the virtual library and writing an assignment ($0.20 < r < 0.29$). Students who use the tablet at work were slightly likely to complete eleven activities ($p < 0.01$ in all cases): watching video, participating in forums, reading materials, communicating with students, listening to audio ($0.30 < r < 0.39$), searching for information, checking news, participating in an online meeting, planning studies, communicating with educators and reviewing feedback ($0.20 < r < 0.29$).

Students who use the tablet in the homes of others were slightly likely to carry out eleven activities ($p < 0.01$ in all cases): communicating with students, reading materials, communicating with educators, searching for information, watching video, checking news, participating in forums ($0.30 < r < 0.39$), participating in an online meeting, planning studies, reviewing feedback and listening to audio ($0.20 < r < 0.29$). Students who use the tablet at university regional centres were slightly likely to carry out two activities ($0.20 < r < 0.29$, $p < 0.01$ in both cases): checking news and watching video. Students who use the tablet in public locations were likely to carry out three activities ($0.40 < r < 0.49$, $p < 0.01$ in all cases): reading materials, watching video and checking news. Students who use the tablet in public locations were also slightly likely to carry out ten remaining activities (p < 0.01 in all cases): communicating with students, participating in forums, searching for information, listening to audio, communicating with educators (0.30 < *r* < 0.39), reviewing feedback, planning studies, writing an assignment, participating in an online meeting and taking a test (0.20 < *r* < 0.29). Students who use the tablet in-transit were slightly likely to carry out seven activities (p < 0.01 in all cases): reading materials, checking news (0.30 < *r* < 0.39), watching video, participating in forums, searching for information, listening to audio and planning studies (0.20 < *r* < 0.29). Students who use the tablet in other locations were slightly likely to carry out five activities (0.20 < *r* < 0.29, p < 0.01 in all cases): reading materials, watching video, listening to audio, reviewing feedback and checking news.

Table 5.42: Correlations between Tablet Learning Locations and Activities

	n	M	SD	Tablet – Home	Tablet – Work	Tablet - Home Others	Tablet - University Centre	Tablet - Public Location	Tablet Transit -	Tablet - Other
Communicate Educator – Tablet	488	0.17	0.38	0.34**	0.24**	0.35**	0.11*	0.32**	0.19**	0.19**
Communicate Students – Tablet	488	0.17	0.38	0.36**	0.30**	0.38**	0.16**	0.36**	0.19**	0.15**
Read – Tablet	488	0.40	0.49	0.59**	0.32**	0.36**	0.19**	0.44**	0.37**	0.27**
Listen – Tablet	488	0.20	0.40	0.34**	0.30**	0.25**	0.16**	0.35**	0.23**	0.24**
Watch – Tablet	488	0.30	0.46	0.48**	0.36**	0.33**	0.20**	0.43**	0.29**	0.25**
Forums – Tablet	488	0.16	0.37	0.33**	0.35**	0.30**	0.14**	0.36**	0.28**	0.14**
Test – Tablet	488	0.09	0.28	0.27**	0.09	0.18**	0.11*	0.21**	0.06	0.07
Write – Tablet	488	0.07	0.25	0.21**	0.17**	0.07	0.10*	0.23**	0.11*	0.10*
Meeting – Tablet	488	0.09	0.29	0.29**	0.26**	0.21**	0.10*	0.22**	0.12*	0.09*
Search – Tablet	488	0.37	0.48	0.60**	0.29**	0.34**	0.18**	0.35**	0.26**	0.18**
Exam – Tablet	488	0.02	0.13	0.12**	0.00	-0.01	-0.03	-0.06	0.00	-0.04
Library – Tablet	488	0.12	0.33	0.27**	0.14**	0.15**	0.16**	0.18**	0.07	0.17**
Feedback – Tablet	488	0.21	0.41	0.39**	0.20**	0.26**	0.18**	0.25**	0.15**	0.22**
Plan – Tablet	488	0.17	0.37	0.31**	0.26**	0.28**	0.09	0.26**	0.21**	0.19**
News – Tablet	488	0.39	0.49	0.62**	0.28**	0.32**	0.25**	0.40**	0.32**	0.22**

* p < 0.05, ** p < 0.01

5.5.1.5.4 Learning Locations and Activities by Smartphone

Table 5.43 shows the relationships (correlations) between activities performed using a smartphone and the locations where used. Students who use the smartphone at home were likely to carry out two activities (0.40 < *r* < 0.49, p < 0.01 in both cases): searching for information and checking news. Students who use the smartphone at home were also slightly likely to carry out seven activities (p < 0.01 in all cases): communicating with students (*r* = 0.39), reviewing feedback, planning studies, watching video, communicating with educators, listening to audio and participating in forums (0.20 < *r* < 0.29). Students who use the smartphone at work were slightly likely to carry out ten activities (p < 0.01 in all cases): searching for information, checking news (0.30 < *r* < 0.39), communicating with students, reading materials, listening to audio, watching video, reviewing feedback, communicating with educators, participating in forums and planning studies (0.20 < *r* < 0.29). Students who use the smartphone in the homes of others were slightly likely to carry out eight activities (p < 0.01 in all cases):

searching for information, checking news, communicating with students (0.30 < r < 0.39), planning studies, communicating with educators, listening to audio, watching video and reviewing feedback (0.20 < r < 0.29). Students who use the smartphone at university regional centres were slightly likely to carry out one activity: communicating with educators (r = 0.20, p < 0.01).

Students who use the smartphone in public locations were slightly likely to carry out nine activities (p < 0.01 in all cases): searching for information, checking news, communicating with students (0.30 < r < 0.39), watching video, planning studies, communicating with educators, listening to audio, reading materials and reviewing feedback (0.20 < r < 0.29). Students who use the smartphone in-transit were likely to carry out two activities (0.40 < r < 0.49, p < 0.01 in both cases): checking news and searching for information. Students who use the smartphone in-transit were slightly likely to carry out eight activities (p < 0.01 in all cases): communicating with students, watching video (0.30 < r < 0.39), listening to audio, communicating with educators, participating in forums, reading materials, planning studies and reviewing feedback (0.20 < r < 0.29). Students who use the smartphone in other locations were slightly likely to carry out five activities (0.20 < r < 0.29, p < 0.01 in all cases): watching video, communicating with students, checking news, searching for information and listening to audio.

Table 5.43: Correlations between Smartphone Learning Locations and Activities

	n	**M**	**SD**	**Smart-phone – Home**	**Smart-phone – Work**	**Smart-phone - Home Others**	**Smart-phone - University Centre**	**Smart-phone - Public Location**	**Smart-phone - Transit**	**Smart-phone - Other**
Communicate Educator – Smartphone	488	0.24	0.43	0.24**	0.21**	0.24**	0.20**	0.26**	0.26**	0.19**
Communicate Students – Smartphone	488	0.38	0.49	0.39**	0.27**	0.32**	0.17**	0.31**	0.32**	0.26**
Read – Smartphone	488	0.23	0.42	0.19**	0.26**	0.16**	0.05	0.21**	0.21**	0.14**
Listen – Smartphone	488	0.23	0.42	0.23**	0.26**	0.22**	0.14**	0.22**	0.27**	0.21**
Watch – Smartphone	488	0.26	0.44	0.27**	0.26**	0.22**	0.18**	0.28**	0.30**	0.27**
Forums – Smartphone	488	0.19	0.39	0.22**	0.21**	0.17**	0.08	0.14**	0.23**	0.17**
Test – Smartphone	488	0.05	0.22	0.16**	0.09*	0.06	0.09	0.16**	0.19**	0.13**
Write – Smartphone	488	0.03	0.18	0.12**	0.12**	0.07	0.11*	0.12*	0.06	0.12**
Meeting – Smartphone	488	0.06	0.24	0.14**	0.12**	0.06	-0.01	0.11*	0.10*	0.07
Search – Smartphone	488	0.43	0.50	0.45**	0.35**	0.38**	0.17**	0.35**	0.40**	0.23**
Exam – Smartphone	488	0.01	0.08	0.07	0.10*	0.05	-0.03	0.05	0.03	0.08
Library – Smartphone	488	0.08	0.27	0.14**	0.15**	0.11*	0.04	0.14**	0.19**	0.17**
Feedback – Smartphone	488	0.27	0.44	0.29**	0.22**	0.20**	0.06	0.20**	0.20**	0.19**
Plan – Smartphone	488	0.24	0.43	0.29**	0.21**	0.25**	0.11*	0.27**	0.21**	0.17**
News – Smartphone	488	0.51	0.50	0.42**	0.34**	0.34**	0.15**	0.34**	0.41**	0.26**

* p < 0.05, ** p < 0.01

5.5.1.5.5 Learning Locations and Activities by Device Frequency Summary

Table 5.45 shows a summary of the relationships (correlations) between activities performed using different devices, across locations (excluding "Other"). Weaker relationships are highlighted in a lighter blue ($0.20 < r < 0.40$), while stronger relationships are highlighted in a darker blue ($r \geq 0.40$).

Table 5.44: Correlations between Learning Locations and Activities across Devices Variables

	Desktop		**Laptop**	**Tablet**						**Smartphone**					
	Home	Work	Home	Home	Work	Other Homes	University	Public Location	Transit	Home	Work	Other Homes	University	Public Location	Transit
Communicate with educator	0.67**	0.29**	0.57**	0.34**	0.24**	0.35**		0.32**		0.24**	0.21**	0.24**	0.20**	0.26**	0.26**
Communicate with students	0.66**	0.29**	0.52**	0.36**	0.30**	0.38**		0.36**		0.39**	0.27**	0.32**		0.31**	0.32**
Read materials	0.62**	0.36**	0.56**	0.59**	0.32**	0.36**		0.44**	0.37**		0.26**			0.21**	0.21**
Listen to audio	0.58**	0.24**	0.45**	0.34**	0.30**	0.25**		0.35**	0.23**	0.23**	0.26**	0.22**		0.22**	0.27**
Watch video	0.67**	0.24**	0.54**	0.48**	0.36**	0.33**	0.20**	0.43**	0.29**	0.27**	0.26**	0.22**		0.28**	0.30**
Participate in forums	0.62**	0.34**	0.54**	0.33**	0.35**	0.30**		0.36**	0.28**	0.22**	0.21**				0.23**
Take quiz/test	0.61**	0.28**	0.49**	0.27**				0.21**							
Write assignment	0.67**	0.30**	0.58**	0.21**				0.23**							
Online meeting/lecture	0.49**		0.37**	0.29**	0.26**	0.21**		0.22**							
Search for information	0.67**	0.36**	0.65**	0.60**	0.29**	0.34**		0.35**	0.26**	0.45**	0.35**	0.38**		0.35**	0.40**
Take exam	0.52**		0.33**												
Use virtual library	0.58**	0.24**	0.44**	0.27**											
Review assignment feedback	0.59**	0.28**	0.54**	0.39**	0.20**	0.26**		0.25**		0.29**	0.22**	0.20**		0.20**	0.20**
Plan study time	0.56**	0.20**	0.46**	0.31**	0.26**	0.28**		0.26**	0.21**	0.29**	0.21**	0.25**		0.27**	0.21**
Check news/ announcements	0.58**	0.33**	0.49**	0.62**	0.28**	0.32**	0.25**	0.40**	0.32**	0.42**	0.34**	0.34**		0.34**	0.41**

* $p < 0.05$, ** $p < 0.01$

5.5.1.6 Influencers of Device Selection at a Point in Time

Students were asked to select which factors influence their choice of device for learning at a particular time. Figure 5.7 shows that the most common factor influencing choice of device for learning at a point in time was the location or environment (73.1% of students selected this). This was followed by the learning goal or activity to accomplish (60.6% of students). The third most common influencer was the amount of time available or needed (54.8% of students). Over a third of students (38.6%) also indicated the device features (interface or screen size) influences their choice. These results confirm that multiple factors influence the selection of a device for study at a particular time, but that learning location, activity and time are important.

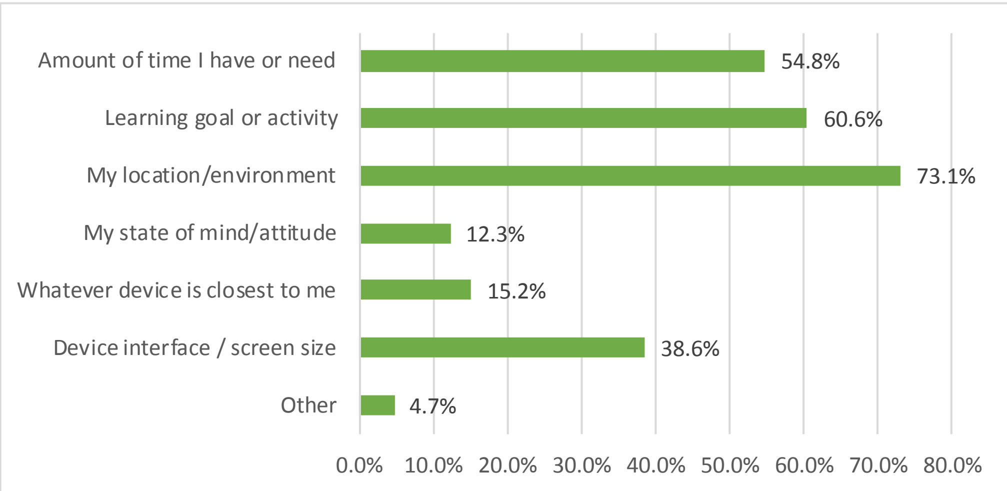

Figure 5.7: Influencers in the Choice of Device for Learning at a Particular Time (Percentages)

5.5.2 Chi-Square Tests

Chi-square tests were performed at the 95.5% confidence level to determine if there were any significant differences between demographic classifications and different variables such as device access and use for desktops, laptops, tablets, smartphones, basic mobiles and e-readers. The seven demographic variables considered were age group, gender, discipline, employment status, national status, year of study and language status. Only the statistically significant chi-square test results are shown. Test results were ignored where more than 20% of the contingency table cells had expected counts less than five (Field, 2013).

5.5.2.1 Device Access

There was a statistically significant difference in the proportion of students with access to desktops in respect to age group ((n=488) X^2 (8) =20.80, p = 0.008). Students aged 25 years and under were less likely to own desktops (48.7%) than students aged 46-55 years (74.7%). There was a statistically significant difference in the proportion of students with access to tablets in respect to age group ((n=488) X^2 (8) =19.68, p = 0.012). Students aged 25 years and under were less likely to own tablets (44.9%) than students aged 36-45 years (67.3%) and above. However, there were no differences in respect to age group for access to the other devices.

There was a statistically significant difference in the proportion of students with access to desktops in respect to gender ((n=488) X^2 (2) =25.79 $p < 0.001$). Males (70.9%) were more likely to own desktops than females (52.1%). However, there were no differences in respect to gender for access to the other devices.

There was a statistically significant difference in the proportion of students with access to desktops in respect to national status ((n=488) X^2 (2) = 14.24, p = 0.001). Local students were more likely to have access to a desktop (76.7%) than international students (48.6%). However, there were no differences in respect to national status for access to the other devices.

No statistically significant differences were found for accessing any of the devices with respect to the other demographic variables (discipline, employment status, year of study and language status).

5.5.2.2 Device Use for Study

There was a statistically significant difference in the proportion of students using tablets for study in respect to age group ((n=337) X^2 (12) =25.22, p = 0.014). Students aged 25 years and under were less likely to use tablets for study (80.0%) than students aged 46-55 years (86.4%). However, there were no differences in respect to age group for use of the other devices for study.

There was a statistically significant difference in the proportion of students using desktops for study in respect to gender ((n=350) X^2 (3) =17.78 $p < 0.001$). Males (94.7%) were more likely to use desktops for study than females (83.3%). However, there were no differences in respect to gender for use of the other devices for study.

There was a statistically significant difference in the proportion of students using desktops for study in respect to employment status ((n=350) X^2 (6) = 18.95, p = 0.004). Employed students, either full-time (90.2%) or part-time (89.1%), were more likely to use desktops for study than unemployed students (80.5%). However, there were no differences in respect to employment status for use of the other devices for study.

There was a statistically significant difference in the proportion of students using smartphones in respect of national status ((n=450) X^2 (3) = 9.60, p = 0.022). Local students were less likely to use smartphones daily (55.4%) than international students (80.0%). However, there were no differences in respect to national status for use of the other devices for study.

No statistically significant differences were found for using any of the devices with respect to the other demographic variables (discipline, year of study and language status). The number of devices students use for study (device range) were also considered. No statistically significant differences were found with respect to age group, gender, discipline, employment status, national status, year of study and language status for the number of devices students used for study.

5.5.2.3 Device Purchase Reason

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to age ((n=420) X^2 (4) = 14.14, p = 0.007). Students aged 25 years and under were more likely to purchase laptops for study (68.5%) than students aged 46-55 years (42.9%) and above. However, there were no differences in respect to age group for the purchase reason for any of the other devices.

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to gender ((n=420) X^2 (1) = 11.92, p = 0.001). Females (63.2%) were more likely to purchase laptops for study than males (46.4%). However, there were no differences in respect to gender for the purchase reason for any of the other devices.

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to employment status ((n=420) X^2 (2) = 14.46, p = 0.001). Employed students, either full-time (49.3%) or part-time (65.0%), were less likely to purchase laptops for study than unemployed students (73.2%). There was a statistically significant difference in the proportion of students purchasing tablets for study reasons with respect to employment status ((n=287) X^2 (2) =19.17, $p < 0.001$). Employed students, either full-time (18.5%) or part-time (38.3%), were more likely to purchase tablets for study than unemployed students (0.0%). However, there were no differences in respect to employment status for the purchase reason for any of the other devices.

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to year of study ((n=420) X^2 (4) = 10.79, p = 0.029). Students in their first year of study were less likely to purchase laptops for study (44.3%) than students between their third and fourth year (61.9%). However, there were no differences in respect to year of study for the purchase reason for any of the other devices.

There was a statistically significant difference in the proportion of students purchasing e-readers for study reasons with respect to language status ((n=130) X^2 (1) = 9.10, p = 0.003). Students with the same home language as the language of study (8.0%) were less likely to purchase an e-reader for study than students with a different home language (27.9%). However, there were no differences in respect to language status for the purchase reason for any of the other devices.

No statistically significant differences were found for the remaining demographic variables (discipline and national status) with respect to purchasing any of the devices for study purposes.

5.5.2.4 Device Level of Expertise

No statistically significant differences were found with respect to any of the demographic variables (age group, gender, discipline, employment status, national status, year of study and language status) for the expertise level in using any of the devices.

5.5.2.5 Device Importance to Academic Success

There was a statistically significant difference in the proportion of students valuing smartphones as important for academic success with respect to year of study ((n=372) X^2 (16) = 35.07, p = 0.004). Students in their first year of study were more likely to value smartphones as important or very important (55.2%) than students in the fourth year or above (37.2%). However, there were no differences in respect to importance for academic success for the other devices. Furthermore, no statistically significant differences were found for any of the other demographic variables (age, gender, discipline, employment status, national status and language status) and the importance to academic success of any of the devices.

5.5.3 Principal Components Analysis: Learning Activities per Device

In order to verify how students use devices for different learning activities, Principal Components Analysis (PCA) was used to supplement the other forms of analysis to determine whether the learning activity variables per device could be grouped into principal components. Table 5.45 shows that for learning activities performed using desktops, PCA showed an acceptable one-factor structure (KMO = 0.967 and a significant Bartlett's test, $p < 0.001$), with factor loadings ranging from 0.716 to 0.916, and 74.2% of total variance explained. Reliability analysis of the compounded factor showed a Cronbach's α of 0.975. This confirms the finding that desktops are used for a wide range of activities and that the learning activities cannot be grouped into components.

Table 5.45 also shows that for learning activities performed using laptops, after the removal of the Take Exam and Online Meeting activities, PCA showed an acceptable one-factor structure (KMO = 0.959 and a significant Bartlett's test, $p < 0.001$), with factor loadings ranging from 0.737 to 0.881, and 67.4% of total variance explained. Reliability analysis of the compounded factor showed a Cronbach's α of 0.958. This confirms the finding that laptops are used for a wide range of activities and the learning activities cannot be grouped into components.

Table 5.45 also shows that for learning activities performed using tablets, after the removal of several variables, PCA showed an acceptable two-factor structure (KMO = 0.889 and a significant Bartlett's test, $p < 0.001$), that accounts for 69.7% of the total variance explained for consuming information activities (38.4%) and for communication activities (31.3%). Respectively, the rotated factor solution (Varimax with Kaiser normalisation) provided factor loadings ranging from 0.703 to 0.818, and from 0.579 to 0.891. The two compounded factors showed a Cronbach's α of 0.881 and 0.856. This confirms the finding that tablets are used mainly for consuming information and for communication activities.

Table 5.45 also shows that for learning activities performed using smartphones, after the removal of several variables, PCA showed an acceptable three-factor structure (KMO = 0.824 and a significant Bartlett's test, $p < 0.001$), that accounts for 63.5% of the total variance explained by communication activities (22.6%), checking activities (20.8%) and consuming information activities (20.1%). Respectively, the rotated factor solution (Varimax with Kaiser normalisation) provided factor loadings ranging from 0.691 to 0.833, 0.629 to 0.705 and from 0.514 to 0.898. The three compounded factors showed a Cronbach's α of 0.745, 0.730 and 0.761. This confirms the finding that smartphones are used mainly for communication activities, for checking information and for consuming information.

Table 5.45: Learning Activities in the Component Matrices for Desktops, Laptops, Tablets and Smartphones

Desktop Learning Activities	**Factor Loadings**	**Laptop Learning Activities**	**Factor Loadings**	**Tablet Learning Activities**	**Factor Loadings**	**Smartphone Learning Activities**	**Factor Loadings**
Participate in Forum	0.916	Communicate with Educators	0.881	**Consume Information**		**Communication**	
Watch Video	0.913	Write Assignment	0.871	Read Materials	0.818	Communicate with Educators	0.833
Review Feedback	0.909	Review Feedback	0.869	Watch Video	0.807	Communicate with Students	0.767
Search for Information	0.906	Participate in Forum	0.862	Check News/ Announcements	0.794	Participate in Forum	0.691
Write Assignment	0.906	Search for Information	0.844	Search for Information	0.741	**Check Information**	
Communicate with Educators	0.891	Watch Video Laptop	0.844	Listen to Audio	0.703	Use Virtual Library	0.705
Take Test	0.888	Communicate with Students	0.841	**Communication**		Search for Information	0.665
Use Virtual Library	0.875	Take Test	0.826	Communicate with Educators	0.891	Review Feedback	0.638
Communicate with Students	0.871	Read Materials	0.809	Communicate with Students	0.867	Check News/ Announcements	0.629
Read Materials	0.856	Plan Study Time	0.767	Participate in Forum	0.734	**Consume Information**	
Check News/ Announcements	0.842	Check News/ Announcements	0.757	Review Feedback	0.579	Listen to Audio	0.898
Plan Study Time	0.830	Use Virtual Library	0.743			Watch Video	0.861
Listen to Audio	0.830	Listen to Audio	0.737			Read Materials	0.514
Participate in Online Meeting	0.739						
Take Exam	0.716						

5.5.4 Multivariate Analysis of Frequency of Device Use

In order to contrast the bivariate relationships and weight the relative contribution of the explanatory variables, the following section shows parallel multiple regressions. The aim was to see how different independent variables (location, activities) could predict a dependent variable (frequency of device use). Ordinal regression models were originally proposed for the ordinal device frequency variables, however p-parallel lines below 0.05 meant that the ordinal regression models could not be accepted. In order to overcome this situation, binary logistic regressions were tested. A large number of binary logistic regressions were tested across different variables, however, only the following binary logistic regression models are shown as they are the most potentially useful. Table 5.46 shows four parallel multiple binary logistic regressions related to the frequency of device usage for desktops, laptops, tablets and smartphones. Device frequency was obtained by grouping frequencies ("Never"+"Monthly" and "Weekly"+"Daily") for each device. The significance and overall fit obtained for the proposed models had valid values: X^2 with p=0.000, Hosmer–Lemeshow's tests were insignificant (p=0.748, p=0.277, p=0.877 and p=0.511), Cox and Snell's (0.241, 0.270, 0.292 and 0.102) and Nagelkerke's (0.500, 0.597, 0.433 and 0.191) R^2 indices had good measurements of goodness-of-fit.

For frequency of desktop usage, the frequent use of a desktop for study was statistically greater among students who placed a very high value of importance for academic success on the desktop (Exp(B)=15.443), used the desktop at home (Exp(B)=6.552) to read materials (Exp(B)=5.262). For frequency of laptop usage, the frequent use of a laptop for study was statistically greater among students who used the laptop at home (Exp(B)=6.744) to take a test (Exp(B)=7.807) and communicate with educators (Exp(B)=3.527). For frequency of tablet usage, the frequent use of a tablet for study was statistically greater among students who placed a very high, high or neutral value of importance for academic success on the tablet (Exp(B)=60.016, Exp(B)=16.733 and Exp(B)=6.962, respectively) and used the tablet in-transit (Exp(B)=3.797) to watch video (Exp(B)=3.080), search for information (Exp(B)=2.849) or read materials (Exp(B)=0.414). For frequency of smartphone usage, the frequent use of a smartphone for study was statistically greater among students who used the smartphone at home (Exp(B)=4.164) to watch video (Exp(B)=2.455).

Table 5.46: Multiple Binary Logistic Regression Models of Device Frequency for Learning

	Regression 1: Desktop Frequency				**Regression 2: Laptop Frequency**				**Regression 3: Tablet Frequency**				**Regression 4: Smartphone Frequency**			
	B	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**
Location – Home	1.880*	0.790	6.552	[1.394-30.799]	1.909**	0.546	6.744	[2.311-19.679]	-0.699	0.544	0.497	[0.171-1.445]	1.427**	0.367	4.164	[2.028-8.552]
Location – Work	1.167	0.801	3.213	[0.668-15.448]	1.258	0.666	3.519	[0.953-12.990]					0.317	0.364	1.373	[0.673-2.804]
Location – In-transit									1.334*	0.597	3.797	[1.179-12.226]	-0.060	0.352	0.942	[0.472-1.878]
Communicate with Educators					1.261*	0.620	3.527	[1.046-11.898]	0.566	0.500	1.762	[0.661-4.693]				
Communicate with Students	0.675	0.577	1.653	[0.473-5.768]									0.269	0.359	1.309	[0.647-2.647]
Read Materials	1.678**	0.591	5.262	[1.191-23.250]	1.093	0.665	2.983	[0.810-10.987]	-0.881*	0.417	0.414	[0.183-0.937]				
Watch Video									1.125**	0.424	3.080	[1.341-7.076]	0.898*	0.441	2.455	[1.033-5.832]
Write Assignment	-0.701	0.855	3.040	[0.825-11.202]	0.367	0.698	1.443	[0.367-5.669]								
Take Test					2.055**	0.698	7.807	[1.986-30.691]								
Search for Information									1.047**	0.383	2.849	[1.345-6.031]	-0.486	0.391	0.615	[0.286-1.324]
Device	***Importance***								***Importance***				***Expertise***			
Very Low	-	-	-	-					-	-	-	-	-	-	-	-
Low	-0.849	1.417	0.428	[0.027-6.878]					0.922	0.678	2.513	[0.665-9.494]	-0.087	0.710	0.917	[0.228-3.690]
Neutral	0.958	0.965	2.607	[0.393-17.290]					1.941**	0.604	6.962	[2.133-22.727]	0.004	0.689	1.004	[0.260-3.875]
High	1.078	0.961	2.940	[0.447-19.353]					2.817**	0.698	16.733	[4.259-65.740]	0.949	0.713	2.583	[0.639-10.452]
Very High	2.737**	1.013	15.443	[2.121-112.426]					4.095**	0.950	60.016	[9.325-386.253]	1.251	0.757	3.494	[0.792-15.414]
Intercept	-1.596	1.284	0.203	-	-1.821**	0.517	0.162	-	-1.074	0.636	0.341	-	0.301	0.642	1.351	-
Model Summary																
Sample Size	306				449				290				367			
X^2 (degrees of freedom)	84.256 (9)				141.126 (6)				100.114 (10)				39.617 (10)			
X^2 Significance	0.000				0.000				0.000				0.000			
Cox & Snell R^2, Nagelkerke R^2	0.241, 0.500				0.270, 0.597				0.292, 0.433				0.102, 0.191			
Hosmer & Lemeshow X^2 (df)	5.089 (8)				5.102 (4)				3.744 (8)				7.244 (8)			
H&L Significance	0.748				0.277				0.877				0.511			

* $p < 0.05$, ** $p < 0.01$

Note: Table shows all variables, but binary logistic regressions only performed with corresponding variables.

5.5.5 Qualitative Analysis

5.5.5.1 Learning Locations

Interviewees (n=18) confirmed that devices are used in multiple locations, some public and some private. Devices are often used in private places such as the home, because these places are quieter, with fewer distractions and students can concentrate better. Away from home, students sometimes study at work (during breaks or if work is quiet). Students also look to take advantage of time while using public transport (such as buses and trains) to check information or read materials.

Interview data confirmed that several students have access to desktops at work, while some students have a desktop at home that is used by the family. Students use desktops and laptops in similar ways. However, desktops are used in fixed places, such as at home, while laptops are more portable and are used at home (even moving around within the home), work and while travelling or at a library. This is exemplified in the following interviewee quotes:

> *I use both (the desktop computer and the laptop). On the one hand, I use my laptop because I usually travel and, therefore, it sometimes happens that I need to do an activity while I am away from home (not only when I am travelling but also when I am at my work place). On the other hand, I use my desktop computer when I am at home.* (Julia, female, 26-35 years)

> *I use the laptop because of the convenience. I can move from one place to another without any problem. I'm usually in the dining room, but if my daughter wants to watch the TV, I go to the kitchen. That is, with the laptop I can easily change my location of where I am learning.* (Marina, female, 36-45 years)

Tablets are used in a variety of locations. This is because tablets are more portable than laptops and tend to be taken to more places. Students can make use of Wi-Fi in public locations, such as coffee shops, to communicate with group members about collaborative projects. The following quotes illustrate the use of tablets in different locations:

> *And the tablet I take it with me almost always, when I'm commuting to work, at home, travelling on the train as well. I take advantage of the time on the train.* (Martina, female, 18-25 years)

> *I have brought the tablet with me, if I've been concerned about the marks or if I had to do an assignment in a group, so I study at breakfast time, as there is Wi-Fi in many coffee shops, so I use it. In the coffee shop I had to talk to my classmates or whatever while I was having a coffee, to connect and talk to them. It was very comfortable to use the tablet.* (Carmen, female, 36-45 years)

Interviewees confirmed that smartphones are used in the most number of places. They can be used either at home or when away from home. They are usually on-person, so they can be used at any time and any place, as illustrated by the following quotes:

> *The mobile phone has the advantage that you can use it wherever you want, i.e., while I am using the public transport, or when you are waiting for someone.* (Elena, female, 26-35 years)
>
> *I use the smartphone when I'm out on public transport, during work breaks, at lunchtime, etc. I can continue studying on the public transport... For example, I can continue at the same point I stopped reading when I was at home. The mobile phone allows me to study anywhere anytime.* (Javier, male, 26-35 years)

5.5.5.2 Learning Activities

Interviewees confirmed that different devices are used in both similar and different ways. For example, desktops and laptops are used for a wide range of similar activities, as exemplified in the following quotes:

> *I do practically everything with the laptop and the PC, I do the assignments, I check the material and I do Internet searches that require time. I use them to print material for reading the material in depth.* (Javier, male, 26-35 years)
>
> *I have a desktop computer, a Mac, in which I carry out the continuous assessment tasks and check the virtual classrooms when I'm at home.* (Nuria, female, 26-35 years)

Students particularly valued using the desktop for writing activities. For students, studying with a desktop meant either going to their work environment or going to a specific room at home because it was setup as a quiet space used for studying at home. This is demonstrated in the following quotes:

> *If I have to write I wait until I get home or the office to use the PC.* (Marc, male, 46-55 years)
>
> *Where I really do the work and where I do my writing tasks is on the desktop computer, which is the one I have suitable for studying. I do the work and my writing tasks in a specific bedroom I have already prepared for working in order to have a suitable working environment. I need the computer to be able to write, to work, to read the material.* (Elena, female, 26-35 years)

While the desktop is seen as a key device for some students, other students feel that the laptop is a central device for study because it is used for the majority of activities. These activities include accessing the VLE, downloading materials, organising materials and writing continuous assessment tasks. The following quotes show how important the laptop is regarded for studies:

The most important UOC learning tasks I do are almost everything… my assignments, accessing the virtual campus... I do everything with the laptop. For me, the laptop is the main device, without the laptop it would also be impossible for me to do anything. (Marina, female, 36-45 years)

I use the laptop for almost everything. In general, I use the laptop in my daily life, at work and for studying. The tasks I do with the laptop are searching for documents on the internet, my assignments and some diagrams. Nowadays, the laptop is the most useful tool for almost everything (working and studying). (Cristina, female, 46-55 years)

Students were asked to explain why laptops were used to perform these learning activities. Students confirmed that laptops are better for writing activities as the screens and keyboards are bigger than handheld devices. They also provide all the software needed for writing assignments. These reasons are described in the following quotes:

I do the tasks with the laptop because the screen is bigger, the keyboard is bigger. I´m also more used to working with the laptop's software. It is more comfortable in this sense. (Martina, female, 18-25 years)

Writing… it's very uncomfortable [on other devices]. I tried with the tablet and the smartphone and I always finish the work on the laptop because it offers everything I need for writing. (Laia, female, 26-35 years)

Interviewees confirmed the main learning activities performed using the tablet were reading materials and watching videos (consuming information). Tablets are also used to check information (marks or forums) during free time or to catch up with studies. Students use the tablet to download and read material, either at home or while travelling, for example, on the train to work. Students particularly preferred reading on the tablet as it is easy to read on a vertical screen and it is also easy to highlight when reading and flip between pages. The tablet is smaller and more portable than the laptop, yet is bigger and more comfortable than using the smartphone to read. These uses are exemplified in the following interviewee quotes:

I use the iPad to read because it is like a book and it's portable. You can read sitting on the couch quietly, it's more comfortable. I find the iPad more comfortable to study the contents. (Marti, male, 46-55 years)

It's easier to use the tablet to check anything. The tablet is like a faster thing. If I'm in a different room at home [from where my laptop is] then I access from the tablet. The tablet is to access information, to do searches. (Laia, female, 26-35 years)

Tablets are also used as substitute devices when a desktop or laptop is not available. However, many students do not feel as comfortable performing some of the activities as they would be using a desktop or laptop. Some students prefer not to write using a tablet, while others can use the tablet to write if their laptop is not available:

But if I´m going to spend the weekend somewhere and I have little [studying] to do, but I don´t have to write, I usually use the tablet. (Martina, female, 18-25 years)

If I have to do some writing or to contribute to something then I bring the tablet with me. I use it to keep working on a task once I've left the laptop at home. (Carmen, female, 36-45 years)

Students also mentioned that it was better to participate in VLE forums using the UOC app on a tablet because when participating in forums using the VLE from a desktop or laptop, the system automatically logs a user out after a certain time, even while a person is writing a forum post:

If you have the forum space open with the computer without using it for a while, it comes a point where the forum closes and you are logged out [of the Virtual Campus]. On the contrary, this does not happen on the tablet, therefore, it is much more comfortable. (Sofia, female, 18-25 years)

Interviewees confirmed that smartphones are used in very limited ways to study. Students use a smartphone to quickly check information (news, forum messages or marks) because the smartphone is with them all the time. Students emphasised the ability of the smartphone to check things quickly and keep up to date with course activities via the UOC app. The smartphone is also used to communicate with educators and other students (group communication), through email, forums, Skype and instant messaging (such as WhatsApp). These two main uses are exemplified in the following interviewee quotes:

I use the mobile phone to check if there is any kind of notification, any document or data, i.e., for something very specific. For example, with the mobile phone I do not usually go beyond reading. (Lucia, female, 36-45 years)

The mobile phone for specific tasks… for quick checks, for a quick task. (Elena, female, 26-35 years)

I usually have the phone with me, depending on where I go, I usually use the phone because maybe, there is group work to do… so I look for a place with Wi-Fi so I can continue the task. (Carmen, female, 36-45 years)

Students sometimes use the smartphone to perform activities when they do not have other devices with them and have urgent matters to attend to. However, because the phone is smaller, materials look smaller and can be more difficult to read. For some students this is a problem, whereas other students prefer the portability of the device to read in public locations or in-transit:

> *I sometimes use the phone to write messages, but to type it's more comfortable on the iMac or the MacBook Pro. I have read materials on the phone, but just few times. Only a little because the format [of the text] is too small so my eyes get tired.* (Marti, male, 46-55 years)
>
> *I use the phone for reading and accessing the virtual classroom too. I read, if for instance, I'm in the metro, it's more comfortable than opening the laptop right there.* (Laia, female, 26-35 years)

One student did provide an example of using the smartphone for a more complex learning activity, in this case to record a presentation:

> *I've used the smartphone for a very specific thing, like in a subject in which we were asked to record ourselves doing a presentation. I didn't know how to use the laptop's software for recording, and I did not want to look for different software to install. As the smartphone is a very camera-oriented device (to take a selfie and to record yourself), it seemed very easy to me. I mean, the real usefulness I found in the smartphone is the task of recording myself doing a presentation.* (Jorge, male, 26-35 years)

5.5.5.3 Devices, Locations and Learning Activities

Interviewees confirmed that the choice of device is dependent on different factors for different students. However, the main influencers of device choice at a point in time are the location and time available as well as the learning activity itself, as illustrated in the following quotes:

> *I think it is more related to the location, time management and the task itself. But, above all, it depends on where I am and the time I have to carry out the work with the device.* (Lucia, female, 36-45 years)
>
> *It depends on the moment and where I use the device. Also, it depends on the task I want to do. If I have to write, I am much more comfortable on the laptop because I feel more comfortable with the keyboard and everything. If I simply have to read information, I usually use the tablet. Basically, the tablet and, for example, it depends on where I am, on the bus or in a cafe. In these cases, I prefer the mobile phone over the tablet. It depends.* (Sofia, female, 18-25 years)

Well… I suppose that depends on the day, where I am and how I feel. (Elena, female, 26-35 years)

In addition to the factors above, many interviewees referred to their comfort levels in using a device. Very often this referred to the features of the device (screen size, speed, keyboard size). However, the level of comfort was also related to the effectiveness of using the device to achieve a particular learning objective:

I've tried to use the integrated keyboard of the tablet and the smartphone but it's very uncomfortable to write and eventually it is more practical to have both hands on the keyboard than on this very small space. And the interfaces, I also find them, more uncomfortable on the phone or tablet than on the laptop. (Laia, female, 26-35 years)

The laptop is the easiest device (with keyboard) for writing an email, a report or some parts of my assignments. For me, it is my priority device, the most comfortable for everything. (Cristina, female, 46-55 years)

What I always look for is to be comfortable, not only to use a device but that it also will be effective for me. The time I'm reading learning material or doing whatever must be profitable, if not I wouldn't do it. (Diego, male, 36-45 years)

5.6 Sequential and Simultaneous Device Use

The aim of this section is to provide a summary of findings that are able to address the second research question (*How do ODL university students make use of handheld devices together with fixed devices to perform learning activities?*).

5.6.1 Descriptive Analysis

5.6.1.1 Use of Multiple Devices Together

Students were found to use multiple devices together in two ways, either sequentially or simultaneously. Sequential usage refers to students starting a learning activity on one device and continuing or finishing the learning activity on a different device. Simultaneous use refers to students using two or more devices at the same time to perform a learning activity. Table 5.47 shows the frequency of how often students use multiple devices, either sequentially or simultaneously. Students were asked to indicate the frequencies using a Likert scale (0 = Never, 1 = Occasionally, 2 = Sometimes, 3 = Frequently, 4 = Very Frequently). Table 5.47 shows the mean for sequential usage frequency was 1.71 (SD of 1.22) which indicates that the average student made use of devices sequentially sometimes.

The mean for simultaneous usage frequency was 1.91 (SD of 1.13) which indicates that the average student made use of devices simultaneously sometimes, but a bit more often than sequentially. The relationship (correlation) between sequential and simultaneous use was tested. Students who frequently use devices for sequential usage are also likely to frequently make use of devices for simultaneous usage ($r_s = 0.54$, $p < 0.01$).

Table 5.47: Sequential and Simultaneous Use of Devices (Percentages)

	n	M	SD	Never	Occasionally	Sometimes	Frequently	Very Frequently
Sequential Frequency	488	1.71	1.22	15.4	35.7	21.9	16.4	10.7
Simultaneous Frequency	488	1.91	1.13	11.5	26.0	30.7	23.4	8.4

5.6.1.2 Synchronisation and Cloud Services

In order for students to move between devices, they need a mechanism to access resources or files across the devices. Students were asked to specify which tools were used to store or access resources to move between devices. Figure 5.8 shows most commonly used tool was the Virtual Campus (VLE) (69.6% of respondents), followed by Google Drive (49.9%) and Dropbox (37.0%).

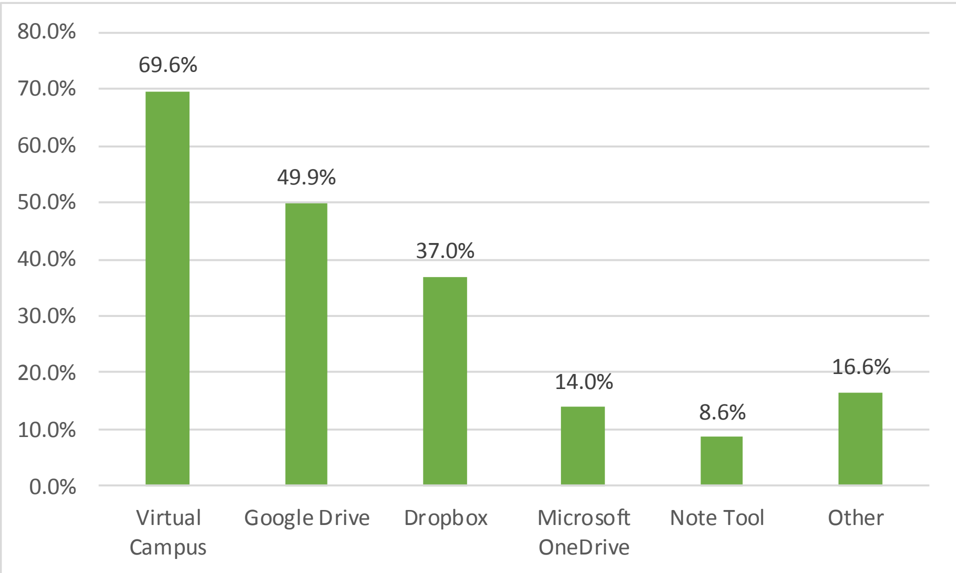

Figure 5.8: Tools Used to Access and Store Resources across Devices (Percentages)

5.6.1.3 Useful Applications for Learning

Students were asked to specify the main two or three applications or software they used for learning. Figure 5.9 shows the most common application categories (together with application examples). The most common application was a cloud storage or collaboration tool (30.7%) such as Google Drive or Dropbox. This was followed by a PDF reader or editor (21.5%) such as Adobe Acrobat. The third most popular tool was the UOC Virtual Campus (19.4%). The results indicate the importance of reading and writing text (PDF readers, office packages) as well as the importance of online access (cloud storage, synchronisation, virtual campus, browsers and searching).

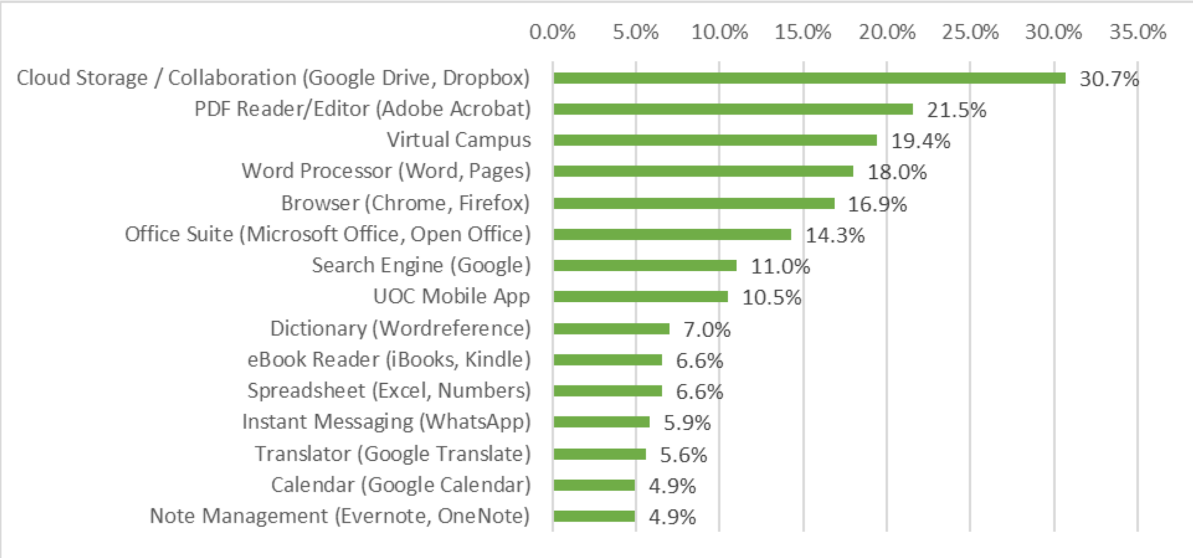

Figure 5.9: Most Useful Applications for Learning (Percentages)

5.6.1.4 Sequential Use

Students who indicated that they made use of sequential devices for learning (n = 413) were asked to select which devices they started learning activities on and then which devices they continued/ended on. Table 5.48 below shows the devices (in each row) that they started on and which devices they continued/ended on. For sequential device learning, the most common devices to start on are smartphones (180 students), followed by tablets (170 students) and laptops (155 students).

Table 5.48: Frequency of Continuing/End Device Use by Device Started On (Percentages)

	n	End Desktop	End Laptop	End Tablet	End Smartphone	End Basic Mobile	End e-Reader
Start on Desktop	124	-	96.0	5.6	4.8	0.0	0.8
Start on Laptop	155	82.6	-	16.1	6.5	0.0	1.9
Start on Tablet	170	41.2	72.4	-	4.1	0.0	0.0
Start on Smartphone	180	37.2	71.7	10.6	-	0.0	1.1
Start on Basic Mobile Phone	10	60.0	60.0	0.0	0.0	-	0.0
Start on e-Reader	33	42.4	57.6	9.1	6.1	0.0	-

n = Excludes students who never make use of sequential device use

Table 5.48 showed the results of sequential device usage from the point of view of the device that is started on. Table 5.49, however, shows the device that is continued or ended on. It shows the devices (in each row) that students continue/end on and which devices they started on. For sequential device learning, the most common devices to continue/end on are laptops (227 students) and desktops (163 students). Mobile devices are very seldomly used to continue/end activities, with no learning activities being continued or completed on a basic mobile.

Table 5.49: Frequency of Starting Device Use by Device Continued/Ended On (Percentages)

	n	Start Desktop	Start Laptop	Start Tablet	Start Smartphone	Start Basic Mobile	Start e-Reader
Continue/End on Desktop	163	-	78.5	42.9	41.1	3.7	8.6
Continue/End on Laptop	227	52.4	-	54.2	56.8	2.6	8.4
Continue/End on Tablet	43	16.3	58.1	-	44.2	0.0	7.0
Continue/End on Smartphone	20	30.0	50.0	35.0	-	0.0	10.0
Continue/End on Basic Mobile	0	-	-	-	-	-	-
Continue/End on e-Reader	5	20.0	60.0	0.0	40.0	0.0	-

n = Excludes students who never make use of sequential device use

5.6.1.5 Simultaneous Use

Students who made use of simultaneous device usage for learning (n = 432) were asked to select which they devices they normally use together for doing so. Figure 5.10 shows the most commonly selected devices used together for learning. As shown in the diagram, a wide variety of device groupings are made use of. The most common device pairing was a laptop and smartphone (22.0% of respondents), followed by a laptop and a tablet (19.4%) and followed by a desktop and laptop (15.7%). Some students also make use of more than two devices at the same time. They most common set of three devices was a laptop, tablet and smartphone (5.4%).

These students were asked about the type of activities performed simultaneously. 52.2% of students use two or more devices for complementary activities, while 16.5% of students use two or more devices simultaneously for multi-tasking. The remaining 31.3% of students make use of a combination of multitasking or complementary activities.

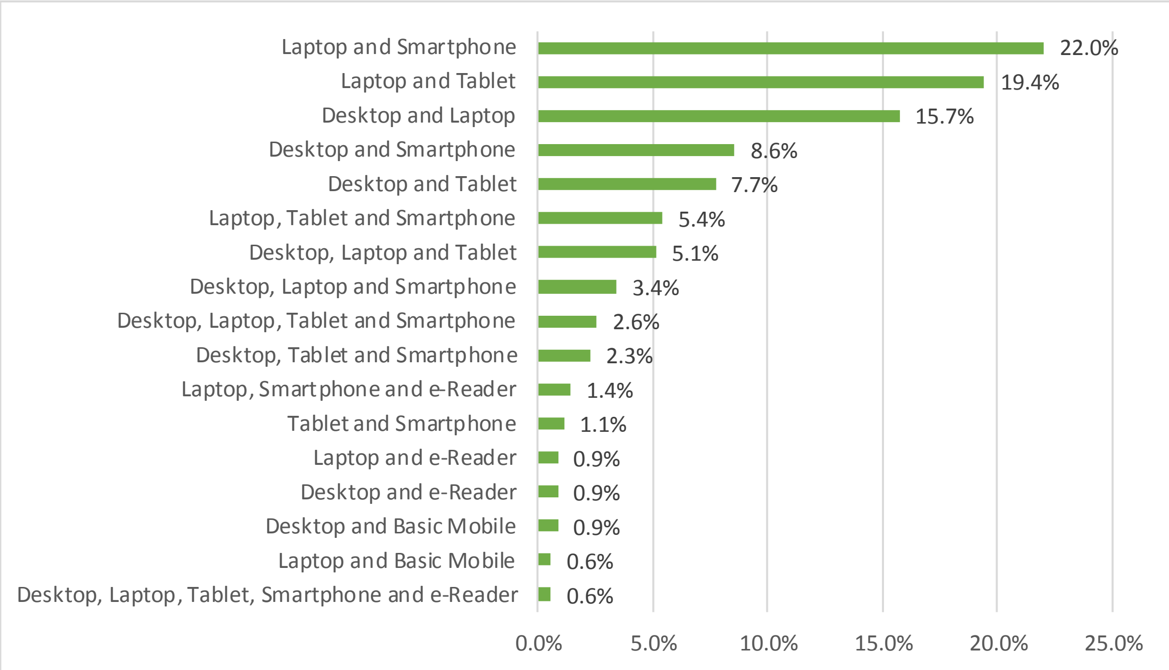

Figure 5.10: Most Common Devices Used Simultaneously for Learning (Percentages)

5.6.1.6 Sequential and Simultaneous Use and Demographic Variables

Table 5.50 shows the relationships (correlations) between sequential and simultaneous frequency use and the different demographic variables, except for Discipline. Correlations analysis could not be performed because Discipline is a nominal variable. No significant relationships (above $r = 0.20$) were found between sequential or simultaneous frequency and any demographic variables (gender, employment status, national status, year of study and language status).

Table 5.50: Correlations between Sequential and Simultaneous Use and Demographic Variables

	n	**M**	**SD**	**Age Group**	**Gender**	**Employ -ment Status**	**National Status**	**Year of Study**	**Language Status**
Sequential Frequency	488	1.71	1.22	-0.06	-0.03	0.15**	-0.02	-0.03	0.02
Simultaneous Frequency	488	1.91	1.13	0.06	0.02	0.02	0.04	0.00	0.01

* p < 0.05, ** p < 0.01

5.6.1.7 Sequential and Simultaneous Use and Device Access

Table 5.51 shows the relationships (correlations) between device access and simultaneous and sequential usage frequencies. Students who have personal access to tablets were slightly more likely to use them for more frequent sequential and simultaneous usage ($r_s = 0.21$ and $r_s = 0.24$, $p < 0.01$ in both cases). No significant relationships (above $r_s = 0.20$) were found between simultaneous and sequential usage frequencies and access to other devices.

Table 5.51: Correlations between Sequential and Simultaneous Use and Device Access Variables

	n	M	SD	Desktop Access	Laptop Access	Tablet Access	Smartphone Access
Sequential Frequency	488	1.71	1.22	0.09*	0.02	0.21**	0.09
Simultaneous Frequency	488	1.91	1.13	0.06	0.07	0.24**	0.15**

* p < 0.05, ** p < 0.01

5.6.1.8 Sequential and Simultaneous Use and Device Frequency

Table 5.52 shows the relationships (correlations) between device frequency for study and simultaneous and sequential usage frequencies. Students who use the tablet more frequently were slightly more likely to use the tablet more frequently with other devices (either sequentially or simultaneously ($r_s = 0.21$ and $r_s = 0.31$, $p < 0.01$ in both cases). No significant relationships (above r_s = 0.20) were found between simultaneous and sequential usage frequencies and frequency use of the other devices.

Table 5.52: Correlations between Sequential and Simultaneous Use and Device Frequency Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smartphone Frequency
Sequential Frequency	488	1.71	1.22	0.11*	0.00	0.21**	0.11*
Simultaneous Frequency	488	1.91	1.13	0.03	0.11*	0.31**	0.17**

* p < 0.05, ** p < 0.01

5.6.1.9 Sequential and Simultaneous Use and Locations and Activities

Table 5.53 shows the relationships (correlations) between the range of activities and geographic reach per device and simultaneous and sequential use frequencies. Students who used tablets and smartphones for a wider range of learning activities slightly more likely to use sequential devices more frequently ($r_s = 0.24$ and $r_s = 0.21$, $p < 0.01$ in both cases). Students who used tablets and smartphones for a wider range of learning activities slightly more likely to use simultaneous devices more frequently ($r_s = 0.34$ and $r_s = 0.32$, $p < 0.01$ in both cases). No significant relationships (above $r_s = 0.20$) were found between simultaneous and sequential use frequencies and the geographic reach of any of the devices.

Table 5.53 Correlations between Sequential and Simultaneous Use and Activity Range and Geographic Reach Variables

	n	M	SD	Activity Range – Desktop	Activity Range – Laptop	Activity Range – Tablet	Activity Range – Smart-phone	Geo-graphic Reach – Desktop	Geo-graphic Reach – Laptop	Geo-graphic Reach – Tablet	Geo-graphic Reach – Smart-phone
Sequential Frequency	488	1.71	1.22	-0.08	-0.06	0.24**	0.21**	0.02	0.10*	0.11	0.08
Simultaneous Frequency	488	1.91	1.13	-0.11	0.01	0.34**	0.32**	0.00	0.12*	0.16**	0.16**

* p < 0.05, ** p < 0.01

5.6.1.10 Sequential and Simultaneous Use and Device Range

Table 5.54 shows the relationships (correlations) between the device range (number of devices used for studies) and simultaneous and sequential use frequencies. Students who use more devices for study were slightly more likely to use devices more frequently, either sequentially or simultaneously (r_s = 0.30 and r_s = 0.27, p < 0.01 in both cases).

Table 5.54: Correlations between Sequential and Simultaneous Use and Device Range Variables

	n	M	SD	Range of Devices
Range of Devices	488	3.15	1.08	-
Frequency Sequential Usage	488	1.71	1.22	0.30**
Frequency Simultaneous Usage	488	1.91	1.13	0.27**

* p < 0.05, ** p < 0.01

5.6.2 Chi-Square Tests

Chi-square tests were performed at the 95.5% confidence level to determine if there were any significant differences between different classifications and the sequential and simultaneous use of desktops, laptops, tablets and smartphones. The differences in simultaneous and sequential device use were assessed against seven demographic variables: age group, gender, discipline, employment status, national status, year of study and language status. Only the statistically significant chi-square test results are shown. Test results were ignored where more than 20% of the contingency table cells had expected counts less than five (Field, 2013).

5.6.2.1 Sequential Device Use

There was a statistically significant difference in the proportion of students using devices sequentially in respect to employment status ((n=488) X^2 (8) =16.53, p = 0.035). Full-time employed students were less likely to never use devices sequentially (12.9%) than unemployed students (22.6%). However, no statistically significant differences were found with respect to students using devices sequentially for the other demographic variables (age group, gender, discipline, national status, year of study and language status).

5.6.2.2 Simultaneous Device Use

No statistically significant differences were found with respect to students using devices simultaneously for any of the demographic variables (age group, gender, discipline, employment status, national status, year of study and language status).

5.6.3 Multivariate Analysis of Sequential and Simultaneous Frequency Use

Parallel multiple regressions were tested to determine how different independent variables could predict a dependent variable (frequency of sequential or simultaneous use). Ordinal regression models were originally proposed for the ordinal frequency variables, however p-parallel lines below 0.05 meant that the ordinal regression models could not be accepted. In order to overcome this situation, binary logistic regressions were tested. Binary logistic regression models were created for sequential and simultaneous frequency by grouping frequencies ("Never"+"Occasionally"+"Sometimes" and "Frequently"+"Very Frequently"). Table 5.55 shows two parallel multiple binary logistic regressions related to frequency of sequential and simultaneous use. The significance and overall fit obtained for the proposed models had valid values: X^2 with p=0.000, Hosmer–Lemeshow's tests were insignificant (p=0.968 and p=0.461), Cox and Snell's (0.167 and 0.202) and Nagelkerke's (0.238 and 0.276) R^2 indices had good measurements of goodness-of-fit.

For sequential frequency usage, the frequent use of sequential devices for study was statistically greater among students who used devices simultaneously more frequently (Exp(B)=5.465) and who used the desktop more frequently (Exp(B)=4.547). For simultaneous frequency usage, the frequent use of devices simultaneously for study was statistically greater among students who used devices sequentially more frequently (Exp(B)=5.660) and who used the tablet more frequently (Exp(B)=2.988).

Table 5.55: Multiple Binary Logistic Regression Models for Sequential and Simultaneous Frequency

	Sequential Frequency				Simultaneous Frequency			
	B	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**
Frequency of Desktop Use	1.514**	0.448	4.547	[1.891-10.934]	-0.506	0.398	0.603	[0.277-1.314]
Frequency of Laptop Use	0.178	0.431	1.194	[0.513-2.782]				
Frequency of Tablet Use					1.095**	0.354	2.988	[1.494-5.976]
Frequency of Smartphone Use	-0.089	0.326	0.915	[0.483-1.732]	0.575	0.348	1.776	[0.899-3.511]
Frequency of Sequential Use					1.734**	0.322	5.660	[3.012-10.640]
Frequency of Simultaneous Use	1.698**	0.292	5.465	[3.085-9.681]				
Intercept	-2.945**	0.623	0.053	-	-1.922	0.444	0.146	-
Model Summary								
Sample Size	293				236			
X^2 (degrees of freedom)	53.371 (4)				53.205 (4)			
X^2 Significance	0.000				0.000			
Cox & Snell R^2, Nagelkerke R^2	0.167, 0.238				0.202, 0.276			
Hosmer & Lemeshow X^2 (df)	0.936 (5)				5.671 (6)			
H&L Significance	0.968				0.461			

* $p < 0.05$, ** $p < 0.01$
Note: Table shows all variables, but binary logistic regressions only performed with corresponding variables.

5.6.4 Qualitative Analysis

5.6.4.1 Synchronisation and Cloud Services

Interviewees confirmed that moving between devices is facilitated by the synchronisation of files using cloud services. The cloud is the key enabler for switching between devices. The benefit of this technology is that synchronisation is automatic and students can continue exactly from where they left off. The VLE is also considered an important tool for file access and storage:

> *I have everything synchronised, all the programs I work with. All the notes I take, presentations, PDFs, all this I use with Microsoft One Note, so when I change the device it is immediate, I don't have to do anything, everything I do is synchronised immediately.* (Marc, male, 46-55 years)

> *But always taking into account that I have everything in the cloud, the books are in the cloud, the continuous assessments. As I have it in Google Drive, I don't mind from which device I'm accessing because everything is always at the point at which I left it before.* (Laia, female, 26-35 years)

> *Besides the cloud, sometimes I access the UOC campus instead of Dropbox, because it is much easier and faster for me. What I do is download the material I need again to the computer, despite having the material in Dropbox.* (Alejandro, male, 46-55 years)

As described above, students make use of different cloud technologies, such as Google Drive, Dropbox or make use of the Virtual Campus. But in some cases, students also rely on older technologies, such as email and memory sticks to transfer files:

If it's from one computer to another, I usually do it with the memory stick or Dropbox and it's from the computer to tablet then Dropbox too and sometimes email, but usually Dropbox. (Martina, female, 18-25 years)

5.6.4.2 Sequential Usage

Interviewees acknowledged that the reason they move from one device to another is for practical reasons, to make use of devices they have access to at that time or to take advantage of available time. Another reason is when students need to complete a learning activity within an urgent timeframe and they are not going to be at home. Occasionally, students may have to study without internet access and then later submit assignments when they have internet access again:

When I am at the library working on my assignments without Internet, what I do is work on my assignment at the library, afterwards, when I arrive home and make some corrections (if needed) I then submit my assignment through the UOC campus. (Celia, female, 26-35 years)

Interviewees provided examples of how they used their devices sequentially for learning. The main types of sequential usage were found to be students moving between different locations, students moving to a different (but related) learning activity and continuing the same learning activity it at a later stage. Table 5.56 provides these usage patterns together with student interview examples.

Table 5.56: Sequential Usage Patterns and Interview Examples

Sequential Patterns	**Devices Used**	**Student Examples**
Move from one location to another, such as from work to home	Tablet/Laptop -> Laptop/Desktop	*If I am working with my laptop or iPad outside home, once I arrive home and switch on the laptop or the home Mac I would be able to see the same page in which I was working on when I was outside home. (Celia, female, 26-35 years)*
	Desktop -> Desktop	*Sometimes I do start a continuous assessment at work and when I have spare time I upload it to Google Drive and then I keep working on the desktop computer at home. (Nuria, female, 26-35 years)*
	Laptop -> Tablet	*If I have to do some writing or to contribute to something, then I take the tablet with me. I use it to keep working on a task once I've left the laptop at home. (Carmen, female, 36-45 years)*
Move from one related learning activity to another, such as reading materials and then starting to write	Tablet -> Laptop	*The most common situation is the one in which I start the work in the tablet, reading all the documentation and once I have read it all (the documentation or the chapter which I was meant to read), then I do the transition to the laptop, usually. The laptop is the "centre of operations". (Pau, male, 26-35 years)*
	Laptop/Desktop -> Tablet	*In my case I study law (court rulings and similar issues) so these documents are long to read, so what I usually do is I find it on the laptop or desktop PC and then I read it on the sofa with the tablet. (Julia, female, 26-35 years)*
	Smartphone -> Laptop	*I basically start searching for information on my mobile phone (which is the device I have always with me), I save this information and then I read the full article on the laptop, at home or anywhere. (Cristina, female, 46-55 years)*
Pause and continue the same learning activity at a later stage	Smartphone -> Laptop	*The situation has happened in which I was reading on the phone and then I got home so I carried on on the laptop. (Laia, female, 26-35 years)*
	Desktop -> Laptop	*Sometimes I come here to the desktop computer, work for a while… half an hour, three quarters of hour and then see that the progress has been almost none… and then I take the laptop and go to a different room. (Pau, male, 26-35 years)*
	Laptop -> Tablet	*For instance, if I'm studying on the Mac Pro and I get tired, I continue on the iPad because it's more comfortable. All the devices are synchronised… I only have to go from one device to another one. (Marti, male, 46-55 years)*

5.6.4.3 Simultaneous Usage

Interviewees were asked to explain why they used their devices at the same time for learning. The main reason why students made use of different devices simultaneously is because of ease of use. Students did not want to have to toggle between two windows on one computer, but wanted to be able to see the information on two screens at the same time. This means that students are able to undertake complementary activities in an easier way. Students can perform a main activity on one device and use a secondary device to perform a complementary activity.

In most instances, students work with two different devices to support their learning. In some cases, students can study with three devices together, as illustrated by the following interview quotes:

When I am doing my assignment I work with the desktop computer, I have the e-reader for checking pdfs and sometimes I have the laptop as well. That is, I work on my assignment with three devices, the desktop computer, the laptop and the e-reader. (Alejandro, male, 46-55 years)

Many times we have to watch some videos, then, of course, I watch it on the tablet and if I also have to check something I use the smartphone because I'm watching the video [on the tablet]. I have to check some things while I'm writing the ideas I'm coming up with and so on… if I have to check any additional information about the video, the writer or whatever, I use the smartphone so I can still watch the video on the tablet. I pause it, then I even use the three devices, the laptop, the tablet and the smartphone. (Carmen, female, 36-45 years)

Although the majority of students sometimes made use of simultaneous devices for learning, several students preferred to only use one device at a time, as it was easier for them and explained that a laptop or desktop provided them with all the necessary tools to be able to perform complementary activities. Some students also mentioned having dual monitors to be able to use two screens on a single device. In this case, these students did not have to use two different devices at the same time, as described by the following interviewee:

In my case it is not usual. As I told you, I have two monitors on the desktop computer so I usually work with these two monitors. (Javier, male, 26-35 years)

Interviewees provided examples of how they used their devices simultaneously for learning. The main activities performed for simultaneous usage were found to be writing assignments together with searching for information or reading materials, watching a video and taking notes, and writing an assignment and communicating with others. Table 5.57 provides these usage patterns together with student interview examples.

Table 5.57: Simultaneous Usage Patterns and Interview Examples

Simultaneous Usage	Devices Used Together	Student Examples
Write Assignment and Search for Information / Read Materials	Tablet + Laptop + Desktop	*Sometimes I work with the desktop and the laptop or the laptop and the tablet beside the laptop. I do the searches in the PDFs on one of the devices and the other one is where I have open the other documents and I carry out the practical task. (Pau, male, 26-35 years)*
	Smartphone + Laptop	*We had access to a book on Google Books so I checked the book contents on the phone because it was easier to search on the phone than on the laptop. When I searched, for instance, I had highlighted this, underlined that, it was easier to look for it on the phone than having two windows open, so I had one screen to write [the laptop] and one screen with the text [the phone]. (Laia, female, 26-35 years)*
	Tablet + Laptop	*An example would be to use the tablet as a device for reading (the subjects' PDFs) and being able to answer the different questions in the assignments on the laptop. (Jorge, male, 26-35 years)*
Watch a Video and Take Notes	Tablet + Desktop	*If I'm watching a video I usually watch it on the tablet, then I use the computer for taking notes. (Sofia, female, 18-25 years)*
	Laptop + Desktop	*I was watching videos from TV3 with the laptop while I was doing a summary and answering the questions with the desktop computer. Working that way, I could watch the video at the same time I could answer the question on the Mac. (Celia, female, 26-35 years)*
Write Assignment and Communicate with Others	Tablet + Desktop	*I have the forum open on the tablet, the messages from teachers or information that the teachers send us through the forum while I am doing the work with the computer. (Sofia, female, 18-25 years)*
	Smartphone + Laptop	*For example, I am checking some forum messages or I am using WhatsApp while I am completing my task with the laptop. (Cristina, female, 46-55 years)*

5.6.4.4 Changes in Study Habits Due to the Use of Multiple Devices

Interviewees were asked to reflect on whether their use of multiple devices has impacted on their study habits. In almost all cases, students expressed a positive change in study habits. Students appreciated the ability to work with different devices and the synchronisation tools that have enabled them to study at more times and in more locations. It also means student feel more organised. Students especially appreciated being able to take advantage of spare time they have available to study, as expressed in the following quotes:

> *The thing of being able to use different devices and having everything synchronised has worked very well for me because I could make the most of my time at lunch time at work. Being able to take advantage of the spare moments you have when working and having everything available… I mean, I wouldn't have had the tools that synchronise everything, it wouldn't be the same for sure. Before, I had to wait until the evening to study and now in this way I've saved more time.* (Marc, male, 46-55 years)

The most essential thing for me is to have all my documents anywhere. I was very happy the day I discovered Google Drive. It's about being able to take that content and not to be limited to work in one place. It's not like, oops I forgot the memory stick and I had these documents there or now I don't have this book here or I don't have anything else. Everything is very accessible. If I don't have this computer now, or if it breaks down, I will be able to carry on studying with another computer. (Laia, female, 26-35 years)

I remember years ago when you had to use a flash drive to move from one device to another and sometimes there was problem when synchronizing the information in all devices. So for me now, without having Dropbox or something similar would be very difficult to organize my studies. (Alejandro, male, 46-55 years)

In addition to the times and places available for study, students also valued the increased access to information via the use of different devices. The following quotes illustrate how students use different devices to access information and connect to others:

They have really facilitated me accessing information, and it is helpful for my studies for me to access complementary tools such as devices. These devices facilitate learning and, therefore, are positive. I feel or I think that these devices are helping me in my learning. (Lucia, female, 36-45 years)

My smartphone makes me feel really more connected day-by-day so I can follow better the day-to-day activities of the class, follow the teacher and I can read the forums. Before, I had to put aside just one day per week to be connected… When I acquired the mobile phone, I have noticed a benefit to my learning habits, I feel more connected and up to date with what is happening in my course. (Elena, female, 26-35 years)

Students also raised the benefit of the flexibility that having multiple devices offers, where devices can be used in different ways and in different locations. Students have also incorporated newer technologies to complement the way they learn with older technologies. These changes in study habits are reflected in the following quotes:

I have all these devices and I use each one in a different way. It allows more flexibility and I think that it makes me more inclined to study when I get home. Depending on my mood, it offers enough variety to choose how I use them each time. It's not reduced to a very tough thing like… now I have to put myself in front of the computer to do this. It is like… now I'm going to read laying on the couch and it's much more flexible learning in which I can take advantage of some moments in which before I wouldn't have started to do some work. Now I can do it, but I can do *it in a different way. I think that it has changed in the way that now is much more flexible and I can do it [study] at more times than before.* (Pau, male, 26-35 years)

My study habits have changed a lot. For example, nowadays it is possible to start an assignment in the computer and continue the task on any other computer or other device (for instance, a tablet). This allows me to take advantage of my time, which is incredible. I can continue studying in the public transport with my mobile phone. For example, I can continue in the same point I stopped reading when I was at home. The mobile phone allows me to study anywhere anytime. (Javier, male, 26-35 years)

At the beginning when I started the degree in Criminology I only used the laptop but since then I got a tablet as a present. At the beginning I didn't see the usefulness, but now I use it a lot, I incorporated it because I used to just use the laptop and the phone. But since I have the tablet, one year ago, I honestly think that it is an ideal complementary device. On the phone everything is much smaller and on the tablet I can see easily… what we were saying before, to carry out a task by watching a video provided by the instructor, then it is very comfortable. (Carmen, female, 36-45 years)

Students appreciate this flexibility, but also realise that being accessible all the time does come at a cost. This cost can be in the form of constant connectivity or the distractions surrounding the use of different devices. The following quotes illustrate the potentially negative changes in study habits:

It's true that you don't rest because sometimes the teacher sends an email and you reply on the street and some time ago we never did things like that. You didn't reply until you got home or only the next day. On the one hand it's positive but on the other hand it's negative. (Martina, female, 18-25 years)

I tend to use more devices although it can also distract you. Sometimes it's not helpful to study. It's easier, but it's also easier to get distracted. (Nuria, female, 26-35 years)

In addition to the use of devices, students still make use of paper or printed materials at the same time. There has been a change in reading habits, but paper is still used together with digital devices. Students mentioned that the increasing reliance on digital devices has meant a reduction in their use of paper, although many still prefer to read on paper, as shown in the following examples:

Well, now I read more in digital format, but I still prefer to read on paper. I try to take notes on the computer, I mean to highlight but I can also use a piece of paper. I never print because I try to save paper and space, this is what I think that has changed the most. Before I had notepads. (Martina, female, 18-25 years)

I used to use more paper than now, although at the end you always have some papers, although I try to use as little paper as possible. It is quite possible and easy because nowadays there are a large number of devices and programs. For example, a few years back I used to print the modules for studying. Nowadays, I do not do that. I prefer to first do a quick reading and then print a summary that I have done rather than print all the materials… I try not to do it. (Alejandro, male, 46-55 years)

Although students expressed that multiple devices have brought about positive changes in study habits, some students believe that the university could still do more to take advantage of the affordances of different devices for learning. The following interviewee highlights how the affordances of smartphones could be used to a greater extent in teaching and learning practices:

As a tool, and I think this is something that it could be improved a lot at UOC, is the smartphone. I mean, the smartphone is a device you always have with you, which is more and more powerful and which allows you to do more and more things. Then, taking into account the affordances of the mobile devices, something that does not make sense, is that there is no good app available from the university. In which there will be a real interface to check the marks, with alerts of new messages in the forum, new communications of the subjects in which you have enrolled, etc. I mean, I think that the smartphone is a very powerful tool because it is connected to the internet continually and moreover the possibilities of notifications that can be created, I think it's something that should be more developed and that that's the way it should evolve. (Jorge, male, 26-35 years)

5.7 Academic and Technological Support

The aim of this section is to provide a summary of findings that are able to address the third research question (*What academic and technological support do students learning with multiple devices require from ODL universities?*).

5.7.1 Descriptive Analysis

5.7.1.1 Design of Learning Experiences for Multi-Devices

Respondents were asked whether educators enabled the use of different digital devices for studies through the design or facilitation of learning experiences. 33.0% of respondents agreed that educators designed/facilitated learning experiences that enabled the use of different devices, while 67.0% of students disagreed. Students who agreed were asked to provide examples in an open question.

The most common experience was that learning resources were made available in different formats, such as text (html, e-pub, doc, pdf) or audio-visual formats that are compatible with different devices. Not only are resources available in different formats, but learning activities such as the discussion forums can also be accessed from different devices. Students make use of the UOC mobile app to access course activities and information. Furthermore, educators share links to supplementary online resources (web pages, videos, articles) that can be accessed from different devices. The accessibility of materials using different devices is highlighted by a survey respondent:

> *The activities and learning resources are accessible from different devices as they are in different formats. So you can access them in web format from your laptop, but if you want to work with mobile or tablet you can download them in PDF format or others, and this greatly facilitates multitasking and access to content anytime, anywhere.* (UOC Survey Respondent #54)

Students also take advantage of different devices through prescribed collaborative group work. Students make use of tools such as wikis, Google Drive and WhatsApp to collaborate and communicate with other students, using different devices. Several students mentioned using Skype to collaborate via video conferencing. In some subjects, students also must deliver multimedia projects that combine video, audio and text. These can be done with the use of different applications and devices. Similarly, in language subjects, students make use of different devices to record videos of themselves speaking. As an example of using different devices for multimedia projects, a respondent said:

> *When we work on videos and multimedia projects that allow us to use different devices depending on the programs or apps to make it better: computer for editing, voice recording or filming on the smartphone, etc.* (UOC Survey Respondent #200)

5.7.1.2 Suggestions for Improving Academic Support

Survey respondents were asked to provide suggestions for improving academic support when using multiple devices via an open question. Several students mentioned that they were happy with the current support services provided. Areas for improvement can be grouped into:

- *Explanatory tutorial videos*: Several students requested that educators record short videos that help students to better understand concepts that are difficult or further explain theory. Students could then download and watch these videos several times.
- *Synchronous Video Conferencing or Chats*. Although the educational model of UOC is focused on asynchronous communication, several students requested the use of synchronous communication channels such as videoconferences with educators, particularly close to exams, where students could ask questions and discuss issues. These could be recorded for students

unable to attend the meetings. As another form of communication, students proposed a channel for synchronous chat with the educator or other students connected in the course to facilitate communication, especially for urgent issues.

- *More Personalised Assessment Feedback*: Several students mentioned the need for more personalised assessment feedback that shows where they were wrong and how to improve. General feedback and a model solution does not always help students to know how to improve. Students also mentioned that sometimes the feedback from assessments or responses to queries are not answered in a timely manner.
- *Subscription to Alerts or Notifications*: Students would like to be able to subscribe to receive alerts (either through email or through the app) to see if there are updates, forum discussions, responses from educators or assessment marks are available.
- *More use of audio-visual materials*. Although students acknowledged that text materials are available in different formats, more resources could be made available in audio or visual forms.

5.7.1.3 Suggestions for Improving Technological Support

Survey respondents were asked to provide suggestions for improving technological support when using multiple devices via an open question. Several students mentioned that they were happy with the current technological support services provided. The most common suggested areas for improvement can be grouped into:

- *Improvement of the UOC Mobile App*: The most common suggestion was to improve the mobile app from the university. Although students recognised there had been improvements in the app, there was still further updates required to features and the interface. The functionality of the app is limited and it is often slow, particular problems include responding to forum messages and opening email attachments.
- *Virtual Campus Accessibility from Mobile Devices*: Several students requested a better responsive design for accessing the Virtual Campus from tablets or smartphones. The current design was not comfortable and made use of pop-up windows, and the font size in the forums is particularly small.
- *Improvements to the Virtual Campus*. Several students suggested improvements to the design and interface of the Virtual Campus. Students also found that it sometimes crashes, particularly at times when many students want to access their results. Students also complained they would be automatically logged out of the Virtual Campus after a certain time, although they were working on a forum message in a pop-up window.
- *Better Support for Using Devices and Tools*. Several students suggested the recommendation or provision of advice of specific devices and device configurations for specific learning activities. This also applied to software or tools to use for studies, such as tutorials about how to install

and use particular programmes needed. More generally, educators can provide instructions for and support the use of devices for improving skills in writing text, using spreadsheets, video editing, graphic editing and data storage.

- *Digital Skills Courses*: Students also asked for courses and information about how to improve their ICT and digital literacy skills.
- *Discounted Rates for Devices and Tools*: Although UOC has a programme for reduced prices on certain hardware, students did not seem to be aware of it or felt it was too limited with students suggesting the need for discounts or subsidies for the purchase of devices and applications.
- *Awareness of technical support*: An overall comment was that students need to be made more aware of the different options available to them for support. For example, a few students were unaware of the university helpdesk available for solving technical and other issues.

5.7.2 Qualitative Analysis

5.7.2.1 Means of Obtaining Academic Support

Interviewees were asked how they obtained help or support when they were unsure how to proceed in the course or needed help with an assignment (in the context of using multiple devices). Students made use of a variety of mechanisms to obtain academic support and often followed several steps to obtain the necessary support.

In the first instance, many students attempted to help themselves by checking the information about the course again, rereading the materials or doing a general search to find out more about the topic or issue. Students then make use of the forums and email the educator. Students often check the forums to see if a similar issue has been raised already. These practices are illustrated in the following quotes:

> *I usually send a message to the teacher, but before asking him/her I normally see if someone have already asked the issue in the forum. So first I check the forum in order to know if someone has already mentioned the issue and if this issue has been solved. If the issue has not been solved yet, I usually send a message to the teacher.* (Sofia, female, 18-25 years)

> *I always have gone to the forum, but I've always find out that I wasn't the first one to have the doubt, there is someone who has had a similar doubt and you solve it with this.* (Laia, female, 26-35 years)

If a similar question has not been posted, students could then write a message in the forum. However, many students prefer to email the educator directly rather than post a message to the group. The main reason for this approach was that they expected to receive a clearer answer from the educator who has expertise. Some students did not want to share their problem with a large group of people. Sometimes the educator would then share the answer with the rest of the group in the forum to help others. An interviewee explains why she prefers to email the educator directly:

> *I think that if I send the issue to the teacher, the answer is more direct and clear. Sometimes, but not always, if you leave the issue in the forum, your peers reply to your message without giving you the right solution. Then, when the teacher replies to these messages, it takes more time.* (Sofia, female, 18-25 years)

Timeliness is an essential component to support. Several students mentioned that they left their assignments to the last minute and so did not have time to send a message and wait for others to reply or that educator replies took longer over a weekend. Students confirmed that educators did reply to their emails, but that sometimes these replies came after they had already submitted their assignment. While some students make use of university channels to obtain support, other students reach out to family members, friends or colleagues for help.

> *I also send a message to the teacher. But it is the last thing I do. The reason is because sometimes if you text them on the weekend, they take more time to answer your message. Obviously, all of us we have a social life apart from work. That is why sometimes I call my mother or my friend, who is studying the same degree at UOC, asking for help.* (Celia, female, 26-35 years)

> *On one occasion, in a group project, we did not understand the solution provided by the instructor. The team had a WhatsApp group and so we chatted there to better understand the solution.* (Jorge, male, 26-35 years)

5.7.2.2 Means of Obtaining Technological Support

Interviewees were asked how they obtained help or support when they experienced technical difficulties or challenges (in the context of using multiple devices). These challenges could range from being unable to access the VLE to having difficulties downloading resources or uploading assignments or software issues. Students made use of a variety of mechanisms to obtain technical support and often followed several steps to obtain the necessary support. These steps depended on the type of technical issue experienced as well as the student's level of technical expertise.

Students normally try to first solve the issue themselves, by doing an online search (usually Googling it). Several students mentioned that they are technically-inclined and so are able to manage any technical issues themselves, for example:

I'm very lucky because I'm an IT engineer, I can solve it by myself. It's true that sometimes I've had problems to access the campus in key moments just before submitting, then I've tried to access from a different device, it's the first thing you think of. (Pau, male, 26-35 years)

Similar to obtaining academic support, depending on the issue, students obtained help by emailing the educator or checking the forums. For software related issues, the following interviewee illustrates the use of forums to obtain help:

I really have not had a real technical problem. Sometimes I needed to download specific software for an assignment and I had some difficulties, but I solved the problem using the class forum. Sometimes another student posts the same problem in the forum and the solution was provided in the same space so I could solve my problem thanks to this forum. (Javier, male, 26-35 years)

If students experienced challenges when accessing the virtual campus or uploading an assignment, then they usually determine if others have the same issue or try again later. Access during peak periods can be challenging, as noted by the following interviewee:

The problems are related to accessing the campus, I mean, in the time period to enrol, for a few days the virtual campus wasn't available or I had to wait for a moment or something like that and also when I tried to check the marks, there was a technical problem in the platform. It is only through waiting that I've solved it, by being patient and trying to get into the virtual campus again. (Jorge, male, 26-35 years)

Students also mentioned experiencing issues such as file incompatibility on different devices or when accessing attachments from forum messages using a tablet. In these cases, students tried again from a different device, as illustrated by the following example:

There have been times where I had learning materials in PDF to read so I used the tablet to download them and read them. I don't know why, but they didn't download and I could not open them, from the UOC's app or even the tablet's browser. Then I had to use the laptop or the desktop computer. There is a problem when they attach documents in the forum, very often you can't open them. (Pau, male, 26-35 years)

Some students were unaware of a support service centre provided by UOC. However, other students made use of the UOC service helpdesk to sort out technical issues related to the virtual campus, as shown in the following quote:

> *I call the UOC technical support. Sometimes it happens that the problem is related to the compatibility of the file and the Mac and pages do not open, in these cases I call Apple technical support. But normally, it is a UOC fault so several times I had to call the central office.* (Celia, female, 26-35 years)

Similar to the ways students obtained academic support, some students made use of university support channels, while other students would reach out to friends and colleagues for help with specific technical issues. The following quotes illustrate how students would reach out to their personal networks:

> *In general terms, I solve those technical problems which are easy to handle. I can call a computer repair technician in cases where problems are harder to solve.* (Lucia, female, 36-45 years)

> *For IT related matters, I call a friend that always understands this type of problem.* (Elena, female, 26-35 years)

5.8 Summary

This chapter has described the results of the UOC case. The chapter was organised by the different types of analysis: the quantitative analysis consisted of descriptive analysis, correlations analysis, chi-square tests, PCA and multiple linear regressions. This was supported by qualitative analysis. The chapter started with an overview of the UOC educational model. The demographic data of the survey was described and found to be representative of the population. This was followed an overview of the data analysis process. The main parts of the chapter were organised by the research questions. The first results section discussed the use of digital devices, locations and learning activities. It was found that students have access to multiple devices and use these devices for study. Desktops and laptops are seen as central devices for study, while handheld devices such as tablets and smartphones are seen as supplementary. Students use these devices in different locations, although home is still the preferred location for study. Students make use of their devices for different learning activities. The next results section discussed the results of how students use fixed devices together with handheld devices. It was found that the majority of students sometimes make use of devices for learning, both sequentially and simultaneously, to improve their study efficiency. This has led to changes in study habits. The final results section described the academic and technological support needs of students using multiple devices for learning. Students make use of a variety of formal and informal methods to meet their needs. The majority of educators do not yet design learning experiences to cater for students using multiple devices, but students have provided suggestions of how they can be better supported, both from an academic and technological point of view. The next chapter will provide the results of the second case study (Unisa).

Chapter 6
Unisa Case Results

This chapter introduces the results of the Unisa case (Section 6.1) and provides an overview of the Unisa teaching and learning model (Section 6.2). The learner demographic data is specified (Section 6.3). The data analysis processes are highlighted (Section 6.4) and then the integrated quantitative and qualitative findings are presented for how students use different digital devices, in different locations to perform different learning activities (Section 6.5) and the quantitative and qualitative results are presented for demonstrating how students use multiple devices together (Section 6.6). Quantitative and qualitative results are then shown for how students use multiple devices obtain academic and technological support (Section 6.7). Finally, a short summary (Section 6.8) closes the chapter.

6.1 Introduction

This chapter presents the results of the Unisa case by showing the results of the quantitative survey and the follow-up qualitative interviews. The first section highlights the teaching and learning model at Unisa, while the next section provides the demographic data of the survey respondents and the representativeness of the sample. The following section highlights the data analysis processes followed. The results are categorised into three sections to address the three research questions in this study. The first research question explores the devices students use, the locations they study in and the learning activities undertaken. The research second question analyses how students make use of multiple devices together. The third research question analyses the academic and technological support that students need. For the each of research question sections, the quantitative results are first presented. The quantitative analysis starts with the descriptive and initial bivariate analysis (correlations) of the variables. Chi-square tests of independence were performed to determine significant associations between categorical variables. More advanced statistics, Principal Components Analysis (PCA) and multivariate (regressions) analysis were performed to categorise how students use devices and to be able to determine the frequency of device usage. The results of the qualitative interviews follow the quantitative data to provide a richer description of the results and explain the quantitative findings with examples. A short summary then concludes the chapter.

6.2 Unisa Teaching and Learning Model

Unisa follows an ODL model of teaching, which combines the following principles: learner-centredness, lifelong learning, flexibility of learning facilitation, removal of barriers to access, recognition of prior learning and provision of relevant learner support. Learning involves the use of blended techniques such as integrated and mixed media, and courseware with various modalities for learning development, facilitation and support. Students are sent study packs (including study guides and tutorial letters) via post (or accessible online) and need to purchase prescribed textbooks. Undergraduate students are required to complete one compulsory fully online module. Students have access to a variety of support services ranging from face-to-face tutorials to video conferences, satellite broadcasts and e-tutors. Unisa has several regional centres that offer administrative and academic support (including computer labs). myUnisa, the university’s VLE, provides students with access to administrative and academic services, and opportunities to engage with educators and other students. Formative assessments consist of multiple-choice tests or short question/essay assignments, while the summative assessment is usually an examination at the end of the semester (Unisa, 2017a, 2017b).

6.3 Demographic Profile

The aim of this section is to identify the characteristics of the sample students as well as the representativeness of the sample. 613 undergraduate students at Unisa completed the survey. Seven demographic classifications were looked at: age, gender, discipline, employment status, national status, year of study, and language status. This demographic data was also used to determine any significant relationships.

Table 6.1 shows the demographic distributions for age, gender, discipline, employment status, national status, year of study, and language status (n=613). The sampling error was calculated to be 3.96% (n=613, with p=q=50.0%, confidence level=95.0%). The total population of students at Unisa (both undergraduate and postgraduate) for 2016 was N= 298 770 (Unisa, 2016).

Table 6.1: Demographic Profile

Demographic	Values	Frequency	Percentage
Age	25 and under	148	24.1
	26-35 years	245	40.0
	36-45 years	154	25.1
	46-55 years	52	8.5
	56 and over	14	2.3
Gender	Female	326	53.2
	Male	287	46.8
Discipline	Arts, Humanities or Languages	41	6.7
	Business or Economics	149	24.3
	Education	34	5.5
	Engineering or Technology	98	16.0
	Environmental or Life Sciences	96	15.7
	Information or Communication Sciences	32	5.2
	Law	84	13.7
	Physical Sciences or Mathematics	13	2.1
	Social Sciences (Psychology, Sociology, etc.)	59	9.6
	Healthcare	7	1.1
Employment Status	Not employed	97	15.8
	Employed part-time	55	9.0
	Employed full-time	461	75.2
National Status	Local student	561	91.5
	International student	52	8.5
Year of Study	Less than 1 year	110	17.9
	1-2 years	161	26.3
	2-3 years	90	14.7
	3-4 years	107	17.5
	More than 4 years	145	23.7
Language Status	Same home and study language	171	27.9
	Different home and study language	442	72.1

In terms of age, 65.1% of the respondents were between 26-35 years and 36-45 years. This is common in an online university, where there is a wide range of student ages, with less than a quarter (24.1%) of “traditional” aged students (25 or under). There was no gender bias, with a slight majority of females (53.2%) over males (46.8%). This is slightly different to the overall profile of Unisa students, where female students are 64.6% of the total student population. Students from a wide variety of disciplines participated in the survey, the most common disciplines were Business or Economics (24.3%), Engineering/Technology (16.0%) and Environmental/Life Sciences (15.7%). 84.2% of students were employed (either part-time or full-time). Almost all students were in South Africa (91.5%), which matches the overall Unisa profile of 91.7% local students in 2016. Students across different years of study participated. The majority of students' home language and language of study were different (72.1%).

In comparison to demographic information about the total student population (undergraduate and postgraduate) for the year 2016 (Unisa, 2016), the sample reflected the population under study and can be considered representative.

6.4 Data Analysis Processes

The analysis processes are described in the Research Methodology chapter (Section 4.5). As discussed in that chapter, the aim of this study was to be exploratory and the main focus was on descriptive analyses, however there was some focus on more advanced statistics. In order to answer the first two research questions, the quantitative data was analysed using univariate analysis, followed by bivariate analysis (correlations). Chi-square tests of independence were performed and multivariate analysis (multiple regressions) was performed. A note on the results of the correlations analysis: The cut-off for weak relationships was set at $r = 0.20$ (Evans, 1996). None of the correlations between devices and the other variables are close to perfect or very strong ($r > 0.80$). This indicates that device usage for study has complex uses and practices that may have different determining factors and explanations. The qualitative data was then analysed using a grounded theory approach to explain and supplement the quantitative findings.

6.5 Devices, Locations and Learning Activities

The aim of this section is to provide a summary of findings that are able to address the first research question (*Which digital devices, and for which purposes and locations, are ODL university students using to perform their learning activities?*). This section focuses on device access and frequency of use, as well as the locations where studies are performed and the learning activities performed.

6.5.1 Descriptive Analysis

6.5.1.1 Device Access

Table 6.2 shows students' access to digital devices (percentages). Students were asked which digital devices have access to or they own (0 = I do not have access, 1 = I use someone else's, 2 = I have my own) from a list of six common devices (desktop, laptop, tablet, smartphone, basic mobile and e-reader). Access to devices was determined by combining "I use someone else's" with "I have my own". The sample means show that a smartphone with a mean of 1.86 (SD of 0.97) is the most common device that is accessed. The second most accessed device is the laptop with a mean of 1.67 (SD of 0.84). Desktops and tablets are also common. However, access to e-readers and basic mobiles is low, the least most accessed device is the e-reader with a mean of 0.29 (SD of 0.95).

Table 6.2: Access to Digital Devices (Percentages)

Device	M	SD	I do not have access	I use someone else's	I have my own
Desktop	0.98	0.99	36.4	29.5	34.1
Laptop	1.67	0.84	10.1	12.6	77.3
Tablet	1.00	0.65	47.1	5.2	47.6
Smartphone	1.86	0.97	6.4	0.8	92.8
Basic Mobile	0.69	0.49	65.3	0.7	34.1
e-Reader	0.29	0.95	84.3	2.3	13.4

n=613

Figure 6.1 visually represents the ownership and access to each device. It shows that students own the majority of the devices they use, with very few students sharing devices (accessing the devices of others). The device most likely to be shared is the desktop (29.5% of respondent's use someone else's), followed by the laptop (12.6% of respondent's use someone else's). Similar to Table 6.2, when combining personal ownership and access, the percentages show that the most commonly accessed devices are smartphones (93.6%) and laptops (89.9%). This is followed by desktops (63.6%) and tablets (52.9%). Basic mobiles (34.7%) and e-Readers (15.7%) are less commonly accessed.

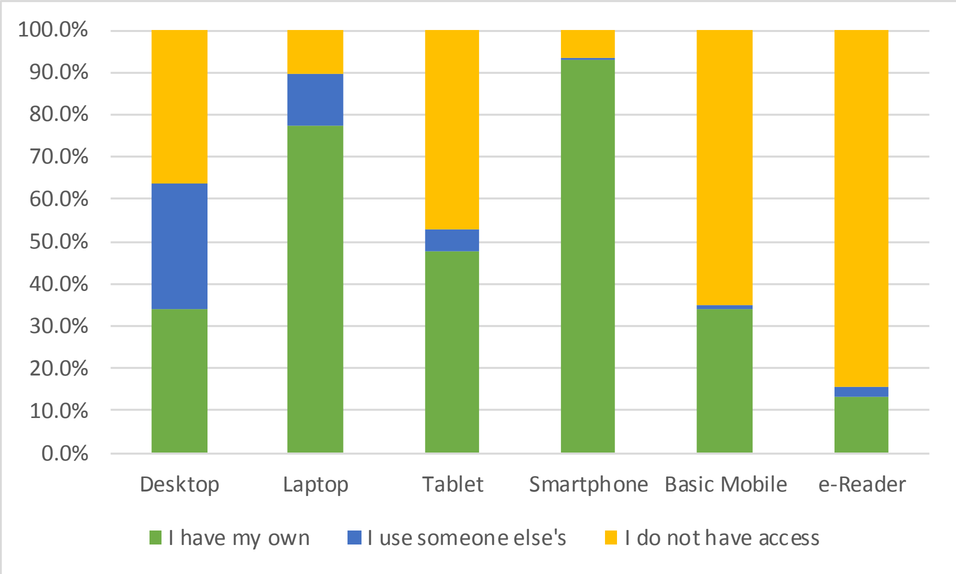

Figure 6.1: Ownership/Access of Digital Devices (Percentages)

Students have access to multiple devices: 98.9% of students had access to at least two devices, while 82.9% of students had access to three or more devices. Figure 6.2 shows the frequency of how many devices students have access to. Most students had access to between three (35.7%) and four (30.0%) devices, with a mean of 3.50 (SD of 3.0). The most common sets of devices students had access to were: a desktop, laptop, tablet and smartphone (14.7%); a desktop, laptop, smartphone (14.2%); a laptop, tablet and smartphone (10.8%); and a laptop and smartphone (10.6%).

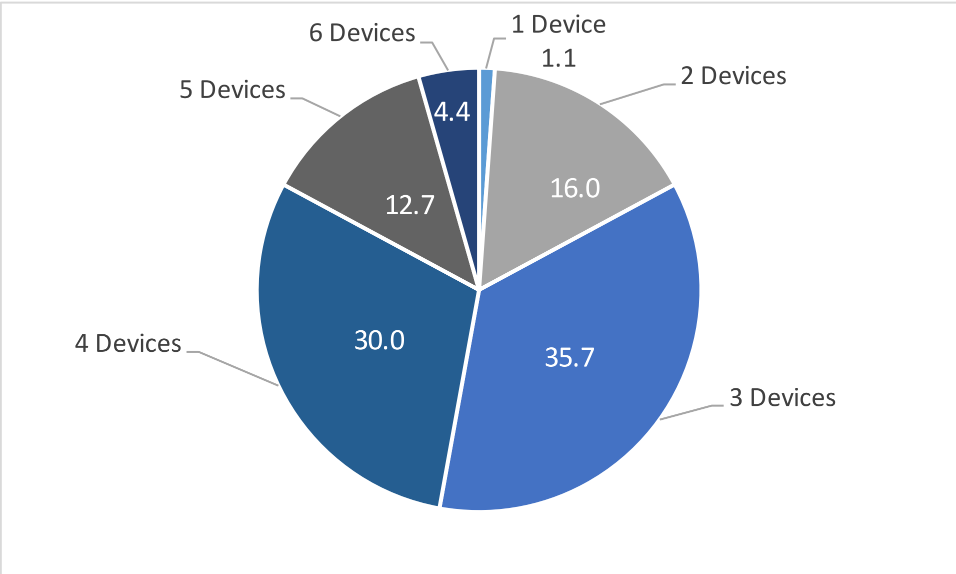

Figure 6.2: Number of Devices Accessed (Percentages)

The following sections describe the analysis of relationships (correlations) between access to a particular device and demographic variables as well as access to other devices.

6.5.1.1.1 Device Access and Demographic Variables

Table 6.3 shows the relationships (correlations) between device access and the different demographic variables, except for Discipline. Correlations analysis could not be performed because Discipline is a nominal variable. No significant relationships ($r > 0.20$) were found between access to any of the devices and the other demographic variables (age, gender, employment status, national status, year of study and language status).

Table 6.3: Correlations between Device Access and Demographic Variables

Device Access	M	SD	Age Group	Gender	Employ-ment Status	National Status	Year of Study	Language Status
Desktop Access	1.25	0.99	0.09*	0.15**	-	-0.03	0.09*	-0.06
Laptop Access	0.98	0.84	0.09*	0.0	0.11**	0.05	0.05	-0.04
Tablet Access	1.67	0.65	0.13**	0.0	0.09*	0.03	0.03	-0.09*
Smartphone Access	1.00	0.97	-0.05	-0.1	0.09*	0.04	-0.02	0.01
Basic Mobile Access	1.86	0.49	-0.04	0.09*	0.16**	0.10*	-0.01	0.12**
e-Reader Access	0.69	0.95	0.02	0.0	-0.09*	-0.01	-0.07	-0.10*

* p < 0.05, ** p < 0.01
n=613

6.5.1.1.2 Device Access (Across Devices)

Tables 6.4 shows the relationships (correlations) between access to different devices. Students who had access to tablets were slightly more likely to have access to e-Readers ($r_s = 0.21$, $p < 0.01$). Students with access to smartphones were slightly less likely to have access to basic mobiles ($r_s = -0.21$, $p < 0.01$). No significant relationships ($r_s > 0.20$) were found between access to any of the other devices.

Table 6.4: Correlations between Accesses to Different Devices

Device Access	M	SD	Desktop Access	Laptop Access	Tablet Access	Smart-phone Access	Basic Mobile Access	e-Reader Access
Desktop Access	0.47	0.50	-					
Laptop Access	0.98	0.84	-0.11**	-				
Tablet Access	1.67	0.65	0.04	0.06	-			
Smartphone Access	1.00	0.97	0.02	0.17**	0.11**	-		
Basic Mobile Access	1.86	0.49	0.08	-0.01	0.02	-0.21**	-	
e-Reader Access	0.69	0.95	0.09*	0.07	0.21**	0.09*	0.10*	-

* p < 0.05, ** p < 0.01
n=613

It is clear that students have access to multiple devices. As discussed in the Literature Review chapter (Chapter 3), access to devices does not automatically imply their use for academic purposes. The next section looks at how frequently students make use of these devices for their studies.

6.5.1.2 Device Use for Study

Table 6.5 shows student's frequency of using different devices for study. Students were asked, based on the devices they had access to, to indicate how often they used these devices for study purposes (0 = Never, 1 = Monthly, 2 = Weekly, 3 = Daily). Frequency of device usage for study was determined by combining "Monthly", "Weekly" and "Daily" uses. The sample means show that a laptop with a mean of 2.39 (SD of 0.80) is the device that is most frequently used for studies. The second most frequently used device for studies is the smartphone with a mean of 2.28 (SD of 1.07), followed by the desktop with a mean of 1.95 (SD of 1.06). This indicates that laptops, smartphones and desktops are frequently used, either weekly or daily, for study. The least frequently used devices for study were the basic mobile with a mean of 1.57 (SD of 1.39) and the e-reader with a mean of 1.29 (SD of 1.20).

Table 6.5: Frequency of Device Use for Study (Percentages)

Device	**n**	**M**	**SD**	**Never**	**Monthly**	**Weekly**	**Daily**
Desktop	389	1.95	1.06	13.1	19.0	27.8	40.1
Laptop	551	2.39	0.80	3.4	9.4	32.1	55.0
Tablet	324	1.91	1.10	16.7	14.8	29.0	39.5
Smartphone	574	2.28	1.07	12.4	9.6	15.9	62.2
Basic Mobile	213	1.57	1.39	40.4	6.1	9.9	43.7
e-Reader	96	1.29	1.20	37.5	19.8	18.8	24.0

n = Excludes students without access to devices

Figure 6.3 visually represents the frequency of use for study of each device. For those students who have access to specific devices, 62.2% use a smartphone daily for study, 55.0% use a laptop and 43.7% use a basic mobile. As 84.2% of students work part-time or full-time and study, it is expected that many do not study every day. If a combination of daily and weekly study usage is considered, 87.1% of students use a laptop, 78.0% use a smartphone, 68.5% use a tablet, 67.9% use a desktop, 53.5% use a basic mobile and 42.7% use an e-reader.

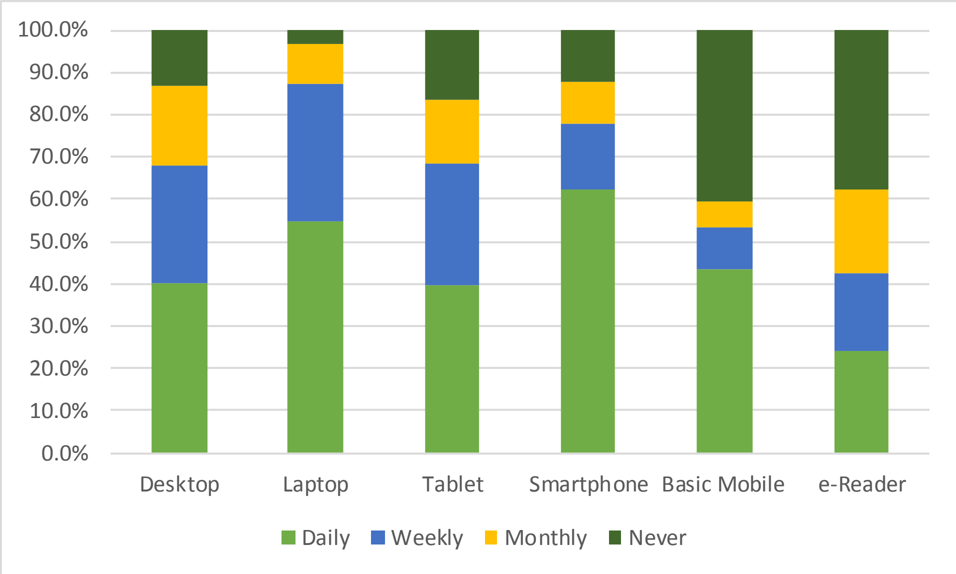

Figure 6.3: Frequency of Usage of Devices for Study (Percentages)

Students use multiple digital devices for study. Figure 6.4 shows the distribution of how many devices students use for study purposes. Most students use between two (28.7%) and three (35.1%) devices, with a mean of 2.99 (SD of 1.12). The most common device sets that students use for study were the laptop and smartphone (17.0%), followed by desktop, laptop and smartphone (14.4%), followed by desktop, laptop, tablet and smartphone (10.9%) and laptop, tablet and smartphone (10.0%).

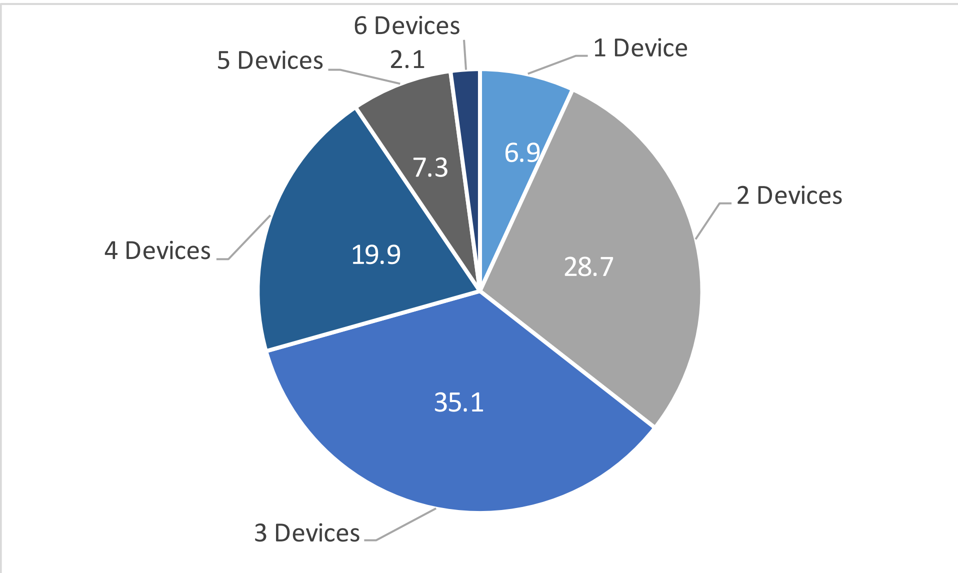

Figure 6.4: Number of Devices Used for Study (Percentages)

Survey respondents were asked to provide examples of any other digital devices that they used for study purposes (other than the six listed above). There were no major findings. A few students (n=4) mentioned the use of a smart TV to watch videos. Students also mentioned the use of peripheral devices, such as printers (n=8) to print study materials and USB modems (n=3) to connect to the internet.

The following sections describe the analysis of relationships (correlations) between the frequency of use of a particular device and demographic variables as well as other related variables (device access, purchase reason, level of expertise and importance to academic success). As with the UOC results, the low use of basic mobiles and e-readers led to the exclusion of these devices from the correlations analysis.

6.5.1.2.1 Device Use and Demographic Variables

Table 6.6 shows the relationships (correlations) between device use frequency and the different demographic variables, except for Discipline. There were no significant relationships ($r > 0.20$) between and frequency of use for any of the devices and age group, gender, employment status, national status, year of study or language status.

Table 6.6: Correlations between Device Frequency and Demographic Variables

Device Frequency	n	M	SD	Age Group	Gender	Employ-ment Status	National Status	Year of Study	Language Status
Desktop Frequency	389	1.95	1.06	0.06	0.01	0.13*	0.02	-0.02	0.05
Laptop Frequency	551	2.39	0.80	0.03	-0.01	-0.06	0.08	-0.13**	0.09*
Tablet Frequency	324	1.91	1.10	0.03	0.08	-0.09	0.03	-0.02	0.17**
Smartphone Frequency	574	2.28	1.07	-0.07	-0.03	-0.11**	0.02	-0.10*	0.14**

* p < 0.05, ** p < 0.01
n = Excludes students without access to devices

6.5.1.2.2 Device Use and Access (Across Devices)

Table 6.7 shows that were no significant relationships (correlations where $r > 0.20$) between access and frequency for desktops, laptops, tablets and smartphones. Tables 6.7 also shows the relationships between the use of a device for study and frequency of use of other devices. Students who frequently use smartphones were also likely to more frequently use tablets and laptops ($r_s = 0.42$ and $r_s = 0.25$, $p < 0.01$ in both cases).

Table 6.7: Correlations between Device Access and Device Frequency Variables

Device Frequency	n	M	SD	Desktop Access	Laptop Access	Tablet Access	Smart-phone Access	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency
Desktop Frequency	389	1.95	1.06	0.04	-0.15**	-0.03	-0.05	-			
Laptop Frequency	551	2.39	0.80	-0.08	0.15**	-0.02	0.10*	0.15**	-		
Tablet Frequency	324	1.91	1.10	0.07	-0.09	0.19**	-0.12*	0.11	0.17**	-	
Smartphone Frequency	574	2.28	1.07	0.03	-0.07	-0.09*	0.09*	0.15**	0.25**	0.42**	-

* p < 0.05, ** p < 0.01
n = Excludes students without access to devices

6.5.1.2.3 Device Use and Purchase Reason

Table 6.8 shows the proportion of students owning devices by reason for purchase. Student who indicated that they owned specific devices, were asked to indicate the reason for purchase (0 = Purchased for university study, 1 = Purchased for another purpose). The sample means show that a laptop with a mean of 0.38 (SD of 0.49) was only device where the majority of students purchased it for study reasons. The second most purchased for study device was the tablet with a mean of 0.60 (SD of 0.49). The devices that are purchased the least for studies are the smartphone with a mean of 0.83 (SD of 0.38) and the basic mobile with a mean of 0.88 (SD of 0.33).

Table 6.8: Proportion of Students Owning Devices by Reason for Purchase (Percentages)

Device	n	M	SD	Purchased for university study	Purchased for another purpose
Desktop	202	0.70	0.46	29.7	70.3
Laptop	471	0.38	0.49	61.8	38.2
Tablet	286	0.60	0.49	40.2	59.8
Smartphone	556	0.83	0.38	17.1	82.9
Basic Mobile	200	0.88	0.33	12.0	88.0
e-Reader	76	0.80	0.40	19.7	80.3

n = Excludes students who do not own devices

Table 6.9 shows the relationships (correlations) between the reason for device purchase and device use frequency. Students who purchased tablets or smartphones for study were slightly more likely to use them more frequently for study (r = -0.35 and r = -0.26, p < 0.01 in both cases). For relationships between devices purchased for study, students who purchased laptops for study were slightly likely to purchase desktops, tablets and smartphones for study (r = 0.37, r = 0.32, r = 0.27, respectively, p < 0.01 in all cases). Students who purchased tablets for study were slightly likely to purchase desktops and smartphones for study (r = 0.32 and r = 0.30, p < 0.01 in both cases). Students who purchased desktops for study were slightly likely to purchase smartphones for study (r = 0.20, p < 0.01).

Table 6.9: Correlations between Device Frequency and Purchase Reason Variables

	n	M	SD	Purchase Desktop	Purchase Laptop	Purchase Tablet	Purchase Smartphone
Purchase Desktop	202	0.70	0.46	-			
Purchase Laptop	471	0.38	0.49	0.37**	-		
Purchase Tablet	286	0.60	0.49	0.32**	0.32**	-	
Purchase Smartphone	556	0.83	0.38	0.20**	0.27**	0.30**	-
Desktop Frequency	389	1.95	1.06	-0.13	0.08	0.01	0.00
Laptop Frequency	551	2.39	0.80	-0.07	-0.06	0.03	0.04
Tablet Frequency	324	1.91	1.10	-0.01	-0.17**	-0.35**	-0.13*
Smartphone Frequency	574	2.28	1.07	-0.14*	-0.20**	-0.23**	-0.26**

* p < 0.05, ** p < 0.01

n = Purchase: excludes students who do not own devices, Frequency: excludes students without access to devices

6.5.1.2.4 Device Use and Level of Expertise

Table 6.10 shows the frequency of device usage for study by level of expertise. Students were asked to indicate their level of expertise with the devices they use for studies using a Likert scale (0 = Very Low, 1 = Low, 2 = Neutral, 3 = High, 4 = Very High). The sample means show that students have the highest level of expertise with a laptop with a mean of 3.60 (SD of 0.62), a tablet with a mean of 3.55 (SD of 0.69) and a smartphone with a mean of 3.55 (SD of 0.76). Students had the lowest level of expertise with the e-Reader with a mean of 3.13 (SD of 1.10).

Table 6.10: Frequency of Device Use by Level of Expertise (Percentages)

Device	n	M	SD	Very Low	Low	Neutral	High	Very High
Desktop	332	3.43	0.80	0.0	1.5	15.1	22.6	60.8
Laptop	527	3.60	0.62	0.0	0.6	5.7	27.1	66.6
Tablet	269	3.55	0.69	0.0	0.7	9.3	23.8	66.2
Smartphone	500	3.55	0.76	0.6	1.8	7.6	21.8	68.2
Basic Mobile	124	3.20	1.14	4.8	4.0	15.3	17.7	58.1
e-Reader	56	3.13	1.10	3.6	3.6	21.4	19.6	51.8

n = Excludes students without access to devices, some values missing

Table 6.11 shows the relationships (correlations) between level of expertise and device frequency for study. Students who have greater expertise in using the desktop were slightly more likely to use it more frequently for study ($r_s = 0.30$, $p < 0.01$). There were no significant relationships ($r_s >$ 0.20) between device usage frequency and expertise level for laptops, tablets and smartphones.

For relationships between levels of expertise in different devices, students who had expertise in using smartphones were more likely to have expertise in using tablets, laptops and desktops ($r_s = 0.71$, $r_s = 0.55$ and $r_s = 0.51$, respectively, $p < 0.01$ in all cases). Students who had expertise in using desktops were more likely to have expertise in using laptops and tablets ($r_s = 0.69$ and $r_s = 0.52$, $p < 0.01$ in both cases). Students who had expertise in using laptops were more likely to have expertise in using tablets ($r_s = 0.53$, $p < 0.01$).

Table 6.11: Correlations between Device Frequency and Expertise Variables

	n	M	SD	Desktop Expertise	Laptop Expertise	Tablet Expertise	Smartphone Expertise
Desktop Expertise	332	3.43	0.80	-			
Laptop Expertise	527	3.60	0.62	0.69**	-		
Tablet Expertise	269	3.55	0.69	0.52**	0.53**	-	
Smartphone Expertise	500	3.55	0.76	0.51**	0.55**	0.71**	-
Desktop Frequency	389	1.95	1.06	0.30**	0.10	-0.09	0.08
Laptop Frequency	551	2.39	0.80	0.11	0.16**	0.08	0.08
Tablet Frequency	324	1.91	1.10	-0.03	0.03	0.18**	-0.06
Smartphone Frequency	574	2.28	1.07	-0.05	0.05	0.05	0.10*

* $p < 0.05$, ** $p < 0.01$

n = Excludes students without access to devices, some values missing

6.5.1.2.5 Device Use and Importance to Academic Success

Table 6.12 shows the frequency of device usage for study by importance to academic success. Students were asked to indicate the importance of the devices they use for academic success using a Likert scale (0 = Very Low, 1 = Low, 2 = Neutral, 3 = High, 4 = Very High). The sample means show that students consider the laptop with a mean of 3.80 (SD of 0.51) to be the most important device for academic success. This is followed by the desktop with a mean of 3.49 (SD of 0.84). Students consider the e-reader with a mean of 2.70 (SD of 1.32) to be the least important for academic success.

Table 6.12: Frequency of Digital Device Use by Level of Importance (Percentages)

Device	n	M	SD	Very Low	Low	Neutral	High	Very High
Desktop	332	3.49	0.84	0.3	2.7	12.7	16.3	68.1
Laptop	530	3.80	0.51	0.2	0.6	2.5	12.3	84.5
Tablet	270	3.29	0.98	1.9	3.3	16.3	21.5	57.0
Smartphone	495	3.44	0.84	0.2	2.6	13.7	19.4	64.0
Basic Mobile	124	2.95	1.17	4.0	8.1	21.8	21.0	45.2
e-Reader	57	2.70	1.32	8.8	8.8	26.3	15.8	40.4

n = Excludes students without access to devices, some values missing

Figure 6.5 visually represents that, in general, the combined daily and weekly use of a specific device for study is related to its specified importance for academic study. However, desktops are considered slightly more important than smartphones, yet smartphones are used more often for study. Laptops are considered to be the most important devices for academic success (96.8%), followed by desktops (84.3%), smartphones (83.4%), tablets (78.5%), basic mobiles (66.1%) and e-readers (56.1%).

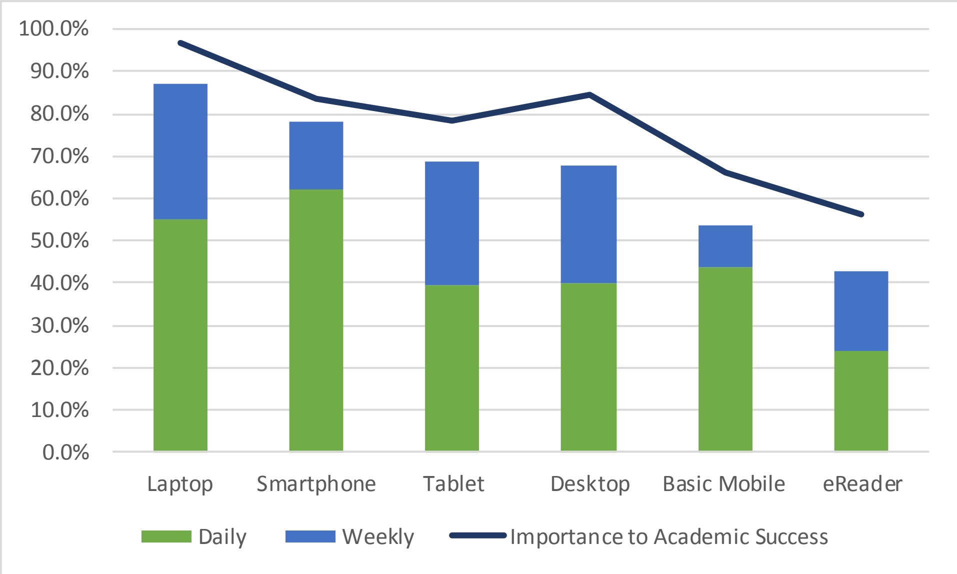

Figure 6.5: Daily/Weekly Use of Devices for Study Compared to Importance (Percentages)

Table 6.13 shows the relationships (correlations) between importance for academic success and device frequency for study. Students who consider the tablet to be important for academic success were more likely to use it more frequently for study ($r_s = 0.50$, $p < 0.01$). Students who consider the desktop, smartphone or laptop to be important for academic success were more likely to use these devices more frequently for study ($r_s = 0.29$, $r_s = 0.29$ and $r_s = 0.25$, $p < 0.01$ in all cases). For relationships between levels of importance in different devices, students who considered tablets to be important were more likely to consider smartphones, laptops and desktops to be important ($r_s = 0.39$, $r_s = 0.25$, and $r_s = 0.23$, respectively, $p < 0.01$ in all cases). Students who considered desktops to be important were slightly more likely to consider smartphones to be important ($r_s = 0.21$, $p < 0.01$).

Table 6.13: Correlations between Device Frequency and Importance Variables

	n	M	SD	Desktop Importance	Laptop Importance	Tablet Importance	Smartphone Importance
Desktop Importance	332	3.49	0.84	-			
Laptop Importance	530	3.80	0.51	0.17**	-		
Tablet Importance	270	3.29	0.98	0.23**	0.25**	-	
Smartphone Importance	495	3.44	0.84	0.21**	0.19**	0.39**	-
Desktop Frequency	389	1.95	1.06	0.29**	0.01	-0.03	-0.03
Laptop Frequency	551	2.39	0.80	-0.09	0.25**	0.01	0.00
Tablet Frequency	324	1.91	1.10	0.09	0.06	0.50**	0.11
Smartphone Frequency	574	2.28	1.07	0.04	0.10*	0.15*	0.29**

* $p < 0.05$, ** $p < 0.01$
n = Excludes students without access to devices, some values missing

Table 6.14 shows the correlations between device expertise and importance for academic success. Students who place greater importance in using the desktop, tablet, laptop or smartphone are more slightly more likely to have greater expertise in the use of these devices ($r_s = 0.31$, $r_s = 0.25$, $r_s = 0.21$ and $r_s = 0.20$, respectively, $p < 0.01$ in all cases).

Table 6.14: Correlations between Device Expertise and Importance Variables

	n	M	SD	Desktop Expertise	Laptop Expertise	Tablet Expertise	Smartphone Expertise
Desktop Importance	332	3.49	0.84	0.31**	0.18**	0.03	0.06
Laptop Importance	530	3.80	0.51	0.06	0.21**	0.16*	0.06
Tablet Importance	270	3.29	0.98	0.00	0.04	0.25**	0.01
Smartphone Importance	495	3.44	0.84	0.10	0.09	0.16*	0.20**

* $p < 0.05$, ** $p < 0.01$
n = Excludes students without access to devices, some values missing

6.5.1.3 Learning Locations

Students were asked to select, for the devices they use for study, in which locations they use these devices for study. These locations were selected based on previous similar studies in distance and dual mode universities (Cross et al., 2015; Murphy et al., 2014). Table 6.15 shows the locations where the different devices are used for study. Unsurprisingly, the most common location for studying with devices across devices was at home. This was followed by at work. Desktops are used for studies at work (56.8%), followed by at home (51.7%). The option of In-transit as a location for desktop use was discarded as it was not applicable. Laptops are used for learning mainly at home (89.9%), but sometimes also at work (39.8%), in public locations with Wi-Fi such as restaurants or libraries (19.0%) and the homes of friends or family (17.5%). Tablets are also mainly used at home for learning (86.8%), but also at work (39.6%), in public locations with Wi-Fi such as restaurants or libraries (26.0%), homes of family or friends (19.6%) and in-transit (19.6%). Given that smartphones are more portable and are usually on-person, they are used for learning across the most number of locations, such as home (93.5%), work (51.6%), public locations with Wi-Fi (37.3%), homes of family/friends (33.7%) and in-transit (32.1%). Similarly, basic mobiles are used at home (91.7%), work (41.3%) and homes of family/friends (31.4%). e-Readers are also used for study at home (81.7%) and work (28.3%).

Table 6.15: Learning Locations by Device (Percentages)

	Desktop	Laptop	Tablet	Smartphone	Basic Mobile	e-Reader
	n=329	n=527	n=265	n=496	n=121	n=60
Home	51.7	89.9	86.8	93.5	91.7	81.7
Work	56.8	39.8	39.6	51.6	41.3	28.3
Home of Family/Friends	9.4	17.5	19.6	33.7	31.4	15.0
University Centre	12.2	15.9	17.4	22.2	23.1	15.0
Public Location with Wi-Fi	9.7	19.0	26.0	37.3	25.6	15.0
In-transit	N/A	4.2	19.6	32.1	24.0	18.3
Other	3.0	6.5	8.3	20.6	19.8	15.0

n = Excludes students who do not use devices

Students could select “Other” to indicate studying in another location. However, due to the question type, this could not be expanded upon in the survey. In follow-up interviews with a sub-set of students, interviewees mentioned, for example, travelling for work. The geographic reach of each device was determined by adding up the number of locations in which the device was used (between 0 and 7) (based on the example of Cross, Sharples, & Healing, 2016). Table 6.16 shows the geographic reach of desktops, laptops, tablets and smartphones. The sample means show that smartphones are used in the most locations with a mean of 2.91 (SD of 1.99). This was followed by tablets with a mean of 2.17 (SD of 1.56) and laptops with a mean of 1.93 (SD of 1.21). Desktops were used in the fewest places with a mean of 1.43 (SD of 0.82).

Table 6.16: Geographic Reach of Devices

	n	**M**	**SD**	**1 location**	**2 locations**	**3 locations**	**4 locations**	**5 locations**	**6 locations**	**7 locations**
Geographic Reach – Desktop	329	1.43	0.82	70.5	22.2	3.0	2.7	1.2	0.3	0.0
Geographic Reach – Laptop	527	1.93	1.21	49.0	27.5	12.0	7.0	3.0	0.9	0.6
Geographic Reach – Tablet	265	2.17	1.56	48.7	23.4	8.7	7.5	6.4	3.4	1.9
Geographic Reach – Smartphone	496	2.91	1.99	34.9	21.2	9.7	8.9	9.7	9.3	6.5

n = Excludes students who do not use devices

The following sections analyse the relationships between locations and the frequency use of each device (desktop, laptop, tablet and smartphone) and then the geographic reach.

6.5.1.3.1 Desktop Frequency and Learning Locations

Table 6.17 shows the means and standard deviations for using desktops for study in different locations (0 = No, 1 = Yes). The sample means show that desktop use at work with a mean of 0.31 (SD of 0.46) was the most common location for studying using a desktop. The second most common location for studies was at home with a mean of 0.28 (SD of 0.45). The other locations all had a mean of 0.07 or less which indicates almost no usage. Table 6.17 also shows the relationships (correlations) between desktop frequency and locations of use for study. Students using the desktop more frequently were more likely to use the desktop at work (r = 0.41, p < 0.01) and slightly more likely to use the desktop at home (r = 0.36, p < 0.01). There were no significant relationships between desktop use frequency and the other locations.

In terms of relationships between locations of desktop use for study, students who use a desktop in a public location were likely to also use a desktop at a university regional centre and in the homes of others (r = 0.47 and r = 0.35, p < 0.01 in both cases). Students who use a desktop in the homes of others were slightly likely to also use a desktop at a university regional centre (r = 0.30, p < 0.01).

Table 6.17: Correlations between Desktop Frequency and Location Variables

	n	M	SD	Desktop Frequency	Desktop - Home	Desktop - Work	Desktop - Home of Others	Desktop - University Centre	Desktop - Public Location	Desktop – Other
Desktop - Home	613	0.28	0.45	0.36**	-					
Desktop - Work	613	0.31	0.46	0.41**	0.10*	-				
Desktop - Home of Others	613	0.05	0.22	0.03	0.09*	0.12**	-			
Desktop - University Centre	613	0.07	0.25	0.00	0.03	0.03	0.30**	-		
Desktop - Public Location	613	0.05	0.22	0.06	0.05	0.08*	0.35**	0.47**	-	
Desktop – Other	613	0.02	0.13	0.05	0.04	0.11**	0.15**	0.18**	0.14**	-

* p < 0.05, ** p < 0.01

6.5.1.3.2 Laptop Frequency and Learning Locations

Table 6.18 shows the means and standard deviations for using laptops for study in different locations (0 = No, 1 = Yes). The sample means show that laptop use at home with a mean of 0.77 (SD of 0.42) was the most common location for studying using a laptop. The second most common location for studies was at work with a mean of 0.34 (SD of 0.47). Table 6.18 also shows the relationship (correlations) between laptop frequency and locations of use for study. Students using the laptop more frequently were more likely to use the laptop at home or at work (r = 0.35, p < 0.01 and r = 0.23, p < 0.01, respectively). There were no significant relationships (r_s > 0.20) between laptop use frequency and the other locations.

In terms of relationships between locations of laptop use for study, students who use a laptop in a public location were slightly likely to also use a laptop at a university regional centre, in-transit, the homes of others and in other locations (r = 0.36, r = 0.34, r = 0.31 and r = 0.22, respectively, p < 0.01 in all cases). Students who use a laptop in transit were slightly likely to also use a laptop in-transit, at a university regional centre and in the homes of others (r = 0.34, r = 0.23 and r = 0.21, respectively, p < 0.01 in all cases). Students who use a laptop in the homes of others were slightly likely to also use a laptop at a university regional centre and in other locations (r = 0.24 and r = 0.24, p < 0.01 in both cases). Students who use a laptop at home were slightly likely to also use a laptop at work (r = 0.20, p < 0.01).

Table 6.18: Correlations between Laptop Frequency and Location Variables

	n	M	SD	Laptop Frequency	Laptop - Home	Laptop - Work	Laptop - Home of Others	Laptop - University Centre	Laptop - Public Location	Laptop – Transit	Laptop – Other
Laptop - Home	613	0.77	0.42	0.35**	-						
Laptop - Work	613	0.34	0.47	0.23**	0.20**	-					
Laptop - Home of Others	613	0.15	0.36	0.06	0.07	0.15**	-				
Laptop - University Centre	613	0.14	0.34	0.09*	0.03	0.04	0.24**	-			
Laptop - Public Location	613	0.16	0.37	0.14**	0.17**	0.15**	0.31**	0.36**	-		
Laptop – Transit	613	0.04	0.19	0.08	0.10**	0.18**	0.21**	0.23**	0.34**	-	
Laptop – Other	613	0.06	0.23	0.07	0.06	0.10*	0.24**	0.15**	0.22**	0.34**	-

* $p < 0.05$, ** $p < 0.01$

6.5.1.3.3 Tablet Frequency and Learning Locations

Table 6.19 shows the means and standard deviations for using tablets for study in different locations (0 = No, 1 = Yes). The sample means show that tablet use at home with a mean of 0.38 (SD of 0.48) was the most common location for studying using a tablet. The second most common location for studies was at work with a mean of 0.17 (SD of 0.38). The other locations all had a mean of 0.08 or less which indicates very little usage. Table 6.19 also shows the relationship (correlations) between tablet frequency and tablet locations of use for study. Students using the tablet more frequently were more likely to use the tablet at home ($r = 0.61$, $p < 0.01$). Students using the tablet more frequently were also slightly more likely to use the tablet at work, in public locations, in a university regional centre, in-transit and the homes of others ($r = 0.34$, $r = 0.29$, $r = 0.25$, $r = 0.24$ and $r = 0.20$, respectively, $p < 0.01$ in all cases).

In terms of relationships between locations of tablet use for study, students who use a tablet in a public location were likely to also use a tablet in-transit, at a university regional centre, in the homes of others, at home, at work and in other locations ($r = 0.54$, $r = 0.49$, $r = 0.47$, $r = 0.36$, $r = 0.33$ and $r = 0.32$, respectively, $p < 0.01$ in all cases). Students who use a tablet at home were likely to also use a tablet at work, in the homes of others, in-transit, at a university regional centre and in other locations ($r = 0.48$, $r = 0.33$, $r = 0.32$, $r = 0.24$ and $r = 0.23$, respectively, $p < 0.01$ in all cases). Students who use a tablet in the homes of others were likely to also use a tablet at a university regional centre, in other locations, in-transit and at work ($r = 0.47$, $r = 0.41$, $r = 0.37$ and $r = 0.36$, respectively, $p < 0.01$ in all cases). Students who use a tablet at a university regional centre were likely to also use a tablet in-transit, at work and in other locations ($r = 0.45$, $r = 0.25$ and $r = 0.25$, $p < 0.01$ in all cases). Students who use a tablet in-transit were slightly likely to also use a tablet in other locations and at work ($r = 0.38$ and $r = 0.36$, $p < 0.01$ in both cases). Students who use a tablet at work were slightly likely to also use a tablet in other locations ($r = 0.29$, $p < 0.01$).

Table 6.19: Correlations between Tablet Frequency and Location Variables

	n	M	SD	Tablet Frequency	Tablet - Home	Tablet - Work	Tablet - Home of Others	Tablet - University Centre	Tablet - Public Location	Tablet – Transit	Tablet – Other
Tablet - Home	613	0.38	0.48	0.61**	-						
Tablet - Work	613	0.17	0.38	0.34**	0.48**	-					
Tablet - Home of Others	613	0.08	0.28	0.20**	0.33**	0.36**	-				
Tablet - University Centre	613	0.08	0.26	0.25**	0.24**	0.25**	0.47**	-			
Tablet - Public Location	613	0.11	0.32	0.29**	0.36**	0.33**	0.47**	0.49**	-		
Tablet – Transit	613	0.08	0.28	0.24**	0.32**	0.36**	0.37**	0.45**	0.54**	-	
Tablet – Other	613	0.04	0.19	0.17**	0.23**	0.29**	0.41**	0.25**	0.32**	0.38**	-

* p < 0.05, ** p < 0.01

6.5.1.3.4 Smartphone Frequency and Learning Locations

Table 6.20 shows the means and standard deviations for using smartphones for study in different locations (0 = No, 1 = Yes). The sample means show that smartphone use at home with a mean of 0.76 (SD of 0.43) was the most common location for studying using a smartphone. The second most common location for studies was at work with a mean of 0.42 (SD of 0.49). Table 6.20 also shows the relationship (correlations) between smartphone frequency and locations of use for study. Students frequently using the smartphone were considerably more likely to use the smartphone at home (r = 0.65, p < 0.01). Students frequently using the smartphone were slightly more likely to use the smartphone at work, in public locations, in the homes of others, at university regional centres and in-transit (r = 0.33, r = 0.27, r = 0.26, r = 0.25 and r = 0.24, respectively, p < 0.01 in all cases).

In terms of relationships between locations of smartphone use for study, students who use a smartphone in a public location were likely to also use a smartphone in-transit, in the homes of others, at a university regional centre, in other locations, at work and at home (r = 0.61, r = 0.60, r = 0.55, r = 0.44, r = 0.38 and r = 0.30, respectively, p < 0.01 in all cases). Students who use a smartphone in-transit were likely to also use a smartphone in the homes of others, in other locations, at a university regional centre, at work and at home (r = 0.53, r = 0.52, r = 0.47, r = 0.38 and r = 0.28, respectively, p < 0.01 in all cases). Students who use a smartphone in the homes of others were likely to also use a smartphone at a university regional centre, in other locations, at work and at home (r = 0.51, r = 0.49, r = 0.37 and r = 0.27, respectively, p < 0.01 in all cases). Students who use a smartphone at a university regional centre were likely to also use a smartphone in other locations, at work and at home (r = 0.44, r = 0.29, and r = 0.23, respectively, p < 0.01 in all cases). Students who use a smartphone at home were likely to also use a smartphone at work and in other locations (r = 0.40 and r = 0.21, p < 0.01 in both cases). Students who use a smartphone at work were slightly likely to also use a smartphone in other locations (r = 0.30, p < 0.01).

Table 6.20: Correlations between Smartphone Frequency and Location Variables

	n	M	SD	Smartphone Frequency	Smart-phone - Home	Smart-phone - Work	Smart-phone - Home of Others	Smartphone - University Centre	Smart-phone - Public Location	Smart-phone - Transit	Smart-phone - Other
Smartphone - Home	613	0.76	0.43	0.65**	-						
Smartphone - Work	613	0.42	0.49	0.33**	0.40**	-					
Smartphone - Home of Others	613	0.27	0.45	0.26**	0.27**	0.37**	-				
Smartphone - University Centre	613	0.18	0.38	0.25**	0.23**	0.29**	0.51**	-			
Smartphone - Public Location	613	0.30	0.46	0.27**	0.30**	0.38**	0.60**	0.55**	-		
Smartphone – Transit	613	0.26	0.44	0.24**	0.28**	0.38**	0.53**	0.47**	0.61**	-	
Smartphone – Other	613	0.17	0.37	0.19**	0.21**	0.30**	0.49**	0.44**	0.44**	0.52**	-

* p < 0.05, ** p < 0.01

6.5.1.3.5 Geographic Reach and Device Frequency

Table 6.21 shows the relationships (correlations) between geographic reach and frequency of device use for study. Students who used a tablet in more places were slightly more likely to use it more frequently for study ($r_s = 0.22$, $p < 0.01$). There were no significant relationships ($r_s > 0.20$) between the geographic reach and frequency of use for the other devices.

In terms of relationships between geographic reach between different devices, students who use a smartphone in a wide number of places were likely to use a tablet, laptop and desktop in a wide number of places ($r_s = 0.65$, $r_s = 0.61$ and $r_s = 0.33$, respectively, $p < 0.01$ in all cases). Students who use a tablet in a wide number of places were likely to use a laptop and desktop in a wide number of places ($r_s = 0.53$ and $r_s = 0.47$, $p < 0.01$ in both cases). Students who use a laptop in a wide number of places were slightly likely to use a desktop in a wide number of places ($r_s = 0.37$, $p < 0.01$).

Table 6.21: Correlations between Geographic Reach and Device Frequency Variables

	n	M	SD	Geographic Reach – Desktop	Geographic Reach – Laptop	Geographic Reach – Tablet	Geographic Reach – Smartphone
Geographic Reach – Desktop	329	1.43	0.82	-			
Geographic Reach – Laptop	527	1.93	1.21	0.37**	-		
Geographic Reach – Tablet	265	2.17	1.56	0.47**	0.53**	-	
Geographic Reach – Smartphone	496	2.91	1.99	0.33**	0.61**	0.65**	-
Desktop Frequency	389	1.95	1.06	0.09	-0.03	-0.07	-0.03
Laptop Frequency	551	2.39	0.80	0.01	0.13**	-0.02	0.01
Tablet Frequency	324	1.91	1.10	0.08	0.00	0.22**	-0.04
Smartphone Frequency	574	2.28	1.07	0.04	0.06	0.04	0.12**

* p < 0.05, ** p < 0.01
n = Excludes students who do not have access to devices

6.5.1.4 Learning Activities

Students were asked to select, for the devices they use for study, which learning activities (from a list of 15 learning activities) they perform using these devices. The list of learning activities was adapted from Cheung (2012), Cross et al. (2015) and Murphy et al. (2014). Table 6.22 shows the learning activities performed on different devices. Students tend to use a central device such as a laptop or desktop to perform the majority of learning activities. Laptops are the most used devices for learning for almost all learning activities. For tablets, the most common learning activities are searching for information (75.1%), reading materials (72.9%) and checking news and announcements (69.2%). For smartphones, the most popular learning activities are checking news and announcements (77.8%), searching for information (71.6%) and communicating with other students (66.3%). The other devices are used more for specific learning activities, highlighting the functionality of devices. For example, basic mobile phones are mainly used to communicate with students (58.3%), while e-readers are used to read materials (77.8%).

Table 6.22 Learning Activities by Device (Percentages)

	Desktop	**Laptop**	**Tablet**	**Smartphone**	**Basic Mobile**	**e-Reader**
	n=295	n=512	n=221	n=451	n=60	n=27
Communicate with educator	60.7	64.3	39.8	44.3	43.3	0.0
Communicate with students	43.7	52.0	42.5	66.3	58.3	3.7
Read materials	70.5	81.4	72.9	56.8	20.0	77.8
Listen to audio	45.8	59.2	51.6	53.4	35.0	14.8
Watch video	53.9	70.1	60.6	51.4	11.7	3.7
Participate in forums	56.3	64.1	45.2	45.7	15.0	3.7
Take test/quiz	65.1	70.1	43.4	34.8	10.0	7.4
Write assignment	77.3	94.1	28.5	16.6	1.7	3.7
Attend online meeting/ lecture	41.7	54.7	35.7	23.3	8.3	7.4
Search for information	78.0	82.4	75.1	71.6	11.7	11.1
Take exam	5.1	3.5	1.8	0.9	1.7	0.0
Use virtual library	55.6	60.0	46.2	28.4	6.7	11.1
Review assessment feedback	72.5	80.5	64.3	57.9	10.0	0.0
Plan/organise study time	48.8	61.5	44.8	49.2	18.3	0.0
Check news/announcements	60.7	64.3	69.2	77.8	21.7	7.4

n = Excludes students who do not use devices, some values missing

Table 6.23 shows the means and standard deviations for the range of activities for desktops, laptops, tablets and smartphones. The range of activities was determined (based on the example of Cross et al., 2016) by adding up the number of learning activities for which this device was used (between 0 and 15). The sample means show that laptops are used for the most number of activities with a mean of 9.62 (SD of 3.87). This was followed by desktops with a mean of 8.36 (SD of 4.21) and tablets with a mean of 7.22 (SD of 4.11). Smartphones were used for the fewest number of activities with a mean of 6.78 (SD of 3.73).

Table 6.23: Means and Standard Deviations of Learning Activity Range by Device

	N	M	SD
Activity Range – Desktop	295	8.36	4.21
Activity Range – Laptop	512	9.62	3.87
Activity Range – Tablet	221	7.22	4.11
Activity Range – Smartphone	451	6.78	3.73

n = Excludes students who do not use devices

The following sections analyse the relationships between each learning activity and the frequency use of each device (desktop, laptop, tablet and smartphone) and then the range of activities. Principal Component Analysis (PCA) is then used to group the activities performed on each device.

6.5.1.4.1 Communicate with Educators by Device Frequency

Table 6.24 shows the means and standard deviations for different device use frequencies for the communicate with educators activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to communicate with educators with a mean of 0.54 (SD of 0.50). The next most frequently used device to communicate with educators was the smartphone with a mean of 0.33 (SD of 0.47). Table 6.24 also shows the relationships (correlations) between specific device frequency and communicating with the educator. Students communicating with educators were more likely to frequently use the desktop, tablet and laptop (r = 0.51, r = 0.43 and r = 0.40, respectively, $p < 0.01$ in all cases) and slightly more likely to frequently use the smartphone (r = 0.30, $p < 0.01$).

In terms of relationships between communicating with educators and the different devices that are used to perform this task, students who communicate with an educator using a desktop were slightly less likely to do so with a laptop also (r = -0.25, $p < 0.01$).

Table 6.24: Correlations between Device Frequency and Communicate with Educator Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Communi-cate Educator - Desktop	Communi-cate Educator - Laptop	Commun-icate Educator - Tablet	Commun-icate Educator - Smart-phone
Communicate Educator – Desktop	613	0.29	0.46	0.51**	-0.16**	0.02	0.04	-			
Communicate Educator – Laptop	613	0.54	0.50	-0.14**	0.40**	-0.07	-0.04	-0.25**	-		
Communicate Educator – Tablet	613	0.14	0.35	-0.12*	-0.02	0.43**	0.07	0.00	0.01	-	
Communicate Educator – Smartphone	613	0.33	0.47	-0.07	-0.04	0.08	0.30**	-0.04	-0.03	0.14**	-

* p < 0.05, ** p < 0.01

6.5.1.4.2 Communicate with Students by Device Frequency

Table 6.25 shows the means and standard deviations for different device use frequencies for the communicate with students activity (0 = No, 1 = Yes). The sample means show that the smartphone was the most frequently used device to communicate with students with a mean of 0.49 (SD of 0.50). The next most frequently used device to communicate with students was the laptop with a mean of 0.43 (SD of 0.50). Table 6.25 also shows the relationships (correlations) between specific device frequency and communicating with other students. Students communicating with other students were more likely to frequently use the tablet, smartphone and desktop ($r = 0.47$, $r = 0.42$ and $r = 0.41$, respectively, $p < 0.01$ in all cases) and slightly more likely to frequently use the laptop ($r = 0.33$, $p < 0.01$).

In terms of relationships between communicating with students and the different devices that are used to perform this activity, no significant relationships ($r > 0.20$) were found.

Table 6.25: Correlations between Device Frequency and Communicate with Student Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Communi-cate Student – Desktop	Communi-cate Student – Laptop	Commun-icate Student – Tablet	Commun-icate Student – Smart-phone
Communicate Student – Desktop	613	0.21	0.41	0.41**	-0.11*	-0.06	-0.01	-			
Communicate Student – Laptop	613	0.43	0.50	-0.11*	0.33**	-0.11*	-0.05	-0.07	-		
Communicate Student – Tablet	613	0.15	0.36	0.00	0.04	0.47**	0.15**	-0.05	0.04	-	
Communicate Student – Smartphone	613	0.49	0.50	-0.15**	0.00	0.09	0.42**	-0.10*	-0.07	0.07	-

* p < 0.05, ** p < 0.01

6.5.1.4.3 Read Materials by Device Frequency

Table 6.26 shows the means and standard deviations for different device use frequencies for the read materials activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to read materials with a mean of 0.68 (SD of 0.47). The next most frequently used device to read materials was the smartphone with a mean of 0.42 (SD of 0.49). Table 6.26 also shows the relationships (correlations) between specific device frequency and reading materials. Students reading materials were more likely to frequently use the desktop and tablet ($r = 0.46$ and $r = 0.46$, $p < 0.01$ in both cases) and slightly more likely to frequently use the laptop and smartphone ($r = 0.36$ and $r = 0.32$, $p < 0.01$ in both cases).

In terms of relationships between reading materials and the different devices that are used to perform this activity, students who read materials using a desktop were slightly less likely to do so with a laptop ($r = -0.20$, $p < 0.01$).

Table 6.26: Correlations between Device Frequency and Read materials Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Read – Desktop	Read – Laptop	Read – Tablet	Read – Smart-phone
Read – Desktop	613	0.34	0.47	0.46**	-0.15**	0.00	-0.01	-			
Read – Laptop	613	0.68	0.47	-0.10*	0.36**	-0.17**	-0.09*	-0.20**	-		
Read – Tablet	613	0.26	0.44	-0.07	0.03	0.46**	0.01	-0.01	-0.04	-	
Read – Smartphone	613	0.42	0.49	-0.05	0.01	0.02	0.32**	0.00	-0.04	0.06	-

* p < 0.05, ** p < 0.01

6.5.1.4.4 Listen to Audio by Device Frequency

Table 6.27 shows the means and standard deviations for different device use frequencies for the listen to audio activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to listen to audio with a mean of 0.49 (SD of 0.50). The next most frequently used device to listen to audio was the smartphone with a mean of 0.39 (SD of 0.49). Table 6.27 also shows the relationships (correlations) between specific device frequency and listening to audio. Students listening to audio were more likely to frequently use the tablet and desktop (r = 0.47 and r = 0.40, p < 0.01 in both cases) and slightly more likely to frequently use the smartphone and laptop (r = 0.37 and r = 0.33, p < 0.01 in all cases).

In terms of relationships between listening to audio and the different devices that are used to perform this activity, no significant relationships (r > 0.20) were found.

Table 6.27: Correlations between Device Frequency and Listen to Audio Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Listen – Desktop	Listen – Laptop	Listen – Tablet	Listen – Smart-phone
Listen – Desktop	613	0.22	0.41	0.40**	-0.09*	0.03	0.02	-			
Listen – Laptop	613	0.49	0.50	0.08	0.33**	-0.07	-0.02	0.01	-		
Listen – Tablet	613	0.19	0.39	-0.04	0.05	0.47**	0.09*	-0.05	0.01	-	
Listen – Smartphone	613	0.39	0.49	-0.01	0.05	0.19**	0.37**	0.00	-0.03	0.15**	-

* p < 0.05, ** p < 0.01

6.5.1.4.5 Watch Video by Device Frequency

Table 6.28 shows the means and standard deviations for different device use frequencies for the watching video activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to watch video with a mean of 0.59 (SD of 0.49). The next most frequently used device to watch video was the smartphone with a mean of 0.38 (SD of 0.49). Table 6.28 also shows the relationships (correlations) between specific device frequency and watching video. Students watching videos were more likely to frequently use the tablet (r = 0.50, p < 0.01) and slightly more likely to frequently use the laptop, desktop and smartphone (r = 0.39, r = 0.34 and r = 0.33, respectively, p < 0.01 in all cases).

In terms of relationships between watching video and the different devices that are used to perform this activity, no significant relationships (*r* > 0.20) were found.

Table 6.28: Correlations between Device Frequency and Watch Video Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Watch – Desktop	Watch – Laptop	Watch – Tablet	Watch – Smart-phone
Watch – Desktop	613	0.26	0.44	0.34**	-0.06	0.05	0.00	-			
Watch – Laptop	613	0.59	0.49	-0.06	0.39**	-0.02	0.03	-0.05	-		
Watch – Tablet	613	0.22	0.41	-0.08	0.08	0.50**	0.05	0.00	-0.03	-	
Watch – Smartphone	613	0.38	0.49	0.07	0.05	0.10	0.33**	0.03	0.02	0.14**	-

* p < 0.05, ** p < 0.01

6.5.1.4.6 Participate in Forums by Device Frequency

Table 6.29 shows the means and standard deviations for different device use frequencies for the participate in forums activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to participate in forums with a mean of 0.54 (SD of 0.50). The next most frequently used device to participate in forums was the smartphone with a mean of 0.34 (SD of 0.47). Table 6.29 also shows the relationships (correlations) between specific device frequency and participating in forums. Students participating in forums were more likely to frequently use the tablet and desktop (*r* = 0.47 and *r* = 0.45, p < 0.01 in both cases) and slightly more likely to frequently use the laptop and smartphone (*r* = 0.35 and *r* = 0.35, p < 0.01 in both cases).

In terms of relationships between participating in forums and the different devices that are used to perform this activity, no significant relationships (*r* > 0.20) were found.

Table 6.29: Correlations between Device Frequency and Participate in Forums Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Forums – Desktop	Forums – Laptop	Forums – Tablet	Forums – Smart-phone
Forums – Desktop	613	0.27	0.44	0.45**	-0.09*	-0.02	0.00	-			
Forums – Laptop	613	0.54	0.50	-0.12*	0.35**	-0.11	-0.04	-0.16**	-		
Forums – Tablet	613	0.16	0.37	-0.09	0.02	0.47**	0.14**	-0.07	-0.07	-	
Forums – Smartphone	613	0.34	0.47	-0.04	0.05	0.10	0.35**	-0.04	-0.09*	0.11**	-

* p < 0.05, ** p < 0.01

6.5.1.4.7 Take a Test/Quiz by Device Frequency

Table 6.30 shows the means and standard deviations for different device use frequencies for the take a test/quiz activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to take a test with a mean of 0.59 (SD of 0.49). The next most frequently used device to take a test was the desktop with a mean of 0.31 (SD of 0.46). Table 6.30 also shows the relationships (correlations) between specific device frequency and taking a test. Students taking a test/quiz were more likely to frequently use the desktop and tablet (*r* = 0.49 and *r* = 0.46, p < 0.01 in both cases) and slightly more likely to frequently use the laptop and smartphone (*r* = 0.37 and *r* = 0.26, p < 0.01 in both cases).

In terms of relationships between taking a test and the different devices that are used to perform this activity, students who take a test using a desktop were slightly less likely to also do so with a laptop (*r* = -0.27, p < 0.01).

Table 6.30: Correlations between Device Frequency and Complete Test/Quiz Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Test – Desktop	Test – Laptop	Test – Tablet	Test – Smart-phone
Test – Desktop	613	0.31	0.46	0.49**	-0.11**	0.05	0.01	-			
Test – Laptop	613	0.59	0.49	-0.21**	0.37**	-0.08	-0.04	-0.27**	-		
Test – Tablet	613	0.16	0.36	-0.10*	0.04	0.46**	0.10*	-0.02	-0.06	-	
Test – Smartphone	613	0.26	0.44	-0.06	-0.02	0.06	0.26**	-0.09*	-0.11**	0.14**	-

* p < 0.05, ** p < 0.01

6.5.1.4.8 Write an Assignment by Device Frequency

Table 6.31 shows the means and standard deviations for different device use frequencies for the writing an assignment activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to write an assignment with a mean of 0.79 (SD of 0.41). The next most frequently used device to write an assignment was the desktop with a mean of 0.37 (SD of 0.48). Table 6.31 also shows the relationships (correlations) between specific device frequency and writing an assignment. Students writing an assignment were more likely to frequently use the desktop (*r* = 0.47, p < 0.01) and slightly more likely to frequently use the laptop or tablet (*r* = 0.38 and *r* = 0.29, p < 0.01 in both cases).

In terms of relationships between writing an assignment and the different devices that are used to perform this activity, students who write an assignment using a desktop were slightly less likely to also do so with a laptop (*r* = -0.33, p < 0.01).

Table 6.31: Correlations between Device Frequency and Write an Assignment Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Write – Desktop	Write – Laptop	Write – Tablet	Write – Smart-phone
Write – Desktop	613	0.37	0.48	0.47**	-0.15**	0.01	0.01	-			
Write – Laptop	613	0.79	0.41	-0.19**	0.38**	-0.06	-0.02	-0.33**	-		
Write – Tablet	613	0.10	0.30	0.01	-0.01	0.29**	0.05	0.03	-0.09*	-	
Write – Smartphone	613	0.12	0.33	-0.03	-0.07	0.05	0.14**	0.06	-0.10*	0.19**	-

* p < 0.05, ** p < 0.01

6.5.1.4.9 Participate in Online Meeting / Lecture by Device Frequency

Table 6.32 shows the means and standard deviations for different device use frequencies for the participate in an online meeting/lecture activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to participate in an online meeting with a mean of 0.46 (SD of 0.50). The next most frequently used device to participate in an online meeting was the desktop with a mean of 0.20 (SD of 0.40). Table 6.32 also shows the relationships (correlations) between specific device frequency and participating in an online meeting. Students participating in an online meeting were more likely to frequently use the tablet (r = 0.41, p < 0.01) and slightly more likely to frequently use the desktop, laptop and smartphone (r = 0.39, r = 0.33 and r = 0.22, respectively, p < 0.01 in all cases).

In terms of relationships between participating in an online meeting and the different devices that are used to perform this activity, no significant relationships (r > 0.20).

Table 6.32: Correlations between Device Frequency and Online Meeting Variables

	n	**M**	**SD**	**Desktop Frequency**	**Laptop Frequency**	**Tablet Frequency**	**Smart-phone Frequency**	**Meet – Desktop**	**Meet – Laptop**	**Meet – Tablet**	**Meet – Smart-phone**
Meet – Desktop	613	0.20	0.40	0.39**	-0.03	0.08	0.10*	-			
Meet – Laptop	613	0.46	0.50	-0.05	0.33**	0.06	0.11**	-0.05	-		
Meet – Tablet	613	0.13	0.34	-0.04	0.06	0.41**	0.15**	-0.01	0.02	-	
Meet – Smartphone	613	0.17	0.38	-0.08	0.02	0.14**	0.22**	0.03	-0.06	0.15**	-

* p < 0.05, ** p < 0.01

6.5.1.4.10 Search for Information by Device Frequency

Table 6.33 shows the means and standard deviations for different device use frequencies for the search for information activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to search for information with a mean of 0.69 (SD of 0.46). The next most frequently used device to search for information was the smartphone with a mean of 0.53 (SD of 0.50). Table 6.33 also shows the relationships (correlations) between specific device frequency and searching for information. Students searching for information were more likely to frequently use the desktop and tablet (r = 0.49 and r = 0.49, p < 0.01 in both cases) and slightly more likely to frequently use the laptop and smartphone (r = 0.39 and r = 0.38, p < 0.01 in both cases).

In terms of relationships between searching for information and the different devices that are used to perform this activity, students who search for information using a desktop were slightly less likely to also do so with a laptop (r = -0.21, p < 0.01). No significant relationships were found between using the other devices to search for information.

Table 6.33: Correlations between Device Frequency and Search for Information Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Search – Desktop	Search – Laptop	Search – Tablet	Search – Smart-phone
Search – Desktop	613	0.38	0.48	0.49**	-0.13**	0.03	-0.02	-			
Search – Laptop	613	0.69	0.46	-0.16**	0.39**	-0.15**	-0.11**	-0.21**	-		
Search – Tablet	613	0.27	0.44	-0.08	-0.01	0.49**	-0.02	-0.02	0.05	-	
Search – Smartphone	613	0.53	0.50	-0.06	0.07	0.06	0.38**	-0.06	0.05	0.06	-

* p < 0.05, ** p < 0.01

6.5.1.4.11 Take an Exam by Device Frequency

Table 6.34 shows the means and standard deviations for different device use frequencies for the take an exam activity (0 = No, 1 = Yes). The sample means show that all the means to take an exam were 0.03 or below, which indicates very little usage. Thus, Table 6.34 also shows that no significant relationships (r > 0.20) were found between specific device frequency and taking an exam. Due to the low use of devices for this activity, the relationships between devices were not considered.

Table 6.34: Correlations between Device Frequency and Take Exam Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Exam – Desktop	Exam – Laptop	Exam – Tablet	Exam – Smart-phone
Exam – Desktop	613	0.02	0.15	0.11*	0.00	-0.01	-0.02	-			
Exam – Laptop	613	0.03	0.17	0.02	0.05	0.00	0.01	0.29**	-		
Exam – Tablet	613	0.01	0.08	0.04	-0.01	0.06	0.00	0.12**	0.35**	-	
Exam – Smartphone	613	0.01	0.08	0.04	0.03	-0.03	0.02	0.12**	0.23**	0.25**	-

* p < 0.05, ** p < 0.01

6.5.1.4.12 Use Virtual Library by Device Frequency

Table 6.35 shows the means and standard deviations for different device use frequencies for the use the virtual library activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to use the virtual library with a mean of 0.50 (SD of 0.50). The next most frequently used device to use the virtual library was the desktop with a mean of 0.27 (SD of 0.44). Table 6.35 also shows the relationships (correlations) between specific device frequency and using the virtual library. Students using the virtual library were more likely to frequently use the tablet and desktop (r = 0.42 and r = 0.41, p < 0.01 in both cases) and slightly more likely to frequently use the laptop and smartphone (r = 0.36 and r = 0.25, p < 0.01 in both cases).

In terms of relationships between using the virtual library and the different devices that are used to perform this activity, no significant relationships (r > 0.20) were found.

Table 6.35: Correlations between Device Frequency and Use Virtual Library Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Library – Desktop	Library – Laptop	Library – Tablet	Library – Smart-phone
Library – Desktop	613	0.27	0.44	0.41**	-0.06	0.07	0.12**	-			
Library – Laptop	613	0.50	0.50	-0.08	0.36**	0.06	0.09*	-0.10*	-		
Library – Tablet	613	0.17	0.37	-0.07	0.02	0.42**	0.12**	0.07	0.10*	-	
Library – Smartphone	613	0.21	0.41	-0.02	0.03	0.06	0.25**	0.08*	0.06	0.19**	-

* p < 0.05, ** p < 0.01

6.5.1.4.13 Review Assessment Feedback by Device Frequency

Table 6.36 shows the means and standard deviations for different device use frequencies for the review assessment feedback activity (0 = No, 1 = Yes). The sample means show that the laptop was the most frequently used device to review feedback with a mean of 0.67 (SD of 0.47). The next most frequently used device to review feedback was the smartphone with a mean of 0.43 (SD of 0.49). Table 6.36 also shows the relationships (correlations) between specific device frequency and reviewing feedback. Students reviewing feedback were more likely to frequently use the desktop, tablet and laptop ($r = 0.49$, $r = 0.47$ and $r = 0.40$, respectively, $p < 0.01$ in all cases) and slightly more likely to frequently use the smartphone ($r = 0.32$, $p < 0.01$).

In terms of relationships between reviewing feedback and the different devices that are used to perform this task, no significant relationships ($r > 0.20$) were found.

Table 6.36: Correlations between Device Frequency and Review Feedback Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Feedback – Desktop	Feedback – Laptop	Feedback – Tablet	Feedback – Smart-phone
Feedback – Desktop	613	0.35	0.48	0.49**	-0.14**	0.00	-0.04	-			
Feedback – Laptop	613	0.67	0.47	-0.13*	0.40**	-0.13*	-0.09*	-0.18**	-		
Feedback – Tablet	613	0.23	0.42	-0.14**	0.02	0.47**	0.03	-0.02	-0.02	-	
Feedback – Smartphone	613	0.43	0.49	-0.01	0.03	0.08	0.32**	0.00	-0.04	0.11**	-

* p < 0.05, ** p < 0.01

6.5.1.4.14 Plan/Organise Study Time by Device Frequency

Table 6.37 shows the means and standard deviations for different device usage frequencies for the plan/organise study time activity. The sample means show that the laptop was the most frequently used device to plan studies with a mean of 0.51 (SD of 0.50). The next most frequently used device to plan studies was the smartphone with a mean of 0.36 (SD of 0.48). Table 6.37 also shows the relationships (correlations) between specific device frequency and planning studies. Students planning studies were more likely to frequently use the desktop and tablet ($r = 0.47$ and $r = 0.45$, $p < 0.01$ in both cases) and slightly more likely to frequently use the laptop and smartphone (*r* = 0.32 and *r* = 0.32, p < 0.01 in both cases).

In terms of relationships between planning studies and the different devices that are used to perform this task, no significant relationships were found.

Table 6.37: Correlations between Device Frequency and Plan Study Time Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Plan – Desktop	Plan – Laptop	Plan – Tablet	Plan – Smart-phone
Plan – Desktop	613	0.23	0.42	0.47**	-0.09*	-0.03	0.01	-			
Plan – Laptop	613	0.51	0.50	-0.02	0.32**	-0.05	-0.01	-0.02	-		
Plan – Tablet	613	0.16	0.37	-0.08	0.03	0.45**	0.06	-0.07	0.00	-	
Plan – Smartphone	613	0.36	0.48	0.05	0.05	0.10	0.32**	-0.03	-0.02	0.08	-

* p < 0.05, ** p < 0.01

6.5.1.4.15 Check News/Announcements by Device Frequency

Table 6.38 shows the means and standard deviations for different device use frequencies for the check news/announcements activity (0 = No, 1 = Yes). The sample means show that the smartphone was the most frequently used device to check news with a mean of 0.57 (SD of 0.50). The next most frequently used device to check news was the laptop with a mean of 0.54 (SD of 0.50). Table 6.38 also shows the relationships (correlations) between specific device frequency and checking news. Students checking news were more likely to frequently use the tablet, desktop and smartphone (*r* = 0.52, *r* = 0.44 and *r* = 0.42, respectively, p < 0.01 in all cases). Students checking news were slightly more likely to frequently use the laptop (*r* = 0.33, p < 0.01).

In terms of relationships between checking news and the different devices that are used to perform this activity, no significant relationships were found.

Table 6.38: Correlations between Device Frequency and Check News Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smart-phone Frequency	Check – Desktop	Check – Laptop	Check – Tablet	Check – Smart-phone
Check – Desktop	613	0.29	0.46	0.44**	-0.09*	-0.03	-0.07	-			
Check – Laptop	613	0.54	0.50	-0.09	0.33**	-0.09	-0.11**	0.01	-		
Check – Tablet	613	0.25	0.43	-0.05	0.04	0.52**	0.01	-0.01	0.07	-	
Check – Smartphone	613	0.57	0.50	-0.05	0.08	0.04	0.42**	-0.06	0.01	0.05	-

* p < 0.05, ** p < 0.01

6.5.1.4.16 Range of Learning Activities

The range of learning activities was looked at in terms of relationships with device frequency, device importance and geographic reach. Table 6.39 shows the relationships (correlations) between the range of activities and frequency of device use for study. Students performing a wider range of learning activities were more likely to frequently use the tablet, desktop, smartphone and laptop (r_s = 0.54, r_s = 0.46, r_s = 0.39 and r_s = 0.21, respectively, p < 0.01 in all cases). Table 6.39 also shows the relationships between the range of activities and the expertise level of using the device. Students performing a wider range of learning activities were slightly more likely to have a greater level of expertise in using the desktop, tablet and laptop (r_s = 0.29, r_s = 0.21 and r_s = 0.20, respectively, p < 0.01 in all cases).

Table 6.39 also shows the relationships between the range of activities and the perceived importance for academic success. Students performing a wider range of learning activities were more likely to value the desktop and tablet as important for academic success (r_s = 0.46 and r_s = 0.46, p < 0.01 in both cases). Students performing a wider range of learning activities were slightly more likely to value the laptop and smartphone as important for academic success (r_s = 0.30 and r_s = 0.30, p < 0.01 in both cases). Table 6.39 also shows the relationships between geographic reach and range of activities for study. Students who performed a wide range of activities were slightly likely to study in a wider range of locations using tablets, laptops, smartphones and desktops (r_s = 0.38, r_s = 0.21, r_s = 0.21 and r_s = 0.20, respectively, p < 0.01 in all cases).

Table 6.39: Correlations between Activity Range and Other Variables

	n	M	SD	Device Frequency	Device Expertise	Device Importance	Geographic Reach
Activity Range – Desktop	295	8.36	4.21	0.46**	0.29**	0.46**	0.20**
Activity Range – Laptop	512	9.62	3.87	0.39**	0.20**	0.30**	0.21**
Activity Range – Tablet	221	7.22	4.11	0.54**	0.21**	0.46**	0.38**
Activity Range – Smartphone	451	6.78	3.73	0.21**	0.14**	0.30**	0.21**

* p < 0.05, ** p < 0.01
n = Excludes students who do not use devices

6.5.1.5 Learning Locations and Activities

The following sections show the relationships between learning locations and activities per device (for desktops, laptops, tablets and smartphones).

6.5.1.5.1 Learning Locations and Activities by Desktop

Table 6.40 shows the correlations between activities performed using a desktop and locations. Students who use the desktop at home were likely to carry out two learning activities: writing an assignment and reading materials (0.40 < r < 0.49, p < 0.01 in both cases). Additionally, students who use the desktop at home were slightly likely to carry out twelve other activities (p < 0.01 in all cases): searching for information, watching video, taking a test, planning studies, reviewing feedback, checking news, communicating with educators, listening to audio, participating in forums (0.30 < r < 0.39), communicating with students, participating in an online meeting and using the virtual library (0.20 < r < 0.29). Students who use the desktop at work were likely to carry out nine activities (p < 0.01 in all cases): reviewing feedback, searching for information (0.50 < *r* < 0.59), reading materials, communicating with educators, checking news, taking a test, writing an assignment, participating in forums and communicating with students (0.40 < *r* < 0.49). Additionally, students who use the desktop at work were slightly likely to carry out five further activities (0.30 < *r* < 0.39, p < 0.01 in all cases): using the virtual library, participating in an online meeting, planning studies, watching video and listening to audio.

Students who use the desktop at regional university centres were slightly likely to carry out six activities (p < 0.01 in all cases): using the virtual library (*r* = 0.30), participating in an online meeting, taking a test, communicating with educators, searching for information and reviewing feedback (0.20 < *r* < 0.29). Students who use the desktop in public locations were slightly likely to carry out three activities (p < 0.01 in all cases): using the virtual library, participating in an online meeting and searching for information (0.20 < *r* < 0.29). No significant relationships (*r* > 0.20) were found between the activities performed using a desktop and the homes of others and other locations.

Table 6.40: Correlations between Desktop Learning Locations and Activities

	n	M	SD	Desktop – Home	Desktop – Work	Desktop - Home Others	Desktop - University Centre	Desktop - Public Location	Desktop - Other
Communicate Educator – Desktop	613	0.29	0.46	0.33**	0.48**	0.16**	0.21**	0.17**	0.12**
Communicate Students – Desktop	613	0.21	0.41	0.28**	0.41**	0.06	0.12**	0.11**	0.09*
Read – Desktop	613	0.34	0.47	0.41**	0.49**	0.13**	0.17**	0.16**	0.15**
Listen – Desktop	613	0.22	0.41	0.33**	0.32**	0.07	0.07	0.07	0.12**
Watch – Desktop	613	0.26	0.44	0.38**	0.33**	0.12**	0.19**	0.16**	0.13**
Forums – Desktop	613	0.27	0.44	0.32**	0.43**	0.11**	0.18**	0.14**	0.12**
Test – Desktop	613	0.31	0.46	0.38**	0.45**	0.17**	0.22**	0.17**	0.11**
Write – Desktop	613	0.37	0.48	0.44**	0.45**	0.19**	0.19**	0.14**	0.11**
Meeting – Desktop	613	0.20	0.40	0.26**	0.34**	0.18**	0.25**	0.21**	0.10*
Search – Desktop	613	0.38	0.48	0.39**	0.53**	0.14**	0.21**	0.21**	0.09*
Exam – Desktop	613	0.02	0.15	0.04	0.06	-0.04	0.09*	-0.04	-0.02
Library – Desktop	613	0.27	0.44	0.24**	0.39**	0.16**	0.30**	0.26**	0.13**
Feedback – Desktop	613	0.35	0.48	0.34**	0.54**	0.11**	0.21**	0.15**	0.10*
Plan – Desktop	613	0.23	0.42	0.38**	0.34**	0.15**	0.12**	0.10*	0.08*
News – Desktop	613	0.29	0.46	0.34**	0.46**	0.13**	0.16**	0.14**	0.06

* p < 0.05, ** p < 0.01

6.5.1.5.2 Learning Locations and Activities by Laptop

Table 6.41 shows the correlations between activities performed using a laptop and locations. Students who use the laptop at home were considerably likely to carry out one learning activity: writing an assignment (*r* = 0.60, p < 0.01). Additionally, students who use the laptop at home were likely to carry out four learning activities (p < 0.01 in all cases): reading materials, searching for information (0.50 < *r* < 0.59), reviewing feedback and taking a test (0.40 < *r* < 0.49). Additionally, students who use the laptop at home were slightly likely to carry out nine further activities (p < 0.01 in all cases): communicating with educators, watching video, checking news, participating in forums, planning studies, communicating with students, listening to audio, using the virtual library (0.30 < *r* < 0.39) and participating in an online meeting (*r* = 0.28). Students who use the laptop at work were slightly likely to carry out fourteen activities (p < 0.01 in all cases): searching for information, reviewing feedback, participating in forums, reading materials, taking a test, writing an assignment, communicating with educators, listening to audio, watching video, checking news, communicating with students, planning studies, participating in an online meeting and using the virtual library (0.20 < *r* < 0.29). Students who use the laptop at regional university centres were slightly likely to carry out one activity: watching a video (*r* = 0.20, p < 0.01). Students who use the laptop in public locations were slightly likely to carry out two activities (p < 0.01 in both cases): checking news and watching a video (0.20 < *r* < 0.29). No significant relationships (*r* > 0.20) were found between the activities performed using a laptop in the homes of others, in-transit and in other locations.

Table 6.41: Correlations between Laptop Learning Locations and Activities

	n	**M**	**SD**	**Laptop – Home**	**Laptop – Work**	**Laptop - Home Others**	**Laptop - University Centre**	**Laptop - Public Location**	**Laptop - Transit**	**Laptop - Other**
Communicate Educator – Laptop	613	0.54	0.50	0.39**	0.24**	0.06	0.16**	0.18**	0.07	0.10*
Communicate Students – Laptop	613	0.43	0.50	0.34**	0.22**	0.03	0.11**	0.18**	0.06	0.10**
Read – Laptop	613	0.68	0.47	0.54**	0.27**	0.05	0.15**	0.18**	0.04	0.04
Listen – Laptop	613	0.49	0.50	0.33**	0.24**	0.11**	0.15**	0.18**	0.04	0.02
Watch – Laptop	613	0.59	0.49	0.39**	0.24**	0.14**	0.20**	0.20**	0.07	0.07
Forums – Laptop	613	0.54	0.50	0.37**	0.28**	0.05	0.12**	0.15**	0.04	0.04
Test – Laptop	613	0.59	0.49	0.43**	0.27**	0.09*	0.14**	0.18**	0.09*	0.09*
Write – Laptop	613	0.79	0.41	0.60**	0.26**	0.09*	0.17**	0.18**	0.06	0.02
Meeting – Laptop	613	0.46	0.50	0.28**	0.21**	0.06	0.14**	0.14**	0.07	0.08
Search – Laptop	613	0.69	0.46	0.52**	0.29**	0.14**	0.17**	0.16**	0.05	0.02
Exam – Laptop	613	0.03	0.17	-0.02	0.00	-0.02	0.01	0.03	-0.03	-0.04
Library – Laptop	613	0.50	0.50	0.33**	0.21**	0.09*	0.13**	0.10*	0.02	0.06
Feedback – Laptop	613	0.67	0.47	0.47**	0.29**	0.12**	0.17**	0.17**	0.00	0.03
Plan – Laptop	613	0.51	0.50	0.35**	0.22**	0.13**	0.08*	0.14**	0.03	0.04
News – Laptop	613	0.54	0.50	0.39**	0.24**	0.13**	0.13**	0.21**	0.02	0.05

* p < 0.05, ** p < 0.01

6.5.1.5.3 Learning Locations and Activities by Tablet

Table 6.42 shows the correlations between activities performed using a tablet and locations. Students who use the tablet at home were considerably likely to carry out three activities (p < 0.01 in all cases): searching for information, reading materials and checking news (0.60 < *r* < 0.69). Additionally, students who use the tablet at home were likely to carry out nine activities (p < 0.01 in all cases): watching video, reviewing feedback, listening to audio (0.50 < *r* < 0.59), taking a test, communicating with students, planning studies, participating in forums, using the virtual library and communicating with educators (0.40 < *r* < 0.49). Additionally, students who use the tablet at home were slightly likely to carry out two further activities (0.30 < *r* < 0.39, p < 0.01 in both cases): participating in an online meeting and writing an assignment. Students who use the tablet at work were likely to carry out eight activities ($0.40 < r < 0.49$, $p < 0.01$ in all cases): reading materials, searching for information, checking news, reviewing feedback, communicating with educators, taking a test, participating in forums and planning studies. Additionally, students who use the tablet at work were slightly likely to carry out six further activities ($p < 0.01$ in all cases): using the virtual library, watching video, communicating with students, listening to audio, participating in an online meeting ($0.30 < r < 0.39$) and writing an assignment ($r = 0.29$). Students who use the tablet at the homes of others were slightly likely to carry out fourteen activities ($p < 0.01$ in all cases): taking a test, writing an assignment, searching for information, checking news, communicating with educators, communicating with students, reviewing feedback, reading materials, using the virtual library, planning studies ($0.30 < r < 0.39$), watching video, listening to audio, participating in forums and participating in an online meeting ($0.20 < r < 0.29$).

Students who use the tablet at university regional centres were likely to carry out one activity: communicating with educators ($r = 0.40$, $p < 0.01$). Additionally, students who use the tablet at university regional centres were slightly likely to carry out thirteen further activities ($0.30 < r < 0.39$, $p < 0.01$ in all cases): communicating with students, taking a test, participating in an online meeting, searching for information, using the virtual library, listening to audio, reviewing feedback, watching video, participating in forums, reading materials, checking news, writing an assignment and planning studies. Students who use the tablet in public locations were likely to carry out seven activities ($p < 0.01$ in all cases): checking news ($r = 0.52$), searching for information, taking a test, planning studies, communicating with educators, reading materials and reviewing feedback ($0.40 < r < 0.49$). Additionally, students who use the tablet in public locations were slightly likely to carry out seven further activities ($p < 0.01$ in all cases): participating in forums, using the virtual library, communicating with students, listening to audio, watching video ($0.30 < r < 0.39$), writing an assignment and participating in an online meeting ($0.20 < r < 0.29$). Students who use the tablet in-transit were likely to carry out three activities ($0.40 < r < 0.49$, $p < 0.01$ in all cases): checking news, reviewing feedback and planning studies. Additionally, students who use the tablet in-transit were slightly likely to carry eleven further activities ($p < 0.01$ in all cases): communicating with educators, reading materials, taking a test, participating in forums, searching for information, communicating with students, watching video, using the virtual library, listening to audio ($0.30 < r < 0.39$), writing an assignment, taking an exam and participating in an online meeting ($0.20 < r < 0.29$).

Students who use the tablet in other locations were slightly likely to carry out thirteen activities ($0.20 < r < 0.29$, $p < 0.01$ in all cases): communicating with educators, checking news, searching for information, listening to audio, writing an assignment, reviewing feedback, planning studies, taking a test, watching video, participating in forums, using the virtual library, communicating with students and reading materials.

Table 6.42: Correlations between Tablet Learning Locations and Activities

	n	M	SD	Tablet – Home	Tablet – Work	Tablet - Home Others	Tablet - University Centre	Tablet - Public Location	Tablet - Transit	Tablet - Other
Communicate Educator – Tablet	613	0.14	0.35	0.43**	0.43**	0.34**	0.40**	0.40**	0.39**	0.27**
Communicate Students – Tablet	613	0.15	0.36	0.45**	0.37**	0.33**	0.39**	0.35**	0.36**	0.21**
Read – Tablet	613	0.26	0.44	0.62**	0.46**	0.31**	0.32**	0.40**	0.39**	0.20**
Listen – Tablet	613	0.19	0.39	0.52**	0.34**	0.26**	0.36**	0.32**	0.31**	0.25**
Watch – Tablet	613	0.22	0.41	0.58**	0.38**	0.29**	0.34**	0.32**	0.34**	0.22**
Forums – Tablet	613	0.16	0.37	0.44**	0.41**	0.26**	0.34**	0.37**	0.37**	0.22**
Test – Tablet	613	0.16	0.36	0.46**	0.42**	0.37**	0.37**	0.42**	0.38**	0.23**
Write – Tablet	613	0.10	0.30	0.37**	0.29**	0.36**	0.31**	0.29**	0.28**	0.25**
Meeting – Tablet	613	0.13	0.34	0.39**	0.33**	0.23**	0.37**	0.28**	0.27**	0.19**
Search – Tablet	613	0.27	0.44	0.64**	0.46**	0.36**	0.37**	0.43**	0.37**	0.26**
Exam – Tablet	613	0.01	0.08	0.06	0.12**	0.12**	0.13**	0.10*	0.27**	0.09*
Library – Tablet	613	0.17	0.37	0.44**	0.39**	0.30**	0.37**	0.37**	0.34**	0.22**
Feedback – Tablet	613	0.23	0.42	0.58**	0.46**	0.33**	0.36**	0.40**	0.42**	0.25**
Plan – Tablet	613	0.16	0.37	0.45**	0.41**	0.30**	0.31**	0.42**	0.41**	0.25**
News – Tablet	613	0.25	0.43	0.60**	0.46**	0.35**	0.32**	0.52**	0.46**	0.27**

* p < 0.05, ** p < 0.01

6.5.1.5.4 Learning Locations and Activities by Smartphone

Table 6.43 shows the relationships (correlations) between activities performed using a smartphone and locations. Students who use the smartphone at home were likely to carry out two activities ($0.40 < r < 0.49$, $p < 0.01$ in both cases): checking news and searching for information. Additionally, students who use the smartphone at home were slightly likely to carry out nine further activities ($p < 0.01$ in all cases): communicating with students, reviewing feedback, reading materials, listening to audio, watching video, planning studies ($0.30 < r < 0.39$), participating in forums, communicating with educators and taking a test ($0.20 < r < 0.29$). Students who use the smartphone at work were slightly likely to carry out seven activities ($p < 0.01$ in all cases): checking news ($r = 0.30$), searching for information, reviewing feedback, planning studies, watching video, communicating with students and reading materials ($0.20 < r < 0.29$). Students who use the smartphone in the homes of others were slightly likely to carry out eleven activities ($p < 0.01$ in all cases): searching for information ($r = 0.32$), watching video, checking news, listening to audio, reading materials, reviewing feedback, communicating with students, participating in forums, taking a test, planning studies and communicating with educators ($0.20 < r < 0.29$).

Students who use the smartphone at university regional centres were slightly likely to carry out eleven activities ($p < 0.01$ in all cases): listening to audio, watching video, participating in forums, checking news ($0.30 < r < 0.39$), searching for information, communicating with students, reviewing feedback, taking a test, planning studies, reading materials and communicating with educators ($0.20 < r < 0.29$). Students who use the smartphone in public locations were slightly likely to carry out twelve activities ($p < 0.01$ in all cases): checking news, searching for information ($0.30 < r < 0.39$), reviewing feedback, planning studies, communicating with students, watching video, reading materials, communicating with educators, listening to audio, participating in forums, taking a test and using the virtual library (0.20 < *r* < 0.29). Students who use the smartphone in-transit were slightly likely to carry out seven activities (p < 0.01 in all cases): checking news (*r* = 0.31), searching for information, planning studies, watching video, listening to audio, communicating with students and reviewing feedback (0.20 < *r* < 0.29). Students who use the smartphone in other locations were slightly likely to carry out four activities (p < 0.01 in all cases): watching video, communicating with students, searching for information and listening to audio (0.20 < *r* < 0.29).

Table 6.43: Correlations between Smartphone Learning Locations and Activities

	n	**M**	**SD**	**Smart-phone – Home**	**Smart-phone – Work**	**Smart-phone - Home Others**	**Smart-phone - University Centre**	**Smart-phone - Public Location**	**Smart-phone - Transit**	**Smart-phone - Other**
Communicate Educator – Smartphone	613	0.33	0.47	0.27**	0.17**	0.20**	0.20**	0.22**	0.14**	0.18**
Communicate Students – Smartphone	613	0.49	0.50	0.39**	0.20**	0.23**	0.27**	0.25**	0.21**	0.23**
Read – Smartphone	613	0.42	0.49	0.33**	0.20**	0.26**	0.21**	0.24**	0.19**	0.14**
Listen – Smartphone	613	0.39	0.49	0.31**	0.19**	0.27**	0.32**	0.22**	0.22**	0.21**
Watch – Smartphone	613	0.38	0.49	0.31**	0.21**	0.28**	0.31**	0.25**	0.25**	0.26**
Forums – Smartphone	613	0.34	0.47	0.28**	0.16**	0.22**	0.30**	0.22**	0.17**	0.16**
Test – Smartphone	613	0.26	0.44	0.25**	0.15**	0.22**	0.25**	0.22**	0.15**	0.16**
Write – Smartphone	613	0.12	0.33	0.15**	0.08	0.11**	0.14**	0.12**	0.10*	0.10*
Meeting – Smartphone	613	0.17	0.38	0.15**	-0.01	0.10*	0.17**	0.13**	0.11**	0.09*
Search – Smartphone	613	0.53	0.50	0.42**	0.27**	0.32**	0.29**	0.35**	0.29**	0.23**
Exam – Smartphone	613	0.01	0.08	0.00	0.05	0.04	0.01	0.08	0.09*	0.07
Library – Smartphone	613	0.21	0.41	0.19**	0.10*	0.17**	0.19**	0.21**	0.16**	0.19**
Feedback – Smartphone	613	0.43	0.49	0.34**	0.23**	0.24**	0.26**	0.27**	0.21**	0.16**
Plan – Smartphone	613	0.36	0.48	0.30**	0.22**	0.21**	0.25**	0.27**	0.26**	0.19**
News – Smartphone	613	0.57	0.50	0.49**	0.30**	0.28**	0.30**	0.36**	0.31**	0.17**

* p < 0.05, ** p < 0.01

6.5.1.5.5 Learning Locations and Activities by Device Frequency Summary

Table 6.44 shows a summary of the relationships (correlations) between activities performed using different devices, across locations (excluding "Other"). Weaker relationships are highlighted in a lighter blue ($0.20 < r < 0.40$), while stronger relationships are highlighted in a darker blue ($r \geq 0.40$).

Table 6.44: Correlations between Learning Locations and Activities by Device Frequency Variables

	Desktop				Laptop				Tablet						Smartphone					
	Home	Work	University Centre	Public Location	Home	Work	University Centre	Public Location	Home	Work	Other Homes	University Centre	Public Location	Transit	Home	Work	Other Homes	University Centre	Public Location	Transit
Communicate with educator	0.33**	0.48**	0.21**		0.39**	0.24**			0.43**	0.43**	0.34**	0.40**	0.40**	0.39**	0.27**		0.20**	0.20**	0.22**	
Communicate with students	0.28**	0.41**			0.34**	0.22**			0.45**	0.37**	0.33**	0.39**	0.35**	0.36**	0.39**	0.20**	0.23**	0.27**	0.25**	0.21**
Read materials	0.41**	0.49**			0.54**	0.27**			0.62**	0.46**	0.31**	0.32**	0.40**	0.39**	0.33**	0.20**	0.26**	0.21**	0.24**	
Listen to audio	0.33**	0.32**			0.33**	0.24**			0.52**	0.34**	0.26**	0.36**	0.32**	0.31**	0.31**		0.27**	0.32**	0.22**	0.22**
Watch video	0.38**	0.33**			0.39**	0.24**	0.20**	0.20**	0.58**	0.38**	0.29**	0.34**	0.32**	0.34**	0.31**	0.21**	0.28**	0.31**	0.25**	0.25**
Participate in forums	0.32**	0.43**			0.37**	0.28**			0.44**	0.41**	0.26**	0.34**	0.37**	0.37**	0.28**		0.22**	0.30**	0.22**	
Take quiz/test	0.38**	0.45**	0.22**		0.43**	0.27**			0.46**	0.42**	0.37**	0.37**	0.42**	0.38**	0.25**		0.22**	0.25**	0.22**	
Write assignment	0.44**	0.45**			0.60**	0.26**			0.37**	0.29**	0.36**	0.31**	0.29**	0.28**						
Online meeting/lecture	0.26**	0.34**	0.25**	0.21**	0.28**	0.21**			0.39**	0.33**	0.23**	0.37**	0.28**	0.27**						
Search for information	0.39**	0.53**	0.21**	0.21**	0.52**	0.29**			0.64**	0.46**	0.36**	0.37**	0.43**	0.37**	0.42**	0.27**	0.32**	0.29**	0.35**	0.29**
Take exam														0.27**						
Use virtual library	0.24**	0.39**	0.30**	0.26**	0.33**	0.21**			0.44**	0.39**	0.30**	0.37**	0.37**	0.34**					0.21**	
Review assignment feedback	0.34**	0.54**	0.21**		0.47**	0.29**			0.58**	0.46**	0.33**	0.36**	0.40**	0.42**	0.34**	0.23**	0.24**	0.26**	0.27**	0.21**
Plan study time	0.38**	0.34**			0.35**	0.22**			0.45**	0.41**	0.30**	0.31**	0.42**	0.41**	0.30**	0.22**	0.21**	0.25**	0.27**	0.26**
Check news/ announcements	0.34**	0.46**			0.39**	0.24**		0.21**	0.60**	0.46**	0.35**	0.32**	0.52**	0.46**	0.49**	0.30**	0.28**	0.30**	0.36**	0.31**

* $p < 0.05$, ** $p < 0.01$

6.5.1.6 Influencers of Device Selection at a Point in Time

Students were asked to select which factors influence their choice of device for learning at a particular time. Figure 6.6 shows that the most common factor influencing choice of device for learning at a point in time was the location or environment (65.3% of students selected this). This was followed by the learning goal or activity to accomplish (56.6% of students). The third most common influencer was the amount of time available or needed (56.1% of students). 42.7% of students also indicated the device features (interface or screen size) influences their choice. These results confirm that multiple factors influence the selection of a device for study at a particular time, but that learning location, activity and time are particularly important.

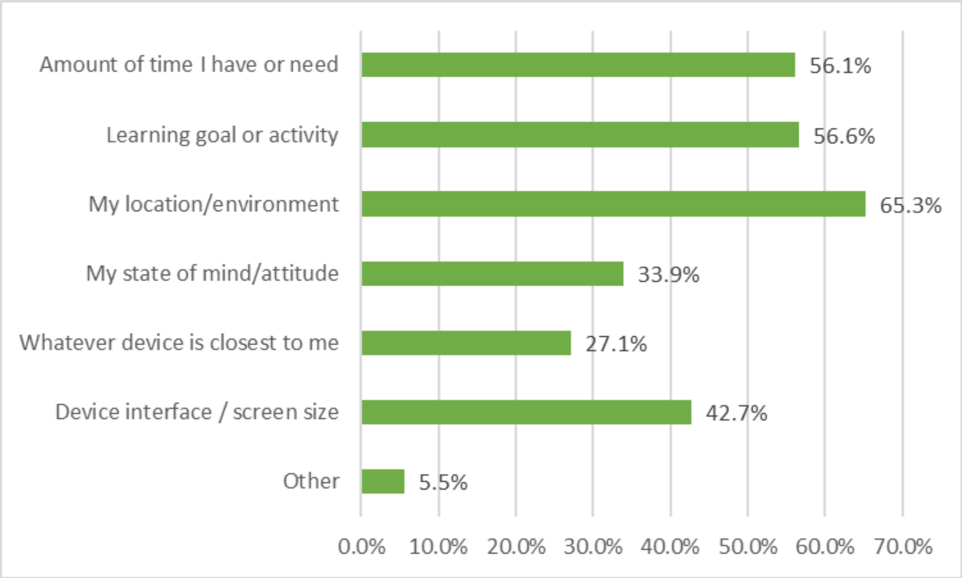

Figure 6.6: Influencers on the Choice of Device for Learning at a Particular Time (Percentages)

6.5.2 Chi-Square Tests

Chi-square tests were performed at the 95.5% confidence level to determine if there were any significant differences between demographic classifications and different variables such as device access and use for desktops, laptops, tablets, smartphones, basic mobiles and e-readers. The seven demographic variables considered were age group, gender, discipline, employment status, national status, year of study and language status. Only the statistically significant chi-square test results are shown. Test results were ignored where more than 20% of the contingency table cells had expected counts less than five (Field, 2013).

6.5.2.1 Device Access

There was a statistically significant difference in the proportion of students with access to tablets in respect to age group ((n=613) X^2 (8) =18.50, p = 0.018). Students aged 25 years and under were less likely to own tablets (39.2%) than students aged 46-55 years (61.5%). However, there were no differences in respect to age group for access to the other devices.

There was a statistically significant difference in the proportion of students with access to desktops in respect to gender ((n=613) X^2 (2) =15.73 $p < 0.001$). Males (42.2%) were more likely to own desktops than females (27.0%). However, there were no differences in respect to gender for access to the other devices.

There was a statistically significant difference in the proportion of students with access to desktops in respect to year of study ((n=613) X^2 (8) = 17.66, p = 0.024). Except for students in their first year, the higher the year of study, the more likely students were to access desktops. There was a statistically significant difference in the proportion of students with access to tablets in respect to year of study ((n=613) X^2 (8) = 21.79, p = 0.005). Students in their second to third year of study were more likely to access tablets (68.9%) than students in other years. However, there were no differences in respect to year of study for access to the other devices.

There was a statistically significant difference in the proportion of students with access to desktops in respect to language status ((n=613) X^2 (2) = 16.10, $p < 0.001$). Students who study in the same language as their home language were more likely to own desktops (43.9%) than students who have a different home language (30.3%). There was a statistically significant difference in the proportion of students with access to tablets in respect to language status ((n=613) X^2 (2) = 6.02, p = 0.049). Students who study in the same language as their home language were more likely to access tablets (59.6%) than those who have a different home language (50.2%). There was a statistically significant difference in the proportion of students with access to e-readers in respect to language status ((n=613) X^2 (2) = 7.33, p = 0.026). Students who study in the same language as their home language were more likely to have access to an e-reader (21.1%) than those who have a different home language (13.6%). However, there were no differences in respect to language status for access to laptops, smartphones and basic mobiles.

No statistically significant differences were found for accessing any of the devices with respect to the other demographic variables (discipline, employment status and national status). The number of devices students accessed (device range) were also considered. No statistically significant differences were found with respect to age group, gender, discipline, employment status, national status, year of study and language status for the number of devices students accessed.

6.5.2.2 Device Use for Study

There was a statistically significant difference in the proportion of students using smartphones for study in respect to employment status ((n=574) X^2 (6) = 16.09, p = 0.013). Employed students, either full-time (59.8%) or part-time (66.0%), were less likely to use smartphones daily for study than unemployed students (72.8%). However, there were no differences in respect to age group for use of the other devices for study.

There was a statistically significant difference in the proportion of students using tablets for study in respect to language status ((n=324) X^2 (3) = 10.03, p = 0.018). Students who study in the same language as their home language were less likely to use tablets daily (28.4%) than those who have a different home language (44.6%). There was a statistically significant difference in the proportion of students using smartphones for study in respect to language status ((n=574) X^2 (3) = 12.13, p = 0.007). Students who study in the same language as their home language were less likely to use smartphones for study (80.6%) than those who have a different home language (90.3%). However, there were no differences in respect to language status for use of the other devices for study.

No statistically significant differences were found for using any of the devices with respect to the other demographic variables (age group, gender, discipline, national status and year of study). The number of devices students used (device range) were also considered. There was a statistically significant difference in the proportion of the number of devices used for study with respect to language status ((n=613) X^2 (5) = 11.24, p = 0.047). Students who study in the same language as their home language were more likely to use between one to two devices for study (41.5%) than those who have a different home language (33.3%). No statistically significant differences were found with respect to age, gender, discipline, employment status, national status and year of study for the number of devices students used.

6.5.2.3 Device Purchase Reason

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to age ((n=471) X^2 (4) = 23.73, p < 0.001). Students aged 25 years and under were more likely to purchase laptops for study (75.5%) than students aged 46-55 years (41.5%). There was a statistically significant difference in the proportion of students purchasing tablets for study reasons with respect to age ((n=286) X^2 (4) = 10.84, p = 0.028). Students aged 25 years and under were more likely to purchase tablets for study (57.1%) than students aged 46-55 years (32.3%) and above. However, there were no differences in respect to age group for the purchase reason for any of the other devices.

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to employment status ((n=471) X^2 (2) = 20.15, p = 0.001). Employed students, either full-time (56.4%) or part-time (75.0%), were less likely to purchase laptops for study than unemployed students (82.6%). There was a difference in the proportion of students purchasing smartphones for study reasons with respect to employment status ((n=556) X^2 (2) =17.56, p = 0.001). Employed students, either full-time (13.5%) or part-time (27.5%), were less likely to purchase smartphones for study than unemployed students (30.7%). However, there were no differences in respect to employment status for the purchase reason for any of the other devices.

There was a statistically significant difference in the proportion of students purchasing laptops for study reasons with respect to language status ((n=471) X^2 (1) = 6.77, p = 0.009). Students with the same home language as the language of study (52.6%) were less likely to purchase laptops for study than students with a different home language (65.5%). There was a statistically significant difference in the proportion of students purchasing tablets for study reasons with respect to language status ((n=286) X^2 (1) = 7.69, p = 0.006). Students with the same home language as the language of study (28.7%) were less likely to purchase tablets for study than students with a different home language (45.8%). There was a statistically significant difference in the proportion of students purchasing smartphones for study reasons with respect to language status ((n=556) X^2 (1) = 14.87, p = 0.001). Students with the same home language as the language of study (7.1%) were less likely to purchase smartphones for study than students with a different home language (20.9%). However, there were no differences in respect to language status for the purchase reason for any of the other devices.

No statistically significant differences were found with respect to the remaining demographic variables with respect to purchasing any of the devices for study purposes (gender, discipline, national status and year of study).

6.5.2.4 Device Level of Expertise

No statistically significant differences were found with respect to any of the demographic variables (age group, gender, discipline, employment status, national status, year of study and language status) for the expertise level in using any of the devices.

6.5.2.5 Device Importance to Academic Success

No statistically significant differences were found with respect to any of the demographic variables (age group, gender, discipline, employment status, national status, year of study and language status) for the importance to academic success of any of the devices.

6.5.3 Principal Components Analysis: Learning Activities per Device

In order to verify how students use devices for different learning activities, Principal Components Analysis (PCA) was used to supplement the other forms of analysis to determine whether the learning activity variables per device could be grouped into principal components. Table 6.45 shows that for learning activities completed on desktops, after the removal of the Take Exam activity, PCA showed an acceptable one-factor structure (KMO = 0.955 and a significant Bartlett's test, $p < 0.001$), with factor loadings ranging from 0.724 to 0.876, and 65.0% of total variance explained. Reliability analysis of the compounded factor showed a Cronbach's α of 0.959. This confirms the finding that desktops are used for a wide range of activities and the learning activities cannot be grouped into components.

Table 6.45 also shows for learning activities completed on laptops, after the removal of several activities, PCA showed an acceptable one-factor structure (KMO = 0.935 and a significant Bartlett's test, $p < 0.001$), with factor loadings ranging from 0.715 to 0.868, and 62.2% of total variance explained. Reliability analysis of the compounded factor showed a Cronbach's α of 0.922. This confirms the finding that laptops are used for a wide range of activities and the learning activities cannot be grouped into components.

Table 6.45 also shows that for learning activities completed on tablets, after the removal of the Take Exam and Write Assignments activities, PCA showed an acceptable one-factor structure (KMO = 0.953 and a significant Bartlett's test, $p < 0.001$), with factor loadings ranging from 0.750 to 0.848, and 64.1% of total variance explained. Reliability analysis of the compounded factor showed a Cronbach's α of 0.953. This different finding showed that tablets are used for a wide range of activities and the learning activities cannot be grouped into components.

Table 6.45 also shows that for learning activities completed on smartphones, after the removal of several variables, PCA showed an acceptable two-factor structure (KMO = 0.917 and a significant Bartlett's test, $p < 0.001$), that accounts for 58.6% of the total variance explained by check and consume activities (34.6%), and communication activities (24.0%). Respectively, the rotated factor solution (Varimax with Kaiser normalisation) provided factor loadings ranging from 0.624 to 0.791 and 0.687 to 0.778. The two compounded factors showed a Cronbach's α of 0.874 and 0.781. This confirms the finding that smartphones are used mainly for checking and consuming information and for communication activities.

Table 6.45: Learning Activities in Component Matrices for Desktops, Laptops, Tablets and Smartphones

Desktop Learning Activities	**Factor Loadings**	**Laptop Learning Activities**	**Factor Loadings**	**Tablet Learning Activities**	**Factor Loadings**	**Smartphone Learning Activities**	**Factor Loadings**
Review Feedback	0.876	Review Feedback	0.868	Search for Information	0.848	**Check and Consume**	
Search for Information	0.870	Search for Information	0.865	Review Feedback	0.844	Search for Information	0.791
Take Test	0.863	Take Test	0.813	Participate in Forum	0.827	Check News/ Announcements	0.772
Communicate with Educators	0.860	Participate in Forum	0.786	Check News/ Announcements	0.820	Read Materials	0.718
Participate in Forum	0.839	Write Assignment	0.782	Take Test	0.810	Review Feedback	0.685
Write Assignment	0.830	Read Materials	0.773	Watch Video	0.800	Watch Video	0.661
Read Materials	0.826	Check News/ Announcements	0.741	Communicate with Educators	0.800	Plan Study Time	0.659
Check News/ Announcements	0.810	Communicate with Educators	0.737	Read Materials	0.792	Listen to Audio	0.624
Plan Study Time	0.767	Virtual Library	0.715	Plan Study Time	0.790	**Communication**	
Watch Video	0.756			Communicate with Students	0.788	Communicate with Educators	0.778
Use Virtual Library	0.756			Use Virtual Library	0.779	Online Meeting	0.713
Communicate with Students	0.745			Listen to Audio	0.756	Communicate with Students	0.709
Online Meeting	0.743			Online Meeting	0.750	Participate in Forum	0.687
Listen to Audio	0.724						

6.5.4 Multivariate Analysis of Frequency of Device Use

In order to contrast the bivariate relationships and weight the relative contribution of the explanatory variables, the following section shows parallel multiple regressions. The aim was to see how different independent variables (location, activities) could predict a dependent variable (frequency of device use). Ordinal regression models were originally proposed for the ordinal device frequency variables, however p-parallel lines below 0.05 meant that the ordinal regression models could not be accepted. In order to overcome this situation, binary logistic regressions were tested. Binary logistic regression models were created for device frequency by grouping frequencies (“Never”+“Monthly” and “Weekly”+“Daily”) for each device. A large number of binary logistic regressions were tested across different variables, however, only the following binary logistic regression models are shown as they are the most potentially useful. Table 6.46 shows four parallel multiple binary logistic regressions related to frequency of device usage for desktops, laptops, tablets and smartphones. The significance and overall fit obtained for the proposed models had valid values: X^2 with p=0.000, Hosmer–Lemeshow’s tests were insignificant (p=0.932, p=0.605, p=0.816 and p=0.777), Cox and Snell’s (0.203, 0.222, 0.269 and 0.084) and Nagelkerke’s (0.315, 0.415, 0.442 and 0.170) R^2 indices had good measurements of goodness-of-fit.

For frequency of desktop usage, frequent use of desktops for study was statistically greater among students who used the desktop at home (Exp(B)=3.148) or at work (Exp(B)=2.835) to plan or organise study time (Exp(B)=3.401), listen to audio (Exp(B)=3.231) and watch video (Exp(B)=0.401). For frequency of laptop usage, frequent use of laptops for study was statistically greater among students who used the laptop at home (Exp(B)=3.206) or at work (Exp(B)=2.809) to watch video (Exp(B)=3.507), use the virtual library (Exp(B)=3.467), communicate with students (Exp(B)=3.014) and plan or organise study time (Exp(B)=2.142). For frequency of tablet usage, frequent use of tablets for study was statistically greater among students who placed a high or very high value of importance for academic success on the tablet (Exp(B)=15.100 and Exp(B)=20.561, respectively) and used the tablet to communicate with students (Exp(B)=5.242), communicate with educators (Exp(B)=0.248) and check news and announcements (Exp(B)=0.228). For frequency of smartphone usage, frequent use of smartphone for study was statistically greater among students who reported a neutral, high or very level of expertise when using the smartphone (Exp(B)=26.426, Exp(B)=23.893 and Exp(B)=23.656, respectively) and used the smartphone to communicate with other students (Exp(B)=2.836).

Table 6.46: Multiple Binary Logistic Regression Models of Device Frequency for Learning

	Regression 1: Desktop Frequency				**Regression 2: Laptop Frequency**				**Regression 3: Tablet Frequency**				**Regression 4: Smartphone Frequency**			
	B	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**
Location – Home	1.147**	0.370	3.148	[1.523-6.508]	1.165**	0.361	3.206	[1.580-6.505]	0.354	0.553	1.425	[0.482-4.211]	0.404	0.515	1.497	[0.546-4.105]
Location – Work	1.042**	0.351	2.835	[1.424-5.644]	1.033**	0.394	2.809	[1.297-6.083]	0.601	0.462	1.823	[0.738-4.505]	0.484	0.334	1.622	[0.843-3.124]
Location – Public													0.636	0.393	1.888	[0.873-4.083]
Location - Transit									-0.421	0.648	0.656	[0.184-2.340]				
Communicate with Educators									-1.393*	0.708	0.248	[0.062-0.995]				
Communicate with Students					1.103*	0.449	3.014	[1.251-7.262]	1.657*	0.788	5.242	[1.118-24.579]	1.042**	0.358	2.836	[1.407-5.718]
Listen to Audio	1.173**	0.448	3.231	[1.344-7.770]									0.431	0.345	1.538	[0.782-3.026]
Watch Video	-0.915*	0.422	0.401	[0.175-0.917]	1.255**	0.365	3.507	[1.715-7.172]	0.681	0.502	1.975	[0.738-5.283]				
Participate in Forum					-0.533	0.424	0.587	[0.256-1.347]	1.199	0.695	3.318	[0.850-12.951	0.634	0.426	1.886	[0.818-4.347]
Take Test	0.525	0.376	1.690	[0.809-3.531]												
Write Assignment					0.401	0.394	1.494	[0.690-3.235]								
Participate in Meeting	0.674	0.474	1.962	[0.775-4.967]												
Search for Information									-0.885	0.519	0.413	[0.149-1.140]				
Use Virtual Library	0.342	0.389	1.408	[0.657-3.015]	1.243**	0.431	3.467	[1.490-8.066]								
Plan Study Time	1.224**	0.425	3.401	[1.478-7.823]	0.762*	0.394	2.142	[1.024-4.484]								
Check News									1.013*	0.515	0.228	[1.004-7.554]				
Device	***Expertise***								***Importance***				***Expertise***			
Very Low									-	-	-	-	-	-	-	-
Low	-	-	-	-					-0.110	1.507	0.896	[0.047-17.168]	2.315	1.556	10.128	[0.480-213.689]
Neutral	-0.211	0.381	0.579	[0.383-1.709]					0.727	1.312	2.068	[0.158-27.055]	3.274*	1.413	26.426	[1.658-421.317]
High	-0.384	0.409	0.348	[0.306-1.519]					2.715*	1.348	15.100	[1.076-211.974]	3.174*	1.360	23.893	[1.661-343.738]
Very High	-0.195	0.991	0.844	[0.118-5.746]					3.023*	1.298	20.561	[1.616-261.539]	3.164*	1.334	23.656	[1.731-323.208]
Intercept	-0.494	0.426	0.245	-	-0.983*	0.343	0.374	-	-1.479	1.209	0.489	-	-2.572	1.445	0.076	-
Model Summary																
Sample Size	332				551				270				500			
X^2 (degrees of freedom)	75.182 (11)				138.639 (8)				84.494 (13)				43.689 (10)			
X^2 Significance	0.000				0.000				0.000				0.000			
Cox & Snell R^2, Nagelkerke R^2	0.203, 0.315				0.222, 0.415				0.269, 0.442				0.084, 0.170			
Hosmer & Lemeshow X^2 (df)	3.037 (8)				6.375 (8)				3.681 (7)				4.820 (8)			
H&L Significance	0.932				0.605				0.816				0.777			

* $p < 0.05$, ** $p < 0.01$

Note: Table shows all variables, but binary logistic regressions only performed with corresponding variables.

6.5.5 Qualitative Analysis

6.5.5.1 Devices

Interviewed students (n=16) mainly have access to between two and four devices. Every student who was interviewed had a smartphone, while only one interviewee did not have access to a laptop (but they did have access to a desktop). Desktops were accessed at either home or at work. Students in rural areas are likely to have less devices than students in urban areas. Students in rural areas had access to two devices, usually a smartphone and a laptop. Interviewed students were split between considering the laptop or the smartphone as the most useful tool for studies. Most students valued the laptop as the most important tool due to the device features and range of functions it provides. However, some students considered the smartphone to be more important, because of its constant access and ability to quickly check things. These contrasting viewpoints are reflected in the following quotes:

> *I can say that the laptop has been the most important tool. Speaking of the size of the laptop, how much information it can hold and how much I can do with it. I can safely say that I can use my laptop for almost entirely everything. And it's efficient enough to help me get the goals at faster rate and a safer approach.* (Bandile, male, 18-25 years)

> *It's my cell phone. Because I carry it everywhere. If I want to check my assignments... I use my phone for everything.* (Lethabo, male, 18-25 years)

6.5.5.2 Learning Locations

Interviewees confirmed that devices (in general) are used in multiple locations, some public and some private. The main location of study is at home. Students use desktops and laptops in similar ways. Desktops are used in fixed places, such as at work or at home. A benefit of using a desktop at work for studies is that it is convenient and students can make use of printing and internet facilities.

Interviewees confirmed that laptops are used at home, work and at a university regional centre. Although laptops are mainly used at home, they are portable and students occasionally make use of either university or public libraries and take their laptops with them to study or conduct research. A few students live close to a university regional centre where they can attend face-to-face tutorials or to use the facilities in the centre. This is exemplified in the following interviewee quote:

> *The laptop I mainly use at home. Because I have access to Wi-Fi. I research at work [using the desktop] and if I am not done, I continue when I get home… with whatever I was doing. I use the desktop at work and the laptop at home... Sometimes if I do have time, then I go to Unisa [regional centre], then I take my laptop with... Then I connect to Unisa Wi-Fi.* (Bokang, female, 36-45 years).

When students travel, either to the homes of family or friends or for work, they take their laptops with them. However, some students only use the laptop at home because of safety concerns in carrying their laptop around. The following quotes highlight these uses of laptops:

> *I have used my laptop on the train in Poland or handing in my assignments from the plane. This last time I worked on the aeroplanes, on trains. It's quite incredible actually to think, you can be anywhere in the world and study something and hand in an assignment and do things.* (Elizabeth, female, 56-65 years).

> *The laptop I only use at home because it's heavy to carry around. It's also not safe. So I prefer using it at home at night or over weekends when I'm at home.* (Bandile, male, 18-25 years).

Students confirmed that tablets (similar to smartphones) are used in a variety of locations. For daily travel, using public transport such as buses or trains, students can use their phones or tablets to check information or read materials. For example:

> *When I'm somewhere waiting for the bus or waiting for the vehicle to go to work, I start reading on the iPad… Sometimes when I'm travelling, I want to use my iPhone, instead of iPad so I can receive a call, I can be on the internet, and also I can save some programmes, some files, downloaded from the internet to my iPhone and transfer it back to my computer or to my iPad.* (Siya, male, 18-25 years).

Interviewees confirmed that smartphones are used in the most number of places. They can be used at home or when away from home. They are usually on-person, so they can be used at any time and any place, as illustrated by the following quote:

> *We'll go on practical courses, two or three times a year. So I take it there and use it at practicals. I also take my devices into the field if I need to map out an area that's burnt or something like that. I could actually map it off my cell phone. I can use it in the field, I can use it anywhere. So I have used it on a mountain or whatever, obviously where I have reception. The photographs I use a lot for my work, there is photographic record of what I have done.* (Elizabeth, female, 56-65 years).

6.5.5.3 Learning Activities

Interviewees confirmed that different devices are used in both similar and different ways. Desktops are used in a similar way to laptops for most learning activities. Some students prefer using a desktop as it has a bigger screen than a laptop. It is more comfortable to sit at a desk and study with the desktop. For example:

I prefer the [desktop] computer because the screen is 19 inches, and its better working like that, because it's behind a desk. Whereas the laptop, it's kind of an older generation laptop, and it's not that fast. I prefer working on the desktop instead of the laptop. (Thato, male, 26-35 years)

Laptops are seen as central devices because they have everything students need, from the storage of all files, to the different software needed and a large screen and keyboard for reading and writing. Students use their laptops extensively for studies and perform a wide range of learning activities, including accessing the internet and conducting research. Students also access myUnisa to download resources, access email and discussion forums and submit assignments. Other activities include watching videos and searching the library. Students prefer writing assignments using the laptop because it is more efficient and faster to type on, due to the keyboard (compared to mobile devices). The screen is bigger than mobile devices and it is easy to have a number of windows open at the same time. The following quotes illustrate the range of learning activities performed using the laptop:

I use my laptop for research on the internet mainly. Then I use the end-user programmes: Microsoft Word, Excel, and Database to type up my assignments. And… storing information, I mean when I download the study materials from the portal. That's also my book, I read on the laptop. If I do not have my hard copies close to me then I read on my laptop. (Bandile, male, 18-25 years)

I basically use it for doing my assignments mostly, because it's easier to type on, it's a lot easier to use. I use it for doing assignments, for going to the online portal and to obtain our textbooks. I use it for things like that. Also looking at interactive videos that our lecturer sends us. (Mia, female, 18-25 years)

Interviewees confirmed that the most common learning activity performed using the tablet is to read (used in the manner of an e-reader). Tablets are used to as a way to carry digital textbooks or journal articles for reading when students have time. Some students use a synchronisation tool (such as Dropbox) on their tablets so that they have all their files available, so that they can access or read them wherever they are. The reason why students prefer tablets for reading is that they can be used for a long time, without charging the battery, while waiting for the bus or in public transport. However, reading is not the only activity performed using tablets. Students used their tablets for emails and for watching videos. The tablet can also be used to access myUnisa to check results and feedback on assignments. Tablets were mainly used for consuming information; however, some students did make use of their tablets for taking notes or creating mind maps. Because they are more portable, tablets were also used for research if a laptop was not around (device substitute). The following quotations illustrate the learning activities performed using a tablet:

My tablet is actually for video use as well as… it's almost like a Kindle. I use it for carrying textbooks, online textbooks. I use it more for reading aspects. (Mia, female, 18-25 years)

So if my husband is using the laptop, then I use the tablet. I almost use it is most of the time for the same things… for research and assignments, checking my marks and everything from Unisa. And getting the feedback from the marked assignments, they normally tell you where you went wrong and everything, so I normally get the assignments to check. (Bokang, female, 36-45 years).

It's convenient for research if I'm not near a laptop. Lugging a laptop around is a bit of an issue, so if I have the tablet, it's easy to do a little bit of research during lunch time or out and about. (Emma, female, 36-45 years).

However, not all students used their tablets extensively for studies. The reason given is that the learning activities performed using the tablet can be performed using either a desktop/laptop or smartphone, as illustrated by the following interviewee:

The iPad, I don't really use it for studies, it doesn't fit in anywhere. If I don't have a computer [with me], I'm not going to have an iPad. If I do have a computer, I prefer to use one of the computers. (Joshua, male, 26-35 years)

Similar to tablets, smartphones are mainly used for consuming information, checking for updates and for communicating with others. The reason that students use their smartphones for learning is that they are convenient as these devices are always with them and they are easy to use to check something quickly. Common activities are to check assignment information, results and communications from educators or etutors (emails and online discussions). Students can access myUnisa from their phones (a mobile-friendly version) to check information such as news and results and download files and later transfer these files to other devices. Unisa also has a library app. Students can also conduct searches to find information. Students like to research, find references and gather information using their phones because it is quick and easy to do (to look up information). Smartphones are the first point of contact to check information while on the move. Another common activity is watching YouTube videos. Some students have Google Drive on their phones so that they have all their files available, so that they can access or read them whenever and wherever they need them. Some students are happy to read on the phone, using Kindle or other apps, while using public transport. To overcome small screen sizes, students can zoom in or out for easier reading. The following quotes illustrate these practices:

> *I think the smartphone is the easiest and quickest way to access YouTube videos… It's just the quickest way for me to access a video or whatever… and Wikipedia search or that sort of thing. I think it's always the quickest... I find it quicker. That's about it really, videos, all the sort of quick reference, things I need is on my cell phone.* (Liam, male, 18-25 years)

> *I would say the same for my cell phone, research, checking, logging in, getting information.* (Muhammad, male, 36-45 years)

> *For instance, I check my results now and then on myUnisa. As well as download any other PDF files should I require them, to read them at any given time, so I have them on my phone.* (Katlego, male, 26-35 years)

An important feature of using phones for study is the communication with other students. For example, many students belong to informal WhatsApp groups to share information and obtain help. Students also use their smartphones to communicate with educators and students through email and access online discussion forums. The following interviewee describes how he used a WhatsApp group:

> *Yes, we do have a [WhatsApp] group. I think we were 56 in that group in the Research Methodology module group. We had a problem and couldn't figure out what was going on. So you just asked the guys in the list about the problem that you are having or something related to the problem and you will find a way out of that.* (Katlego, male, 26-35 years)

When students are without access to other devices, they sometimes use their phone as a substitute to read a textbook or by taking some notes and emailing these to themselves. Usually this occurs when students have a deadline and other devices are not nearby. For example:

> *The iPhone is literally exam results and accessing myUnisa on the move. It's really the last-ditch effort, if I am in a situation where I can study but have nothing with me. I will bring up a textbook, which is obviously saved on Dropbox. And study from there. But it's really a last-ditch thing due to screen size and usability.* (Joshua, male, 26-35 years)

> *It depends where I am, and what my deadline is. Because I might find myself doing some notes on the cell phone as well and emailing it to myself.* (Muhammad, male, 36-45 years)

Another form of device substitution is for internet access. Not all students have internet access on their laptops, so they use their phones to submit assignments, for example:

I used to submit even some of my assignments via my cell phone. I could just transfer the file, send it to my phone and then submit the assignment. At some points when I didn't have internet on my laptop, I would use it through my phone. (Lesedi, female, 26-35 years)

However, not all students used their smartphones extensively for learning. The main reasons given are because they are small and cannot be used for many activities. For example, some students prefer not to read on their phones because of the small screen size or not to type because it is slow to do so. The following quotes demonstrate how the features of smartphones limit the ways they are used:

Because of its screen size, it's not really that functional. It's usually to check up on assignment dates and basically emails and stuff, communications from the lecturer or something. (Thato, male, 26-35 years)

6.5.5.4 Devices, Locations and Learning Activities

Interviewees confirmed that the choice of device is dependent on different factors for different students. However, the main influencer of device choice at a point in time was the learning activity itself. For example, laptops or desktops were preferred for writing activities (assignments or taking notes). Tablets or smartphones were preferred for reading, research or gathering information. Time is another influencer. A laptop is preferred for activities that require a lot of time, while a smartphone is preferred for quick activities such as checking or a quick referencing. It also depends on convenience and location or environment. The following quotes highlight these influencers:

It depends on the study thing. But I would say I just always start on the Mac. It's that whole thing of sitting down and actually doing the work. Because when you are just on your mobile phone, its quick for someone to call you over, or get a phone call, so I tend to start with the Mac always. But if I just want to check something on myUnisa, my first point of contact is always the smartphone. (Zoey, female, 26-35 years)

Well, it depends on what I'm going to do. If I'm just going to check something real quick then I will use my cell phone. If need to do an assignment then I would use my PC. (Faith, female, 18-25 years)

Whatever's the easiest and quickest way. I think, ergonomically speaking, it depends, where I am, if I'm going to study on the couch, then I won't be sitting with my laptop open on my lap. I would watch the videos on my smartphone rather and be taking notes. (Liam, male, 18-25 years)

In addition to the factors above, many interviewees referred to their comfort levels in using a particular device. Very often this referred to the features of the device (screen size, keyboard size). In addition to device characteristics, device quality also affects the use of the device. For example, this refers to the age of the device, the processing speed or the cost of the device. For example:

> *I don't use my tablet that often to be honest. It's a really old one, I bought a long time ago. I only really use it for that textbook app. It's really brilliant. That's really it for the tablet. Because it's so old, a lot of the applications don't even support it anymore.* (Liam, male, 18-25 years)
>
> *Whereas the laptop, it's kind of an older generation laptop, and it's not that fast. I prefer working on the desktop instead of the laptop.* (Thato, male, 26-35 years)

Device choice also depends on whether the device is shared. For example, students with families shared a desktop or tablet, which meant that these devices were not always available to use, as illustrated in the following quote:

> *With the tablet, the problem is that, you know when you have kids, they like playing games. I would say then that I would choose the laptop most of the time. If I'm alone I pick whatever, but depending how many are around, I don't touch the tablet.* (Bokang, female, 36-45 years)

6.6 Sequential and Simultaneous Device Use

The aim of this section is to provide a summary of findings that are able to address the second research question (*How do ODL university students make use of handheld devices together with fixed devices to perform learning activities?*).

6.6.1 Descriptive Analysis

6.6.1.1 Use of Multiple Devices Together

Students were found to use multiple devices together in two ways, either sequentially or simultaneously. Sequential usage refers to students starting a learning activity on one device and continuing or finishing the learning activity on a different device. Simultaneous use refers to students using two or more devices at the same time to perform a learning activity. Table 6.47 shows the frequency of how often students use multiple devices, either sequentially or simultaneously. Students were asked to indicate the frequencies using a Likert scale (0 = Never, 1 = Occasionally, 2 = Sometimes, 3 = Frequently, 4= Very frequently). Table 6.47 shows the mean for sequential usage frequency was 2.01 (SD of 1.20) which indicates that the average student made use of devices sequentially sometimes. The mean for simultaneous usage frequency was slightly higher at 2.05 (SD of 1.20) which indicates that the average student made use of devices simultaneously sometimes. The relationship (correlation) between sequential and simultaneous use was tested. Students who frequently use devices for sequential usage are also likely to frequently make use of devices for simultaneous usage ($r_s = 0.49$, $p < 0.01$).

Table 6.47: Sequential and Simultaneous Use of Devices (Percentages)

	n	M	SD	Never	Occasionally	Sometimes	Frequently	Very Frequently
Sequential Frequency	613	2.01	1.20	11.3	24.5	28.7	22.8	12.7
Simultaneous Frequency	613	2.05	1.20	11.4	21.5	31.6	21.9	13.5

6.6.1.2 Synchronisation and Cloud Services

In order for students to move between devices, they need a mechanism to access resources or files across the devices. Students were asked to specify which tools were used to store or access resources to move between devices. Students make use of a variety of different technologies and synchronisation tools. Figure 6.7 shows most commonly used tool was the USB / flash drive (68.8% of respondents). For the online tools, the most common tools were myUnisa (VLE) (53.0%), followed by Google Drive (44.0%) and Dropbox (32.3%).

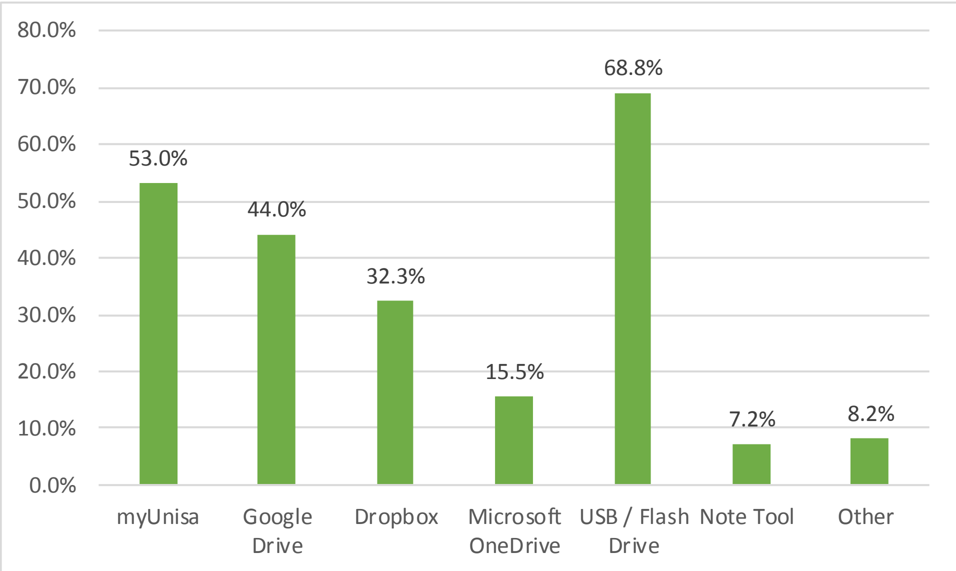

Figure 6.7: Tools Used to Access and Store Resources across Devices (Percentages)

6.6.1.3 Useful Applications for Learning

Students were asked to specify the main two or three applications or software they used for learning. Figure 6.8 shows the most common application categories (together with application examples). The most common application was a PDF reader or editor (27.1%) such as Adobe Reader. This was followed by a word processor (26.4%) such as Microsoft Word. The third most popular tool was a search tool such as Google or Google Scholar (24.7%). This was followed by a web browser (19.4%) such as Chrome or Internet Explorer. The results indicate the importance of reading and writing text (PDF readers, office packages) as well as the importance of online access (searching and browsers).

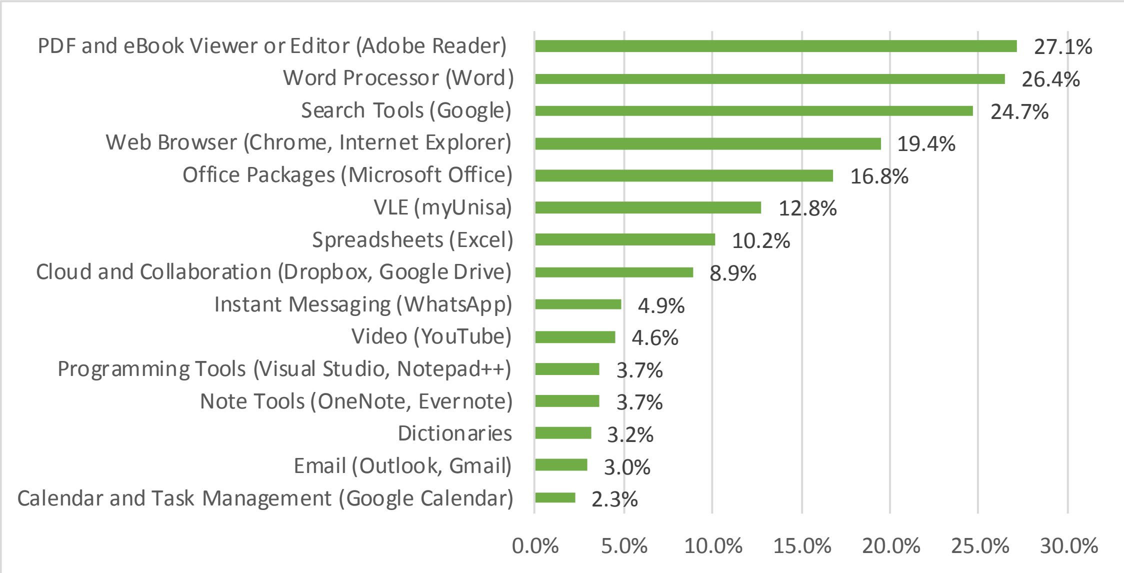

Figure 6.8: Most Useful Applications for Learning (Percentages)

6.6.1.4 Sequential Use

Students who indicated that they made use of sequential devices for learning (n = 544) were asked to select which devices they started learning activities on and then which devices they continued/ended on. Table 6.48 below shows the devices (in each row) that they started on and which devices they continued/ended on. For sequential device learning, the most common devices to start on are smartphones (271 students), followed by laptops (185 students) and tablets (153 students).

Table 6.48: Frequency of Continuing/End Device Use by Device Started On (Percentages)

	n	End Desktop	End Laptop	End Tablet	End Smartphone	End Basic Mobile	End e-Reader
Start on Desktop	145	-	69.7	17.2	32.4	2.8	1.4
Start on Laptop	185	59	-	20.5	38.9	1.1	0.0
Start on Tablet	153	34	67.3	-	20.9	0.7	1.3
Start on Smartphone	271	31	73.8	17.3	-	1.5	0.0
Start on Basic Mobile Phone	53	40	43.4	11.3	37.7	-	1.9
Start on e-Reader	24	29	58.3	25.0	16.7	8.3	-

n = Excludes students who never make use of sequential device usage

Table 6.48 showed the results of sequential device usage from the point of view of the device that is started on. Table 6.49, however, shows the device that is continued or ended on. It shows the devices (in each row) that students continue/end on and which devices they started on. For sequential device learning, the most common devices to continue/end on are laptops (284 students), desktops (164 students) and smartphones (114 students). Mobile devices are very seldomly used to continue/end activities, with very few activities being continued or completed on a basic mobile or e-reader.

Table 6.49: Frequency of Starting Device Use by Device Continued/Ended On (Percentages)

	n	**Start Desktop**	**Start Laptop**	**Start Tablet**	**Start Smartphone**	**Start Basic Mobile**	**Start e-reader**
Continue/End on Desktop	164	-	66.5	31.7	50.6	12.8	4.3
Continue/End on Laptop	284	35.6	-	36.3	70.4	8.1	4.9
Continue/End on Tablet	77	32.5	49.4	-	61.0	7.8	7.8
Continue/End on Smartphone	114	41.2	63.2	28.1	-	17.5	3.5
Continue/End on Basic Mobile	9	44.4	22.2	11.1	44.4	-	22.2
Continue/End on e-Reader	2	100.0	0	100.0	0	50.0	-

n = Excludes students who never make use of sequential device usage

6.6.1.5 Simultaneous Use

Students who made use of simultaneous device usage for learning (n = 543) were asked to select which they devices they normally use together for doing so. Figure 6.9 shows the most commonly selected devices used together for learning. As shown in the figure, a wide variety of device groupings are made use of, however, by far the most common device pairing was a laptop and smartphone (39.6% of respondents). This was followed by a laptop and a tablet (14.2%). Some students also made use of more than two devices at the same time. They most common set of three devices was a laptop, tablet and smartphone (9.3%), followed by a desktop, laptop and smartphone (4.2%).

These students were asked about the type of activities performed simultaneously. 19.7% of students use two or more devices simultaneously for multi-tasking, while 40.1% of students use two or more devices for complementary activities. The remaining 40.1% of students make use of a combination of multitasking or complementary activities.

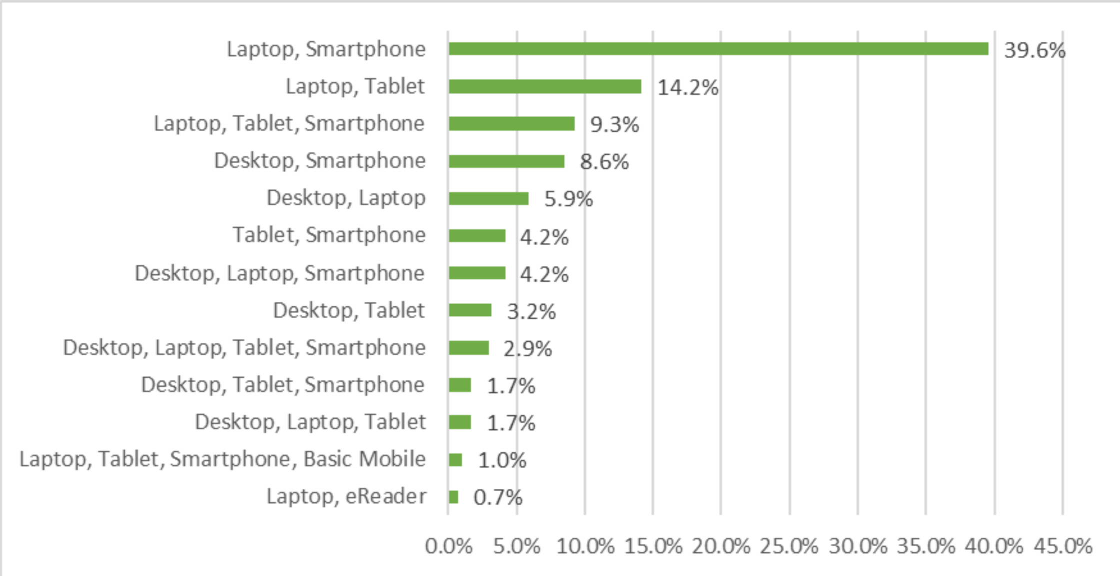

Figure 6.9: Most Common Devices Used Simultaneously for Learning (Percentages)

6.6.1.6 Sequential and Simultaneous Use and Demographic Variables

Table 6.50 shows the relationships (correlations) between sequential and simultaneous frequency use and the different demographic variables, except for Discipline. Correlations analysis could not be performed because Discipline is a nominal variable. No significant relationships (*r* > 0.20) were found between sequential or simultaneous frequency and any demographic variables (gender, employment status, national status, year of study and language status).

Table 6.50: Correlations between Sequential / Simultaneous Use and Demographic Variables

	n	M	SD	Age Group	Gender	Employ-ment Status	Nationality Status	Year of Study	Language Status
Sequential Frequency	613	2.01	1.20	0.04	0.04	0.03	0.04	-0.05	0.14**
Simultaneous Frequency	613	2.05	1.20	0.01	0.03	0.00	-0.01	-0.04	0.03

* p < 0.05, ** p < 0.01

6.6.1.7 Sequential and Simultaneous Use and Device Access

Table 6.51 shows the relationships (correlations) between device access and simultaneous and sequential use frequencies. No significant relationships (r_s > 0.20) were found between simultaneous and sequential usage frequencies and access to the different devices.

Table 6.51: Correlations between Sequential / Simultaneous Use and Device Access Variables

	n	M	SD	Desktop Access	Laptop Access	Tablet Access	Smartphone Access
Sequential Frequency	613	2.01	1.20	0.06	-0.02	0.10*	-0.01
Simultaneous Frequency	613	2.05	1.20	0.01	0.05	0.15**	0.06

* p < 0.05, ** p < 0.01

6.6.1.8 Sequential and Simultaneous Use and Device Frequency

Table 6.52 shows the relationships (correlations) between device frequency for study and simultaneous and sequential usage frequencies. Students who use the smartphone more frequently were slightly more likely to use it more frequently with other devices (sequentially) ($r_s = 0.20$, $p < 0.01$). No significant relationships ($r_s > 0.20$) were found between simultaneous and sequential use frequencies and frequency use of the other devices.

Table 6.52: Correlations between Sequential / Simultaneous Use and Device Frequency Variables

	n	M	SD	Desktop Frequency	Laptop Frequency	Tablet Frequency	Smartphone Frequency
Sequential Frequency	613	2.01	1.20	0.07	0.04	0.17**	0.20**
Simultaneous Frequency	613	2.05	1.20	0.10*	0.08	0.19**	0.16**

* p < 0.05, ** p < 0.01

6.6.1.9 Sequential and Simultaneous Use and Locations and Activities

Table 6.53 shows the relationships (correlations) between the range of activities and geographic reach per device and simultaneous and sequential usage frequencies. No significant relationships ($r_s > 0.20$) were found between simultaneous and sequential usage frequencies and the activity range of any of the devices. No significant relationships ($r_s > 0.20$) were found between simultaneous and sequential usage frequencies and the geographic reach of any of the devices.

Table 6.53: Correlations between Sequential / Simultaneous Use and Activity Range and Geographic Reach Variables

	n	M	SD	Activity Range – Desktop	Activity Range – Laptop	Activity Range – Tablet	Activity Range – Smart-phone	Geo-graphic Reach – Desktop	Geo-graphic Reach – Laptop	Geo-graphic Reach – Tablet	Geo-graphic Reach – Smart-phone
Sequential Frequency	613	2.01	1.20	0.03	-0.03	0.15*	0.14**	-0.04	0.01	0.03	-0.05
Simultaneous Frequency	613	2.05	1.20	0.01	0.04	0.16*	0.14**	0.08	0.10*	0.10	0.02

* p < 0.05, ** p < 0.01

6.6.1.10 Sequential and Simultaneous Use and Device Range

Table 6.54 shows the relationships (correlations) between the range of devices and simultaneous and sequential usage frequencies. Students who use more devices for study were slightly more likely to use devices more frequently, either sequentially or simultaneously ($r_s = 0.30$ and $r_s = 0.29$, $p < 0.01$ in both cases).

Table 6.54: Correlations between Sequential / Simultaneous Use and Device Range Variables

	n	M	SD	Range of Devices
Range of Devices	613	2.99	1.12	-
Frequency Sequential Usage	613	2.01	1.20	0.30**
Frequency Simultaneous Usage	613	2.05	1.20	0.29**

* p < 0.05, ** p < 0.01

6.6.2 Chi-Square Tests

Chi-square tests were performed at the 95.5% confidence level to determine if there were any significant differences between different classifications and the sequential and simultaneous use of desktops, laptops, tablets and smartphones. The differences in simultaneous and sequential device use were assessed against seven demographic variables: age group, gender, discipline, employment status, national status, year of study and language status. Only the statistically significant chi-square test results are shown. Test results were ignored where more than 20% of the contingency table cells had expected counts less than 5 (Field, 2013).

6.6.2.1 Sequential Device Use

There was a statistically significant difference in the proportion of students using devices sequentially in respect to language status ((n=613) X^2 (4) =18.31, p = 0.001). Students who study in the same language as their home language were less likely to frequently make use of sequential devices for learning than students with different home and study languages. However, no differences were found with respect to students using devices sequentially for the other demographic variables (age group, gender, discipline, employment status, national status and year of study).

6.6.2.2 Simultaneous Device Use

There was a statistically significant difference in the proportion of students using devices simultaneously in respect to national status ((n=613) X^2 (4) = 13.36, p = 0.010). Local students were more likely to use devices simultaneously frequently than international students. However, no differences were found with respect to students using devices simultaneously for the other demographic variables (age group, gender, discipline, employment status, year of study and language status).

6.6.3 Multivariate Analysis of Sequential and Simultaneous Frequency Use

Parallel multiple regressions were tested to determine how different independent variables could predict a dependent variable (frequency of sequential or simultaneous use). Ordinal regression models were originally proposed for the ordinal frequency variables, however p-parallel lines below 0.05 meant that the ordinal regression models could not be accepted. In order to overcome this situation, binary logistic regressions were tested. Binary logistic regression models were created for sequential and simultaneous frequency by grouping frequencies ("Never"+"Occasionally"+"Sometimes" and "Frequently"+"Very Frequently"). Table 6.55 shows two parallel multiple binary logistic regressions related to frequency of sequential and simultaneous use. The significance and overall fit obtained for the proposed models had valid values: X^2 with p=0.000, Hosmer–Lemeshow's tests were insignificant (p=0.512 and p=0.868), Cox and Snell's (0.148 and 0.157) and Nagelkerke's (0.202 and 0.215) R^2 indices had good measurements of goodness-of-fit.

For sequential frequency usage, the frequent use of sequential devices for study was statistically greater among students who used devices simultaneously more frequently (Exp(B)=4.564) and who used the smartphone more frequently (Exp(B)=2.879). For simultaneous frequency usage, the frequent use of devices simultaneously for study was statistically greater among students who used devices sequentially more frequently (Exp(B)=5.358) and who used the smartphone more frequently (Exp(B)=1.689).

Table 6.55: Multiple Binary Logistic Regression Models for Sequential and Simultaneous Frequency

	Sequential Frequency				**Simultaneous Frequency**			
	B	**S.E.**	**Exp(B)**	**95% CI**	**B**	**S.E.**	**Exp(B)**	**95% CI**
Frequency of Laptop Use	-0.334	0.437	0.716	[0.304-1.685]	0.561	0.333	1.753	[0.912-3.368]
Frequency of Tablet Use	-0.114	0.307	0.892	[0.489-1.628]				
Frequency of Smartphone Use	1.058**	0.364	2.879	[1.410-5.878]	0.524*	0.260	1.689	[1.015-2.811]
Frequency of Sequential Use					1.679**	0.204	5.358	[3.594-7.986]
Frequency of Simultaneous Use	1.518**	0.272	4.564	[2.677-7.781]				
Intercept	-1.686**	0.469	0.185	-	-2.129	0.374	0.119	-
Model Summary								
Sample Size	285				521			
X^2 (degrees of freedom)	45.777 (4)				88.914 (3)			
X^2 Significance	0.000				0.000			
Cox & Snell R^2, Nagelkerke R^2	0.148, 0.202				0.157, 0.215			
Hosmer & Lemeshow X^2 (df)	5.255 (6)				0.724 (3)			
H&L Significance	0.512				0.868			

* $p < 0.05$, ** $p < 0.01$

Note: Table shows all variables, but binary logistic regressions only performed with corresponding variables.

6.6.4 Qualitative Analysis

6.6.4.1 Internet Access and Cloud Services

For internet access, students either make use of ADSL or Wi-Fi at home, or students purchase mobile data packages to use with their devices. For students with Wi-Fi access, internet costs are not a problem. However, for students who use mobile data, internet access can be very expensive. Internet accessibility is illustrated in the following different examples:

> *I don't have any other ways to access the internet. Just on my phone. I just buy airtime bundles and convert them to data. It's quite expensive. Because now and then you need to download the files as well as watch YouTube videos. Should you have any other issue… when you are a student there are other things you need to solve, you need to learn them through YouTube so you watch some videos of how to solve the problem on YouTube. That's what I do.* (Katlego, male, 26-35 years)

> *Well, I live with my parents still so, we have Wi-Fi, we have a Telkom* [the national telecommunications provider] *landline. Then we have a subscription with Afrihost* [a private internet service provider]. *So mostly Wi-Fi, I try to avoid mobile data as much as I can because it's incredibly expensive.* (Liam, male, 18-25 years)

For students who live in rural areas, not only is the cost of internet access an issue, but the quality of access is as well:

> *For instance, I stay in a rural area. If you try open the internet there is Edge, there is no high-speed data, there's no 4G network. It becomes slow. If you download a file, it takes ages to come up. The infrastructure of the network should be improved in order for us to have better access to learning as well as other materials. That's our challenge.* (Katlego, male, 26-35 years)

Where they can, students find ways to overcome internet access challenges. For example, students use the data on their phone to act as a mobile hotspot to connect their laptop to the internet:

> *What I do is use my phone, I put data bundles on my phone, and I use my phone as a Wi-Fi hotspot to access the internet on my laptop.* (Katlego, male, 26-35 years)

Interviewees confirmed that moving between devices is facilitated by the synchronisation of files using cloud services. The benefit of this technology is that synchronisation is automatic and students can continue exactly from where they left off:

I have Google Drive and Dropbox. So I am able to work online and offline and to just synchronise when I'm online. (Lesedi, female, 26-35 years)

But if it's an assignment, I'm going to be working on it during the night, and I would pick up the next day at the office with the same assignment. That's all through Dropbox. I work with Dropbox and then it synchs to the other computer and I just carry on. (Joshua, male, 26-35 years)

I have had that scenario where I started working on a project at work [on the PC], then continuing or finishing at home on the laptop. But mostly if it's research-based, it will be Google Documents. So that makes it easy. Google really makes life easy for me. So I don't have to worry about "Is this the latest version of the document I have and so forth". (Ruben, male, 26-35 years)

As described above, students make use of different cloud technologies, such as Google Drive, Dropbox or make use of myUnisa to access or store files. But in several cases, students also rely on older technologies, such as email or memory sticks to transfer files:

So I'll be running two simultaneous projects and I'll either copy my data onto Google Drive or I'll carry the data on a memory stick to the home computer. (Thato, male, 26-35 years)

6.6.4.2 Sequential Use

Interviewees acknowledged that the reason they move from one device to another is for practical reasons, to make use of devices they have access to at that time or to take advantage of available time. Students move between devices when they need to complete a learning activity within an urgent timeframe and they are not going to be at home. Another reason is that some devices do not have internet access. For example, students would prepare an assignment using a laptop, but then transfer the assignment to a mobile device to upload the assignment using the internet on the mobile device. Finally, a student may move between devices because one device does not have battery life remaining.

Interviewees provided examples of how they used their devices sequentially for learning. The main types of sequential usage were found to be students moving between different locations, students moving to a different (but related) learning activity, continuing the same learning activity at a later stage and moving because of device features. Table 6.56 provides these usage patterns together with the devices used and examples from student interviews.

Table 6.56: Sequential Usage Patterns and Interview Examples

Sequential Patterns	Devices Used	Student Examples
Move from one location to another, such as from work to home	Desktop -> Laptop	*I'm looking at the time, maybe my assignment is due, I have to finish, so I will do part of it at work and as soon as I get home I continue where I left off. I do what I need to at home then I continue.* (Bokang, female, 36-45 years)
	Tablet -> Laptop	*Sometimes I will be at university and I will be using my tablet. And I'll come home and transfer it via USB onto my laptop and just carry on typing from there, should it be an essay.* (Mia, female, 18-25 years)
Move from one related learning activity to another, such as reading materials and then begin to write	Smartphone -> Laptop	*With, say something a little more complex to understand, I would move from my smartphone to my laptop. To research it further, to be able to open a lot of tabs or whatever.* (Liam, male, 18-25 years)
Pause and continue the same learning activity at a later stage	Smartphone -> Laptop	*Because I might find myself doing some notes on the cell phone as well and emailing it to myself. And then maybe just continuing on my laptop when I've got the time.* (Muhammad, male, 36-45 years)
	Laptop -> Tablet or Smartphone	*Having to work full-time and having a family, there are things you will need to do. I will always start with the Mac, but I could finish on the iPad or iPhone. I pretty much don't have a preference between the two.* (Zoey, female, 26-35 years)
Move from one device to another because of device features (lack of battery or internet access)	Laptop -> Tablet	*Because usually I'm not using the computer for connection to the internet…To submit the assignment, I can take it from my laptop and transfer it to my iPad. From my iPad I can attach and send to Unisa for electronic assignment submission to Unisa.* (Siya, male, 18-25 years)
	Smartphone -> Laptop	*It happens most of the time that I read on the phone and then read on the laptop. If you want to see a broad view than [the phone] then you go to the laptop and I carry on on the laptop.* (Katlego, male, 26-35 years)

6.6.4.3 Simultaneous Use

Interviewees were asked to explain why they used their devices at the same time for learning. The main reason why students made use of different devices simultaneously is for ease of use. Students did not want to have to toggle between two windows on one computer, but wanted to be able to see the information on two screens at the same time. This means that students are able to undertake complementary activities in an easier way. Students can perform a main activity on one device and use a secondary device to perform a complementary activity. In effect, it is an element of multitasking to have various aspects related to study available together, as described by this interviewee:

> *It's the ability to be able to multitask. I can have the library online, I can have the textbook I need to work from, either in PDF or in paper in front of me, and then the assignment or the paper I am working on, on the computer in front of me. So it's not just the computer, it's the ability of the computer to multitask, access to the internet and have the resources on the internet and I have myUnisa with previous exam papers.* (Joshua, male, 26-35 years)

Although the majority of students sometimes made use of simultaneous devices for learning, several students only used one device at a time, as some students mentioned having dual monitors to be able to use two screens on a single device. In this case, these students did not have to use two different devices at the same time, as described by the following interviewee:

> *I have the luxury of having an extra monitor, which I can just connect to my laptop, so I can do dual-screen work that makes it a little bit easier… As well as for research purposes, where I need to incorporate someone else's idea into my document, it helps to have the dual screen.* (Ruben, male, 26-35 years)

Interviewees provided examples of how they used their devices simultaneously for learning. The main activities performed for simultaneous usage were found to writing assignments together with searching for information or reading materials, watching a video and taking notes, writing an assignment and communicating with others and reading materials and searching for information. Table 6.57 provides these usage patterns together with student interview examples.

Table 6.57: Simultaneous Usage Patterns and Interview Examples

Simultaneous Usage	Devices Used Together	Student Examples
Write Assignment and Search for Information / Read Materials	Laptop + Notebook	*I would then use my laptop for actual submission or typing. I would use my notebook for research, so I would have an eBook open generally. And the other devices as well, I'd use those as research tools and I'd use the laptop as the submission tool.* (Muhammad, male, 36-45 years)
	Laptop + Tablet + Smartphone	*Well, for example, I would use the laptop and I would be typing up an essay. And I would use my tablet or my phone to either watch a video or look at the source documents. So I would be looking at, for example, on my tablet, I would be looking at an article or thesis, on my phone I would be looking at a video from another source that I can use as well.* (Mia, female, 18-25 years)
Watch a Video / Read Materials and Take Notes	Tablet + Laptop	*Usually when I have downloaded some journal article from the internet on my iPad, I can read from my iPad and take notes on my laptop.* (Siya, male, 18-25 years)
	Laptop + Tablet	*It's mostly during exam periods. I actually sit and make the notes on the Mac, while watching videos and tutorials on the iPad.* (Zoey, female, 26-35 years)
Write Assignment and Communicate with Others	Laptop + Smartphone	*When I use them at the same time most of the time is when I'm doing assignments. When I have to look up something on the internet or I have to gather some information or I need to ask someone to help me explain what I don't understand over the social media. Then I do call them or I just send them a text and they help me out. That's usually when I get to use both devices.* (Bandile, male, 18-25 years)
	Desktop + Tablet + Smartphone	*And quite often I will WhatsApp, because I have a study buddy who happens to be sitting in Kwazulu-Natal* [a different province]. *We'll do the assignments on our desktops, watch the videos on the iPads and then communicate via WhatsApp… We'll compare answers and things like that.* (Zoey, female, 26-35 years)
Read Materials and Search for Information	Smartphone + Laptop	*Let me say I'm reading a PDF file on my phone, and I'm connected to the internet on my laptop and I'd like to find out the meaning of a word or a term I don't know then I use Google on my laptop. Then I will search there. That's what I do. It happens whenever I read words that I don't know the meaning of, it happens now and then.* (Katlego, male, 26-35 years)
	Tablet + Smartphone	*If I'm busy with the tablet, and I need an extra screen and I want to just cross-reference something that's on the article that I'm currently reading, I can do it off the cell phone. It's just to verify the data that's on the one.* (Emma, female, 36-45 years)

6.6.4.4 Changes in Study Habits Due to the Use of Multiple Devices

Students make use of both digital resources (e-books and journal articles and study guides) and printed resources (study guides or textbooks) for reading. However, as Unisa has moved towards internet-dependent learning, more students are making use of digital resources. In terms of reading, two patterns emerged from the interviews. Some students prefer to read hard copies (as they have traditionally done), while other students have changed their reading habits and read more using their devices. For the students who prefer hard copies, they prefer the feel of paper as they are more used to it. These students also prefer to highlight, “scribble” notes and add post-its. Some students find font sizes in digital materials to be a problem. These reading practices are explained below:

> *I generally would use the textbooks first. If I don’t have a textbook, and I have an assignment due then I have to buy the eBook. The eBook is not my first preference at this point. I think the font size has a lot do with it also. You can have a whole textbook in front of you with the font size that you are accustomed to, as compared to a laptop where the font is half the size of what the book actually would be in. If you want to have a clear look at the writing, you need to zoom in, but then you are missing some of the other pages. I think it’s got do with how I have been educated over the years, so that’s what I’m used to, I suppose.* (Muhammad, male, 36-45 years)

> *We do get tutorial letters from the university and also some study guides and books. Sometimes I even purchase them. I have always found it better to use a hard copy book. Of course, I will need the laptop maybe to help me reference the book quicker. I may search for something using my laptop on the Adobe page, then it just refers me… but I prefer hard copy, because I believe that something that you read and write down, it sticks in the mind. Other than something you just read. I do use a hard copy a lot, especially for putting stickers and for the references.* (Bandile, male, 18-25 years)

While some students can find cheaper e-books, other subjects have textbooks that are not available online or, if they are, are more expensive than the hardcopy version. For students who prefer reading digitally, the advantage of using their devices is that there reading resources are always with them and can be read anywhere (without needing to carry books around). Another benefit is the search functionality where students can quickly find a specific page or word:

> *My studies have changed a lot. Because I don’t buy anymore the printed paper books. I do not buy printed books, only if there is no digital or pdf version. Or perhaps if the digital version price is more than the printed version, at that time I can buy the printed version. But usually my behaviour is geared towards digital ones. It has helped me to read anytime, in the state of moving anyplace.* (Siya, male, 18-25 years)

> *I prefer using the PDF files to books. Especially with the PDF files there’s a quick search. Whenever I would like to search for a specific topic, I just go to Control F and I find the quick search and I find it. It happens that sometimes maybe I will use books. But most of the time I use my laptop or my phone when I study.* (Katlego, male, 26-35 years)

Interviewees were asked to reflect on whether their use of multiple devices has impacted on their study habits. However, the feedback from most students indicated that changes in study habits mainly aligned to the reliance on internet access. This is not unexpected as Unisa has moved from internet-supported to internet-dependent provision. For Unisa students, internet access is seen as the most important tool for their studies. A major change in their studies has been the accessibility of the wealth of additional resources available online, as highlighted by the following interviewees:

> *…Access to the internet is very important. Because there are a million people that can help you with any given thing on any given day. But if you don't have access to the internet, the computer's not going to help you at all.* (Thato, male, 26-35 years)
>
> *Especially with Unisa, its distance learning, you don't interact with any lecturer personally. If I YouTube or use Google Search or find any other Google Scholar article that I can read... for those you need access to the internet. The most important [tool] is internet access, with less money that you spend, because internet is quite expensive.* (Katlego, male, 26-35 years)

The previous quote reinforces the fact that, for many students, internet access for studies is both necessary, yet still a challenge due to costs and other factors. The move from internet-supported to internet-dependent learning has meant a major change for the study patterns of students. Internet access has meant that students do not need to wait to physically receive study guides and textbooks, they can access materials as soon as they register:

> *As soon as I am registered, I am able to access myUnisa, to access the materials and get started as soon as possible. Those devices and access to the internet makes this possible.* (Thato, male, 26-35 years)

As another example of changing study habits brought about by internet-dependent learning, the times and locations needed for studies have also changed, for example:

> *Now it's a click of a button and your assignment is submitted wherever you are. You don't have to conform your life around your studies, they are actually interrelated. And also if you need information or to do research, you can just go online, instead of having to go to the library.* (Muhammad, male, 36-45 years)

The previous quotation indicates that the internet has meant that study times have become more integrated into other aspects of students' lives. The easy accessibility of study materials is a major change for study habits, enabled by both internet access and multiple devices. In achieving the goal of seamless learning, students are able to start, stop and continue studies at times that are convenient for them. This has meant that learning is seen as a continuous activity and no longer requiring time to be set aside for a separate time "for learning", for example:

I have adapted to what works for me and as much technology as possible seems to work for me. If there is a distraction, an email, a work matter that needs to be attended to, or a personal matter that can be attended to, 90% of the time I can very quickly take care of it. Because I am sitting behind a computer working. It's not this quiet sacred space or anything like that. Again it's multitasking, even outside of the computer. It's almost like a form of integrated learning. I don't have time to have a separate time to live and a separate time to study, the two need to coincide. That's what fully adopting technology has been able to give me. (Joshua, male, 26-35 years)

Its perpetual – you can start with something and then you can stop and then you can just pick up exactly where you left off again, and continue again and then stop again… at the click of the button. Previously you had to… okay, let me drag out all my textbooks now, my highlighters, where did I stop, where's my bookmarks? All those things... Now all those things can be in one unit, if you choose it to be, all the e-resources as well. So it's more easily accessible. (Muhammad, male, 36-45 years)

The variety of resources and support options available (either learning resources or communicating with others) has meant that studies can be done more efficiently. The use of different devices has not only provided greater communication opportunities with other students, but also offered new ways of learning. These practices are exemplified by the following interviewee quotes:

My studying has become, what I can say, more or less improved. Other than the olden days, where you used one textbook and then you moved to another, and if you didn't have another textbook then you were more or less doomed. Now with my cell phone I can contact a friend. They can send me the textbook or the resources they have via WhatsApp and social media. I am able to study and use a variety of resources that are at my disposal... Devices have really helped us communicate, study and almost do entirely everything. (Bandile, male, 18-25 years)

Now instead of writing notes by hand, you could type them or could use the voice recording feature on your phone. (Faith, female, 18-25 years)

A benefit of using multiple devices and cloud services for study purposes is that files are backed up and available in case something goes wrong. This is exemplified in the following quotation:

The challenge I encountered at first, was not backing up most of my files and then losing the work. I've learnt from experience, losing the work. Not having them on multiple devices as well. Now it's much easier because I have them on multiple devices and I have them also in a cloud system so I can still access them. That was the challenge then. Because even if my laptop would *crash… I had an incident like that, I didn't know how to get my work. It helps to have them on multiple platforms or devices.* (Lesedi, female, 26-35 years).

6.7 Academic and Technological Support

The aim of this section is to provide a summary of findings that are able to address the third research question (*What academic and technological support do students learning with multiple devices require from ODL universities?*).

6.7.1 Descriptive Analysis

6.7.1.1 Design of Learning Experiences for Multi-Devices

Survey respondents were asked whether educators enabled the use of different digital devices for studies through the design or facilitation of learning experiences. 45% of respondents agreed that educators designed/facilitated learning experiences that enabled the use of different devices, while 55% of students disagreed. Students who agreed were asked to provide examples in an open-ended question. The most common experience was that online resources (such as PDFs or videos) are accessible from different devices. Not only are resources accessible from different devices, but course activities such as the discussion forums can also be accessed from different devices. Students can submit their assignments using different devices. Students make use of the mobile-friendly version of myUnisa to access course information. Furthermore, educators can share links to supplementary online resources (web pages, videos, articles) that can be accessed from different devices. Educators also communicate with students through different channels such as emails, text messages or instant messages (WhatsApp) that students can access on different devices. As one student commented, different educators make use of different techniques to help students make use of different technologies:

> *Each lecturer has a different technique. One gives us multiple links for interactional study videos. Another gives us online tasks/tests on socrative.com to do. Others give us presentations for us to make on certain chapters to help us interact more not only with technology but with the work.* (UOC Survey #53)

Several students also mentioned that the university should provide more information about how students can study with different devices, for example:

> *I think the university should report more on the possible use of multiple devices to study because many students only use the laptop or desktop computers and there are other options that can support sound and that are unknown to many.* (UOC Survey #275)

6.7.1.2 Suggestions for Improving Academic Support

Survey respondents were asked to provide suggestions for improving academic support when using multiple devices through an open-ended question. Several students mentioned that they were satisfied with the current support services provided. Areas for improvement can be grouped into:

- *Communication Improvement*: Several students requested faster response times from educators or from the university. Some students experienced not receiving responses when sending emails or phoning the university.
- *Explanatory tutorial videos*: Several students requested that educators record short videos that help students to better understand difficult concepts or further explain theory. These could be made available via DVDs or on YouTube to be accessible for all students. Students could then download and watch these videos several times.
- *Assessment Feedback Improvement*: Several students mentioned the need for more personalised assessment feedback that shows where they were wrong and how to improve as well as the need for a faster turnaround time for feedback. General feedback and a model solution does not always help students to know how to improve. Students also requested feedback to be sent electronically through different channels (such as email, discussion forums or text messages).
- *Synchronous Video Conferencing or Chats*: Although the educational model of Unisa is focused on asynchronous communication, several students requested the use of synchronous communication channels such as videoconferences with educators, particularly close to exams, where students could ask questions and discuss issues. These could be recorded for students unable to attend the meetings. As another form of communication, a channel for synchronous chat with the educator or other students connected in course to facilitate communication, especially for urgent issues.
- *More use of audio-visual materials*: Although students acknowledged that text materials are available, more resources could be made available in audio (podcasts) or visual forms. These could be made available online or sent via DVD.

6.7.1.3 Suggestions for Improving Technological Support

Survey respondents were asked to provide suggestions for improving technological support when using multiple devices through an open-ended question. Several students mentioned that they were satisfied with the current technical support services provided. The most common suggested areas for improvement can be grouped into:

- *Internet Accessibility and Costs*: Many students mentioned the expensive costs of mobile data and suggested several ways for the university to help reduce these costs for students. Firstly, the university could negotiate with service providers to make access to the myUnisa website zero-rated or free from data charges. Secondly, the university could subsidise the cost of internet access through vouchers or to negotiate with mobile operators for lower tariffs for Unisa students.

- *Discounted Rates for Devices and Tools*: Similar to the suggestion above, several students requested support in the purchase of digital devices such as laptops and tablets. This could be in the form of purchasing discounts negotiated with suppliers or in the form of subsidies for the purchasing of devices and applications.
- *myUnisa Accessibility from Mobile Devices*: Several students requested a better design for accessing myUnisa from tablets or smartphones. Students noted that sometimes information does not display properly on the mobile site.
- *Creation of a myUnisa Mobile App*: Another suggestion was to create a mobile app that students could use via their mobile devices to access course and university information.
- *Improvements to myUnisa*: Several students suggested improvements to the design and interface of myUnisa. Students also expressed frustrations at frequent updates and the occasional crashes, when the site was unavailable. Students also requested that educators make better use of the tools within myUnisa to improve interactions.
- *Digital Skills Courses*: Students asked for courses and information about how to improve their ICT and digital literacy skills. This could be done online or through workshops at regional centres.

6.7.2 Qualitative Analysis

6.7.2.1 Means of Obtaining Academic Support

Interviewees were asked how they obtained help or support when they were unsure how to proceed in the course or needed help with an assignment (in the context of using multiple devices). Students made use of a variety of mechanisms to obtain support and often followed a number of steps to obtain the necessary support to achieve their academic objectives.

In the first instance, many students attempted to help themselves by reviewing the course information again, rereading the materials (study guides, textbooks and tutorial letters) or conducting a general internet search to find out more about the topic or issue. Although many students reach out to other students for help, they tend to first review the materials and reflect about the situation, as demonstrated by the following interviewees:

> *The first place is actually my tutorial letter. Because most of the things they ask in the assignments come from the study guides and the tutorial letters. But if I do not get as much information that I need, then the next place is the internet. So I will do a web search to try and get help. Other than that then I will go to other students. But it's not always the case, because*

it's not like when you studying certain topics, that's what they are studying also. It takes time. My chief reference is the study guide and the internet. (Bandile, male, 18-25 years)

Using Google most of the time as well as asking any other fellow students "how did they come to a solution?". But what I usually do, personally, is if something gives me a problem today, I will leave it until tomorrow and think about. Then certainly I will be able to find a solution to the problem. (Katlego, male, 26-35 years)

If students are unable to overcome the issue themselves, they then contact the educator or tutor and make use of the discussion forums. Students often check the forums to see if a similar issue has been raised already. If a similar question has not been posted, students could then write a message in the forum. While some students explained that they would receive answers to their questions, other students noted that sometimes questions in the discussion forums would go unanswered. These practices are illustrated in the following quotes:

My first go-to would be normally the Unisa discussion forums. So I'll go read through the discussion forum to see if anyone has had a similar problem or not. Read through that content first. If not, I post a question. If I don't get an answer within the first couple of days, I will move to different IT forums online. (Ruben, male, 26-35 years)

If I am experiencing a problem, I know there should be another student experiencing the same problem, so I normally log onto the forum and everything and go through them. I know someone would have explained. If I not, I attend the tutorials on Saturdays, I do ask the tutors. They do advise us, although they don't give us answers, but they give us advice how to... I make sure I attend on Saturdays, because they always have classes. Sometimes I even phone the lecturers (Bokang, female, 36-45 years).

As illustrated in the previous quotation, student who live near regional centres will make use of the facilities at those centres to obtain additional face-to-face support. These facilities include tutorials, video conferences and computer laboratories. This form of support (regional centres), however, comes at a great cost or is not available to all students, particularly those who live a great distance away from a regional centre, as described by the following students:

I live in a rural area… We do suffer, especially the engineering students, there's no classes, there's no video conferencing, there is not anything. We just go maybe sometimes use some data to go to YouTube and learn... Because when I am alone and I want to do a video conference, I cannot do a video conference, because it is expensive. I pay the same fees as those students in

Johannesburg, who have access to tutors and to the video conferences. (Lethabo, male, 18-25 years)

Another thing that frustrated me last year was I was doing a business studies management module… I had to drive to Pietermaritzburg to attend a video [conferencing] session at the university [regional centre, over 200 kilometres away], when I could have sat at home and attended the lecture on my laptop. I had to spend close to R1000 [+- 60 euros] on that trip just on petrol. I could have logged on at home over the internet. Or the lecturer could have recorded the session and posted it on myUnisa… [but] they don't have the infrastructure. (Liam, male, 18-25 years)

While most students tend to ask for support from experts (educators or tutors), students will also reach out to other students. This could be either a specific colleague or make use of WhatsApp study groups. Very often, students within a course will create their own informal WhatsApp study groups to share information and help each other. Although groups can be formed in Facebook or through other channels, WhatsApp groups (accessible on smartphones) tend to be the most popular groups and can consist of 50 or more students in a group. The following quotes illustrate how students obtain support from other students:

With the cell phone, what I have actually discovered is that there are WhatsApp groups that we as students have created. There we are able to share information and so forth. If someone has some other study material or some information that they know, they are able to share it on WhatsApp and Facebook and other places. And we also do use other email software, we can call and can have video calls, and drop your files and maybe explain and discuss your assignments. Or just studying, how we can help one another. (Bandile, male, 18-25 years)

So Google or other students or even other students that have qualified, who I know. Either telephonically or WhatsApp. (Katlego, male, 26-35 years)

While the majority of students seek help from other students or personal networks, there is a minority of students who consider themselves as independent learners who prefer not to reach out to other students. These students tend to rely on themselves and the learning content to help them achieve their objectives, as illustrated by the following interviewees:

I've never ever used the e-tutors or any of the discussion groups. I find a way. I normally Google, to get a head start as to which direction I'm supposed to go in. But invariably, I always seem to find my way… because I think the learning material is quite self-explanatory and it's quite precise. Once in a while I will pop the lecturer an email. That's if time permits, but if not then I *have to make a plan basically... Maybe I'm just a very independent type of study person, I don't know.* (Muhammad, male, 36-45 years)

I work alone. Completely alone, so I will seek other reference material for other perspectives. If I'm really not understanding the work, the textbooks have gotten other people through it, so obviously I am a fan of the textbooks. So, I will go reread the material. I will look for other sources via the internet. (Joshua, male, 26-35 years)

6.7.2.2 Means of Obtaining Technological Support

Interviewees were asked how they obtained help or support when they experienced technical difficulties or challenges (in the context of using multiple devices). These challenges could range from being unable to access the VLE, having difficulties downloading resources or uploading assignments, to software issues. Students made use of a variety of mechanisms to obtain technological support and often followed several steps to obtain the necessary support. These steps depended on the type of technical issue experienced as well as the student's level of technical expertise. Several students mentioned they had technical backgrounds and could generally deal with technical challenges themselves. Generally, students make use of the resources they have available to them, and by trying different strategies, they can overcome the technical challenge experienced.

Similar to obtaining academic support, students normally first try to solve the technical issue themselves, before reaching out to others for help. The most common strategy is to do an online search (usually Googling it), for example:

Most of the time, when I find, especially with the technical things I cannot figure out, I will firstly try to figure out myself. But my first point of contact is Google to look for how do I do this or if I'm stuck, how to get around it. (Lesedi, female, 26-35 years).

Similar to obtaining academic support, students obtained help by contacting the educator or e-tutor (either through telephone, email or the discussion forums). Usually students find the telephone or forum to be more helpful than email. For example:

If I want to... sometimes the assignment doesn't even show on myUnisa, I normally phone the lecturer. There was a time when I phoned one of the lecturers then he told me I wasn't the first student to phone, there were others. (Bokang, female, 36-45 years).

Unisa never replies to emails, so I will generally drop the lecturer a message via myUnisa. The lecturers or tutors, they are generally pretty good about getting back to me. (Joshua, male, 26-35 years).

If students experience challenges when accessing the VLE or uploading an assignment, then they usually determine if others have the same issue or try again later. When myUnisa is not available for a period, some students revert to the previous correspondence mode of interaction or make use of regional centres, as described by the following interviewees:

> *That actually can be quite a big challenge at times. Because when you have issues or questions that you have for myUnisa or other portals, it's not like when we ask for help, they respond immediately. Most of the time we just try and work with the resources that we have. Go back to the old-fashioned ways, where we used paper and try the postage, if it works. But I can say that's the major challenge or setback that we have, because speaking from my side, I'm an employee and a student at the same time, I cannot access the post easily, because I am at work during the day and the only time I have for studying is at night. So I really depend on the portal, on the myUnisa website. So if it's not working and I cannot submit my assignment or if my assignment is delayed, then it will cost me a lot for those modules.* (Bandile, male, 18-25 years)

> *If I am having an issue uploading my documents, I would rather go and drop them off at Unisa than sort of waiting for it to be... For an assignment in a previous year, I had to actually go to the Unisa campus and hand my documentation in there.* (Mia, female, 18-25 years).

The previous quote highlights the dependence students have on university systems being available to them at all times, as well as highlighting how students need to balance their studies with work and other commitments. Similar to the ways students obtained academic support, some students made use of university support channels, while other students reached out to friends and colleagues for help with specific technical issues. The following quote illustrates how students would reach out to their personal networks:

> *But normally, I think you network, and you ask people, your friends or your family, you know "I've got a problem" and speak to them and generally you get the answer.* (Muhammad, male, 36-45 years)

6.8 Summary

This chapter has described the results of the Unisa case. The chapter was organised by the different types of analysis: the quantitative analysis consisted of descriptive analysis, correlations analysis, chi-square tests, PCA and multiple linear regressions. This was supported by qualitative analysis. The chapter started with an overview of the Unisa teaching and learning model. The demographic data of the survey was described and found to be representative of the population. This was followed an overview of the data analysis process. The main parts of the chapter were organised by the research questions. The first results section discussed the results of the digital devices, locations and learning activities. It was found that students have access to multiple devices and use these devices for study. Desktops and laptops are seen as central devices for study, while handheld devices such as tablets and smartphones are seen as supplementary. Students use these devices in different locations, although home is still the preferred location for study. Students make use of their devices for different learning activities. The next results section discussed the results of how students use their fixed devices together with handheld devices. It was found that the majority of students sometimes make use of devices for learning, both sequentially and simultaneously, in order to improve their study efficiency. This has led to changes in study habits. However, the cost and quality of internet access is important. The final results section described the academic and technological support needs of students using multiple devices for learning. Students make use of a variety of formal and informal methods to meet their needs. The majority of educators do not yet design learning experiences to cater for students using multiple devices, but students have provided suggestions of how they can be better supported, both from an academic and technological point of view. The next chapter provides a discussion of the results from the two cases.

Chapter 7
Discussion

This chapter introduces the discussion of the results (Section 7.1). The discussion highlights the main findings and implications from the case studies. The expanding access to and use of multiple devices is first considered (Section 7.2), followed by an overview of how students use their devices in multiple locations to perform multiple learning activities (Section 7.3). The next sections explore how students make use of different devices together, either sequentially or simultaneously (Section 7.4) and how the use of multiple devices is enabled by internet access and cloud synchronisation services (Section 7.5). Based on the results, a framework for the use of multiple devices for learning is proposed (Section 7.6). The changes in study habits due to learning with multiple devices are then explored (Section 7.7), followed by a consideration of learner support needs (Section 7.8). A continuum of seamless learners is proposed (Section 7.9). Finally, a short summary (Section 7.10) closes the chapter.

7.1 Introduction

This chapter provides a discussion of the results of the two case studies (UOC and Unisa) presented in the two preceding chapters. The general findings are synthesised from both cases. They are a result of the integration of the quantitative and qualitative findings. This study explored how students make use of different devices to support their learning practices. The findings are analysed, evaluated and interpreted. This chapter begins by discussing the increased access to and use of different devices for study purposes. The next section considers how these devices are used for study in multiple locations and to perform multiple learning activities. This is followed by a discussion of how students use their devices together, either sequentially or simultaneously. The use of devices together for learning is enabled by internet access and cloud services so the following section discusses the importance of cloud services and synchronisation tools. These findings are then consolidated into the proposal of a framework for student use of multiple devices. This is followed by discussion of the changing study habits of students using multiple devices. The next section explores how to support students using multiple devices, both academically and technologically. The final section proposes a continuum of seamless learners. A short summary then concludes the chapter.

Table 7.1 provides a summary of the main findings in each of the sections of the discussion. The two sections not included in the table refer to two contributions proposed in this chapter: the proposed framework for multi-device use and the proposed continuum of seamless learners. Each section in this chapter elaborates on the main findings highlighted in the table.

Table 7.1: Summary of Main Findings

Section	Main Findings
Access to and use of multiple devices	• ODL students access multiple devices, on average between three and four devices. The most commonly owned devices are smartphones and laptops. • Students use most of the devices they have access to for study purposes. The average student uses three devices for learning. The most commonly used devices are laptops, desktops, smartphones and tablets. • Most students have high or very high levels of expertise in using their different devices for learning, while place a high or very high value on the importance of fixed devices (laptops and desktops) for academic success.
Range of learning locations and activities	• Student study in both private (home and the homes of family/friends) and public locations (work, cafes, libraries, in-transit), but home is still the preferred location. • The more portable a device, the more places it is used for study. Desktops are used on average in one location, laptops and tablets in two locations and smartphones in three locations. • Device patterns of use are similar and different. Students view fixed devices (laptops and desktops) as central, using them for a wide range of learning activities (8-12), while handheld devices are seen as supplementary and used for fewer activities (5-7). • Desktops and laptops are used for almost all learning activities (including assessment preparation), while tablets are mainly used for consumption and communication and smartphones for communication, checking and consumption.
Sequential and simultaneous devices use	• ODL students make use of devices sequentially (moving between devices) or simultaneously (two or more devices) across time and locations for ease of use and efficiency reasons. • For sequential use, students usually move from less portable to more portable devices when moving between locations and activities or to pause/continue later or because of device features. • For simultaneous use, students usually use a laptop with a tablet or smartphone to perform complementary activities using two screens.
Internet, cloud services and synchronisation	• Moving between devices is facilitated by cloud services that enable automatic synchronisation. Cloud services (Google Drive, Dropbox) enable seamless learning. Some students rely on older technologies for synchronisation such as memory sticks. • Not all students have constant or convenient internet access, particularly in rural areas. This limits the opportunities for seamless learning, yet students can be resourceful.
Changes in study habits	• Students are able to study in more places and at more times, be more connected, be more flexible in their study choices and are more comfortable in the use of device affordances. • This means that multiple devices and the associated services can improve student productivity and help to better balance studies with other responsibilities.
Academic and technological support needs	• Educators can design more learning activities that incorporate the affordances of different devices, consider how students use devices together and consider the locations where students study. • Academic support can be improved through: explanatory video tutorials, synchronous web conferences and more personalised assessment feedback. • Technological support can be improved through: improved VLE accessibility and mobile apps, VLE design and usability improvements and discounted rates for devices, software and internet access.

7.2 Access to and Use of Multiple Devices

This section explores the devices that students have access to and their use for study purposes. Educators need to be aware of what technologies their students have access to and how they use them. This can help educators design more relevant learning experiences. The findings show that students have access to multiple devices, both fixed and handheld. While researchers in the past envisioned learners supported by one-to-one technology (Chan et al., 2006), students now have many technologies available to them. The most commonly accessed devices at UOC are: smartphones (92% of students), laptops (92%), desktops (75%), tablets (69%), e-readers (32%) and basic mobiles (15%). While at Unisa, the most commonly accessed devices are: smartphones (94% of students), laptops (90%), desktops (64%), tablets (53%), basic mobiles (35%) and e-readers (16%). In both cases, access to smartphones and laptops are both close to market saturation, while more than half of students have access to a desktop or tablet. To a much lesser extent, students also have access to other handheld devices, such as basic mobiles and e-readers. Almost all of these devices are personally owned and shared use is rare. An exception to this are desktops, which are often accessed at work or are shared with others at home. These results are close to the findings of comparable studies. These findings are similar, albeit slightly lower than the results of the 2016 ECAR study of undergraduate students in the United States, which found that 96% of students owned a smartphone, 93% owned a laptop and 57% owned a tablet (Brooks, 2016). In comparison to other studies of ODL students, the Unisa results show an increase in access to technologies compared to a previous study (Liebenberg et al., 2012). A 2016 study of undergraduate access to handheld devices at the Open University in the United Kingdom found that 82% of students owned a mobile phone (either a smartphone or a basic mobile), 58% had access to a tablet and 25% had access to an e-reader (Cross et al., 2016). A study at a dual-mode Australian university found that 95% of online/distance students accessed smartphones, 93% accessed laptops, 76% accessed desktops, 73% accessed tablets, 56% accessed MP3 players, 24% accessed basic mobiles and 23% accessed e-readers (Farley et al., 2015).

Almost all students at both case studies had access to at least two devices, while most students had access to either three or four devices. 89% of students at UOC had access to three or more devices, in comparison to 83% at Unisa. This is comparable to the findings of the 2016 ECAR study where 52% of students owned a laptop, tablet and smartphone, only 5% owned one device, while 1% owned no devices. The most common dual-device ownership was a laptop and smartphone (Brooks, 2016). Although researchers are concerned about disadvantaging students without device access and the associated connectivity (Cross et al., 2015; Liebenberg et al., 2012; Murphy et al., 2014), the findings suggest that device access is no longer an issue of concern for ODL universities and that educators can expect students to have access to a variety of devices. Although ODL universities cannot assume access to specific devices for all students (although it is likely that almost all students will have access to a laptop and smartphone), students are likely to have access to a range of devices. ODL universities should thus focus more attention on how students use these devices for study purposes and how to better integrate these technologies into teaching and learning.

As discussed in the Literature Review chapter (Section 3.2.3), ODL students are diverse. There was a wide variety of ages represented and the majority of students work as well as study. Students have access to and make use of their devices in a variety of different ways. However, different demographic factors (such as age, gender, employment status) were not found to have any impact on device access nor on device use. These findings confirm that each ODL student has their own specific needs, device types and contexts of use (Ferran-Ferrer et al., 2014).

The findings show that students not only have access to multiple devices, but that they make use of these devices for study purposes. Students use most of the devices they have access to for study purposes. The average UOC student uses between three and four devices for learning, while the average Unisa student uses three devices. The most commonly used devices at UOC are: laptops (97%), desktops (89%), tablets (87%), smartphones (82%), e-readers (63%) and basic mobiles (55%). The most commonly used devices at Unisa are: laptops (97%), smartphones (88%), desktops (87%), tablets (85%), basic mobiles (65%) and e-readers (60%). Although students have greater access to smartphones, larger devices such as laptops are used more frequently for studies. This is because of the greater functionality of these devices for learning. These results are similar to comparable studies. The 2016 ECAR study found 95% of students used a laptop in at least one course, 79% used a smartphone, 39% used a tablet and 7% used a wearable device (Brooks, 2016). In comparison to studies of ODL students, the 2016 Open University handheld devices study found that mobile phones were used less for study than tablets: 82% of students with access to a tablet used it for university study, 66% of mobile phone owners used their mobile phones for study and 42% of students with access to an e-reader used it for study (Cross et al., 2016). The 2013 study of students at a dual mode university in Australia found that 91% of online/distance students used laptops for their studies, 80% used tablets and 77% used desktops, 73% used smartphones, 25% used e-readers and 6% used basic mobile phones (Farley et al., 2015).

E-readers and basic mobile phones are infrequently used for study by the majority of students. Part of the reason why is because of the limited functionality of these devices and that students often have access to other devices that can perform the same function. For example, interviewed students referred to reading e-books using the Kindle or similar app on their smartphones and tablets. The respondents in the two case studies were asked to specify whether they used any other devices for learning. Only a few UOC students mentioned having smart TVs to watch videos and only one respondent mentioned owning a wearable device (a smartwatch). Likewise, at Unisa, only a few students mentioned the use of printers to print materials and having smart TVs to watch videos. This aligns to previous studies that found very low levels of use of wearable devices (Brooks, 2016), smart TVs and internet-connected game consoles for learning (Cross et al., 2016).

Laptops were found to be the only devices where a majority of students purchased their laptops for study purposes. 55% of UOC students and 62% of Unisa students purchased their laptops for study purposes. All other devices were mainly purchased for other reasons. This finding concurs with the finding of Cross et al. (2015), who found that the majority of students did not purchase their handheld devices for study purposes. This finding also underscores the view that educators and students co-opt technologies that were not originally intended for educational use (Traxler, 2010). Across both cases, students who did purchase tablets for study purposes were more likely to use them more frequently for study.

In terms of expertise in using devices for study purposes, an interesting finding was that the majority of students in both case studies had a high or very high level of expertise in using each device for study. For UOC students, this was found to be 93% for laptops, 92% for desktops, 68% for tablets, 64% for basic mobiles, 60% for smartphones and 52% for e-readers. For Unisa students, this was found to be 94% for laptops, 90% for tablets, 90% for smartphones, 83% for desktops, 76% for e-readers and 71% for basic mobiles. The results indicate that the majority of students do not find it frustrating or challenging to use their devices for study, unlike some previous findings in the literature (Gikas & Grant, 2013). This finding confirms that as students use their devices more for study purposes, they gain greater confidence, agency and familiarity with the technologies (Traxler, 2010). This finding suggests that the relatively lower usage of handheld devices for study is not due to a lack of expertise in using these devices for study. Across both cases, students who had greater expertise in using desktops were more likely to use them more frequently for study.

In terms of valuing devices as important to academic success, the majority of students in both case studies placed a high or very high level of importance in using laptops and desktops. For UOC students, 93% placed a high or very high level of importance in using laptops, compared to 85% for desktops, 48% for tablets, 41% for smartphones, 22% for basic mobiles and 20% for e-readers. For Unisa students, this was found to be 97% for laptops, 84% for desktops, 83% for smartphones, 79% for tablets, 66% for basic mobiles and 56% for e-readers. This finding shows that students consider fixed devices to be more important than handheld devices for study. The UOC results are particularly similar to the 2016 ECAR study which found that 93% of students considered a laptop to be very or extremely important to academic success, 46% for smartphones and 41% for tablets (Brooks, 2016). Across both cases, students who valued desktops, laptops, tablets or smartphones as being of greater importance for study were more likely to use them more frequently for study. Similarly, students who valued these four devices as being of greater importance for study were more likely to have a higher level of expertise in using each device.

7.3 A Range of Learning Locations and Activities

This section further explores students' use of multiple devices by considering the locations where they study and the different learning activities they undertake. The findings show that ODL students study in multiple locations. These locations include private (homes and the homes of others) and public locations (work, cafes and libraries). However, home is still the location most preferred for study across devices. Other common locations for study include: homes of family or friends, work, public locations with Wi-Fi (such as libraries and cafes) and in-transit. A small proportion of students also make use of regional university centres. A 2016 study of undergraduates at the Open University investigated the locations where students study using handheld devices. A difference in that study was that home use was categorised as either "quiet private" areas such as home study rooms or "communal private" areas such as living rooms. Other locations were work, in-transit, "quiet public" areas such as libraries, "communal public" areas such as cafes and being on holiday (Cross et al., 2016). Home was also found to be the most common location of study in a previous Open University study. The most common place for study using a handheld device was found to be the living or communal room at home (Cross et al., 2015).

The more portable a device, the more places it is used for study. In the UOC case, desktops are usually used in one location, laptops and tablets in two locations and smartphones in between three and four locations. In the Unisa case, desktops are used usually in one location, laptops and tablets in two locations and smartphones in three locations. Although individual students make use of their devices in each of the different locations they have access to, Table 7.2 shows the most likely locations where students use desktops, laptops, tablets and smartphones for study. Across both cases, desktops are usually used in only one location, either at home or at work. Laptops and tablets are usually used in two locations, with tablets likely to be used in as many as five locations. Smartphones are usually used in three locations, but can be used in as many as six locations. Although laptops and tablets are portable, many students use these devices mainly at home. This aligns to an Open University finding that some mobile devices remain geographically fixed (Cross et al., 2015). As smartphones tend to always be on-person, they can be used wherever a student is and therefore in a greater number of locations. Students were found to prefer using the smartphone to check for information and undertake quick or short activities across different locations. The mobility of smartphone use aligns to studies at the Open University where mobile phones were found to be used more than tablets or e-readers at work or on public transport (Cross et al., 2015). About a quarter of students used their handheld devices at home, at work and in other locations such as cafes, restaurants, libraries and on holiday (Cross et al., 2016). Similarly, students at a dual mode university in Australia made use of their mobile technologies in a variety of locations, often while waiting or in-transit (Farley et al., 2015).

Table 7.2: Likely Learning Locations for Frequent Device Users

	Desktop	**Laptop**	**Tablet**	**Smartphone**
Home	X	X	X	X
Homes of Family / Friends			X	X
Work	X	X	X	X
Public Location with Wi-Fi			X	X
University Regional Centre				X
In-transit			X	X

The findings show that the majority of ODL students study in informal learning settings, such as at home, work, in-transit or in cafes. Very little studying is done in semi-formal (libraries) or formal learning settings (university centres). Across both cases, students who use tablets and smartphones in more places are more likely to use them more frequently for study. Students were found to use their smartphones, in particular, across a greater number of locations. This emphasises the mobility of ODL students. This finding aligns to previous findings that some students transcend traditional stationary study environments and show mobility in their study routines (Andrews & Tynan, 2012; Cross et al., 2016; Murphy et al., 2014).

Educators set learning tasks for students to achieve specific educational outcomes. Students then undertake a variety of activities to achieve these tasks. The findings show students use their multiple devices to perform multiple learning activities. A list of fifteen learning activities was compiled that indicates the variety of activities ODL students perform. These activities can be grouped as follows:

- *Communication activities*: communicating with educators, communicating with students, participate in forums, participate in online meetings.
- *Consuming information activities*: read materials, listen to audio, watch video.
- *Assessment activities*: review assessment feedback, take a test/quiz, take an exam, write an assignment.
- *Search activities*: search for information, use the virtual library.
- *Study management activities*: check news/announcements, plan/organise study time.

Students across both case studies were found to use their devices to perform most of these activities. When evaluating the use of devices for each activity, one activity that was seldomly performed using a device was taking an exam. However, this is expected to increase in the future. In 2016/2017, UOC started piloting the use of online examinations through the use of different security and identification techniques (UOC Internal Communication, dated 8 June 2016, or see http://tesla-project.eu). The communication with educators and other students emphasises the social aspect of learning. Not only do students regularly communicate with educators, tutors and students, but students sometimes have to work collaboratively on projects or assessments. Searching for information online makes up an important aspect of formal studies as many students search for supplementary resources or to find support. Useful resources that are found can then be shared informally with other students. Educators need to help students to find (and evaluate) the best resources to suit their needs. This reinforces the importance of developing digital literacy skills to find and evaluate information (Chen & DeNoyelles, 2013). One additional activity that would be included in the list of activities in any future research, based on interview data, would be to “Make notes/Summarise information”. Although students usually perform one learning activity at a time, in some cases, students will perform complementary activities at the same time, such as reading materials and searching for information about what they are reading. Not all learning activities take place with the use of devices. For example, students still make use of paper and physical textbooks to perform learning activities (either with or without the use of devices). However, the use of different devices has meant that many students are doing more reading on screen (digital reading) and making less use of physical paper for reading.

Fixed and handheld devices are used in both similar and different ways and patterns of use vary among ODL students. Although each individual student makes use of different devices to support their learning in a personal way, some patterns of use can be generalised for most students. UOC students used their laptops for an average of twelve learning activities and eleven activities for desktops. Unisa students used their laptops for an average of ten activities and eight activities for desktops. Laptops and desktops are thus seen as central devices for study. The affordances of these larger devices mean that they can be used for almost all learning activities. Many students consider laptops to be the most useful tool for learning because they can be used for almost everything and are slightly more portable than desktops. Desktops and laptops are used in similar ways for a broad range of activities, including production and assessment activities such as writing assignments. Students prefer using these devices for writing because of the larger screen and dedicated keyboard (easier to type) as well as the relevant software. The widespread use of laptops and desktops for study is congruent with the findings from other studies. At a dual-mode university in Australia, laptops were found to be used for the majority of learning activities, highlighting that it is the dominant technology used by most students for learning purposes. Laptops were mainly used to access course materials, access the VLE and complete assignments. Desktops were used to access course materials, search the internet and email educators and students (Murphy et al., 2014). Another study at an Australian campus university also found that larger devices with keypads were preferred for assignment preparation (Reid & Pechenkina, 2016).

Handheld devices (tablets and smartphones) are used for a smaller range of activities than the larger devices, with UOC students using tablets to perform six learning activities and smartphones to perform five activities (on average). Similarly, UOC students use tablets to perform seven learning activities and smartphones to perform seven activities. Handheld devices are mainly used for communication, checking and consuming information activities. They are very seldomly used for writing activities. This is because of the small screen size and typing is slow or uncomfortable. A major difference in use compared to fixed devices is that handheld devices are favoured for very quick or short activities, while larger devices are preferred for more complex activities. This is because handhelds are easy to use and quick to access in a number of different contexts. These findings are similar to the findings of an Open University study that looked at the use of tablets and smartphones for three common learning activities: reading materials, preparing assignments and accessing discussion forums. Tablets were mainly used for reading followed by accessing forums. Smartphones were used less for these two activities. Tablets and smartphones were seldomly used to prepare assignments. Handheld devices were found to be underutilised for assessment purposes, while the researchers acknowledged that some students may prefer to write assignments using the keyboard of a laptop or desktop. The researchers concluded that the relative lack of use of tablets and, to a lesser extent, smartphones for study indicates that barriers remain (Cross et al., 2016).

Tablets and smartphones were found to be popular devices for consuming information in both cases. The reasons include that these devices are portable and can be used in a variety of locations. Information can also be very quickly accessed when using these devices. The communication features of a smartphone also leads this device to be useful for communication activities. Students particularly valued the smartphone to be kept up-to-date and to quickly communicate with others. However, handheld devices can be used very differently by students depending on their view of the role of the device. Some students preferred to use their handheld devices for a few simple and quick activities, while other students made use of their handheld devices more frequently and for a greater range of learning activities. For example, although some students have difficulty reading text on the smaller screens, other students are happy to read materials using these devices, echoing the findings of previous researchers (Kukulska-Hulme, 2010). These findings are similar to other studies in the literature. The use of handheld devices enable students to consume different kinds of information, almost instantaneously and wherever they are (Traxler, 2010). A study of medical students in the United States found that learners only used some features of mobile devices frequently such as browsing and email, while less frequently using them for reading and note taking. The same study found learner approaches to using mobile devices to be heterogeneous. Students use mobile devices in very different ways and to different extents, both out of individual choice and in response to different environments. Some use them regularly for many activities, some infrequently for one or two tasks (Ellaway et al., 2014). Handheld devices were found to be used for reading and accessing social media in a study at an Australian campus university (Reid & Pechenkina, 2016). In a study at a dual-mode Australian university, tablets were used mainly for accessing course materials, searching the internet and taking notes (Murphy et al., 2014).

In addition to tablets and smartphones, students do sometimes use other handheld devices. However, basic mobile phones and e-readers are used in very limited ways for learning across both cases. This is because of the limited functionality of these devices. Basic mobile phones are mainly used for communication, while e-readers are mainly used for reading materials. This matches a finding in the Open University study where e-readers were only used for reading materials (Cross et al., 2016).

As shown in the previous paragraphs, students make use of their devices in a variety of ways. However, the use of devices is more complex and nuanced than using each device in a set manner. A framework proposed for using different devices (the laptop to manage, the tablet to immerse and the phone to check) (Ferran-Ferrer et al., 2014) was found not to significantly capture the variety or nuances in the use of different devices. Although each student uses their devices according to their needs, general patterns of use for desktops, laptops, tablets and smartphones can be summarised for most students in both cases, as shown in Table 7.3. This table shows that desktops and laptops are used very similarly, for a wide variety of learning activities, but are particularly valued for reading and writing. Tablets and smartphones are used more for consuming and checking information as well as communication activities. Examples of common learning activities are provided for each device. As a similar activity across devices, all devices are commonly used to search for information online.

Table 7.3: Main Uses of Devices for Learning

Device	**Learning Uses**	**Common Learning Activity Examples**
Desktop	Used for almost all learning activities.	Read materials Search for information Write assignments
Laptop	Used for almost all learning activities.	Read materials Search for information Write assignments
Tablet	Used mainly for consuming information (reading, watching videos) and communication activities (email, discussion forums).	Check news and announcements Read materials Search for information
Smartphone	Used mainly for communication activities (email, discussion forums, WhatsApp), checking information and consuming information (reading, watching videos).	Check news and announcements Communicate with other students Search for information

While handheld devices are used in more limited ways than larger devices, they can be used as substitutes for larger devices when other devices are not available. As long as students continue to value the use of handheld devices as supplementary, while valuing larger devices as central for study, the use of handheld devices in academics will remain lower than the use of fixed devices. The supplementary role of handheld devices is congruent with findings from a study of medical students they were used to augment and not replace laptops. Learners were found to use handheld devices strategically, using them when there was an educational advantage (Ellaway et al., 2014). Handheld devices are often used for migrated activities, that is, activities previously undertaken on larger devices. Yet alongside migrated activities, handheld devices enhance the study experience by "undertaking activities the student would not otherwise have done" (Cross et al., 2015, p. 13). Several examples were found in the case studies of students using handheld devices in emerging ways. The first example of this kind of use is the reliance of students on WhatsApp and other social media to communicate with other students synchronously to help or support each other. The second example is the use of smartphones to self-record video presentations or to take pictures, sounds or videos of activities or evidence. These records can be used together to create multimedia presentations. The third example is the use of different devices together (discussed in the next section (Section 7.4)). The use of particular features of smartphones have been raised in the literature. In an Australian dual-mode university study, smartphones were mainly used for engagement with peers or educators through email and social media and taking photos or videos to support learning (Murphy et al., 2014). Mobile devices enable students to capture data such as images, sounds, voices and other data (Traxler, 2010).

Across both cases, students who used desktops, laptops and tablets for a wider range of activities were more likely to use them more frequently for study. Similarly, students who used desktops and tablets for a wider range of activities were more likely to have greater levels of expertise in using these devices for study. Students who used desktops, laptops, tablets and smartphones for a wider range of activities were more likely to value them as important for study. Students who used tablets for a wider range of activities were more likely to use them in a greater number of locations. This finding is similar to the finding at the Open University where a strong significant association was found between geographic reach of study and the range of activities performed using handheld devices (Cross et al., 2016).

Students were also found to use their devices for slightly different activities in different locations. The activities that are performed in various locations using different devices can create new contexts of use, particularly in the development of study routines. For selecting a device to use at a particular time, ODL students are influenced by their location or environment, the learning activity to perform and the amount of time they have. This aligns to the findings from the Open University where it was found that students who use handheld devices across multiple locations experience changes in how, where and when they study (Cross et al., 2016). Similarly in a study of medical students, learners were found to adapt their use of mobile devices to the learning cultures and contexts they found themselves in (Ellaway et al., 2014). A study of mobile devices at an Australian university found that the use of available devices was shaped by students' immediate needs and technological habits. For selecting a device for mobile learning students were influenced by their experience with similar devices and the level of fit-for-purpose of the device. Other considerations for students included brand loyalty or operating system preference as well as the device functionality and compatibility with the institutional VLE (Reid & Pechenkina, 2016).

7.4 Sequential and Simultaneous Device Use

Although the use of one device at a time is more common, students do make use of different devices at different times or locations to complete learning activities. This section explores how students use their devices together, using a classification of how consumers use their devices (Google, 2012). Students sometimes start a learning activity on one device and then continue or end the activity on a different one. This can be characterised as sequential use of devices. Students move between devices for practical reasons, to make use of devices they have access to at that time or at that location to take advantage of available time for study. Sequential use is also performed because of the intended learning activity. Another reason for moving between devices is because of features of the device, such as screen size or internet access. This may also include the quality of the device (age, cost or processing speed). Generally, in both cases, students start on handheld devices and continue or end on fixed devices (moving from more portable to less portable devices). The main reasons are because (i) students usually have their portable devices with them (such as a smartphone) while on the move and can then switch to a larger device when in a more stationary environment; and (ii) students can quickly check information on their smartphones and tablets and then move to larger devices for more complex activities, such as writing. Across both cases, three main situations of sequential usage were identified:

- Moving between locations (e.g. work to home).
- Moving from one learning activity to a related activity (e.g. move from reading to writing).
- Pausing an activity and continuing the activity at a later stage.

Unisa students also identified a fourth situation of sequential usage: moving to a different device because of device features (such as limited battery or internet access).

Students also make use of multiple devices at the same time for learning. Students sometimes use two or more devices at the same time. This can be characterised as simultaneous use of devices. Students use two or more devices at the same time because of ease of use and to be efficient in their studies. They are able to view “two screens” at the same time to perform complementary activities, or a main activity supported by a supplementary activity. This is a form of multi-tasking, yet it is multi-tasking to achieve a specific academic purpose. Most students made use of their devices together to perform complementary activities or a combination of complementary and multi-tasking activities. In addition to the devices, students may make use of paper materials (such as textbooks or printed study guides) at the same time. The most common devices to use together at UOC are: (i) a laptop and smartphone; (ii) a laptop and tablet; or (iii) a desktop and laptop, while the most common devices to use together at Unisa are: (i) a laptop and smartphone; (ii) a laptop and tablet; or (iii) a laptop, tablet and smartphone. These combinations again emphasise the central role of laptops for study and the complementary role of handheld devices. It must be noted that not all students use their devices together. For example, students with dual monitors (either with a desktop or laptop) make use of the dual screens to undertake many of the same activities as students using two devices at the same time, while some students prefer using only one device at a time. Across both cases, three main instances of simultaneous usage for multiple activities were identified:

- Writing an assignment on one device and searching for information or reading materials on another device.
- Watching a video on one device and making notes on another device.
- Writing an assignment on one device and communicating with other students on another device.

Unisa students also identified a fourth situation of simultaneous usage: reading materials on one device and searching for information on another device.

Students who study using devices sequentially are also likely to make use of devices simultaneously. The greater the number of devices that students use for learning, the more likely students make use of these devices together, either sequentially or simultaneously. There are no previous studies that have specifically explored how students use different devices together. However, the findings match an Australian campus university study (Reid & Pechenkina, 2016) which found that that students tend to use their devices simultaneously and in a complementary manner, rather than using one device for all learning activities. Students felt that having additional devices improved their productivity, efficiency and helped them multi-task better.

7.5 Internet, Cloud Services and Synchronisation

This section explores the associated services that are intertwined with multiple devices. It examines internet access, the use of cloud services and the role of synchronisation tools. The movement between devices is facilitated by cloud services that facilitate automatic synchronisation across devices. The cloud is the key enabler for switching between devices so that students can continue exactly from where they left off. This is the fulfilment of the aspiration of seamless learning. These services also facilitate collaborative work. The benefits of cloud services are that students can access prior work, have information backed up and easily integrate new ideas. Students are able to act on an idea with immediacy, to make adjustments to assignments, to record or share ideas, wherever they are situated (Barden & Bygroves, 2017; Sharples, 2013). UOC students revealed that the most useful tools for accessing and storing resources across devices was the VLE, followed by Google Drive and Dropbox. Similarly, Unisa students also revealed the importance of these tools. However, the most important tool for Unisa students was a USB flash drive, indicating that students could not always rely on internet services. While cloud services are often used to move between devices, some students still rely on older technologies such as email or USB/flash drives to move information between devices. As students increasingly rely on cloud services and other technologies to enable seamless learning, universities should ensure that students have access to these services and are able to use them to support their learning.

The use of cloud services assumes constant or at least convenient internet access. This was not found to be an issue for UOC students, however, it was an issue for some Unisa students. Students mainly accessed the internet at home via ADSL or Wi-Fi or made use of mobile data packages. Internet access via handheld devices was considered critical for students without regular internet access for larger devices. For students who rely on mobile data packages, data can be very expensive. Rural area students were also limited by the quality and speed of internet access. These findings echo previous findings at Unisa, where access to the internet needs to address more than physical access, but also issues of quality and affordability (Liebenberg et al., 2012). As a confirmation of the resourcefulness of ODL students

(Andrews & Tynan, 2012), some Unisa students found ways to overcome challenges in internet access by, for example, submitting their assignments using their mobile phones or setting up mobile hotspots.

As noted by Traxler (2010), not only are the devices themselves important, but so are the associated software and services. Across devices, students particularly value specific software and applications that enable them to perform their learning activities. The most useful categories of tools for UOC students are: i) cloud storage and collaboration tools; ii) PDF readers/editors; iii) the VLE; iv) word processors; and v) web browsers. For Unisa students, the most useful categories of tools are: i) PDF readers/editors; ii) word processors; iii) search tools; iv) web browsers; and v) office packages. These findings indicate that for reading materials, students value PDF readers or editors, while for writing assignments, students value text editors and other office tools. Students also require applications for using the internet, such as browsers and search engines that enable them to search for and access information. Another important application is the VLE where students can access materials, submit assessments and interact with educators and other students. As noted above, students also rely on cloud services for storage and collaborative activities. These findings, together with the internet access challenges highlighted above, suggest that ODL universities need to support their students in accessing and using affordable and high-quality internet services. Universities can support students through negotiating with Mobile Network Operators (MNOs) for VLEs to be zero-rated or provide students with information on how to manage data services and reduce data consumption. For example, in South Africa during the #FeesMustFall protests in 2016, MNOs zero-rated some university websites (and VLEs) for a limited period (Lotz, 2016), while one MNO later zero-rated 19 of the 23 public university websites ("Vodacom zero-rates data charges", 2017).

7.6 A Framework for Student Use of Multi-Devices for Learning

The findings from the previous sections have been consolidated to propose a framework for the frequency of multi-device use for learning. This framework is based on the synthesis of both quantitative and qualitative findings. Figure 7.1 shows the proposed Framework for Student Use of Multi-Devices for Learning. The figure shows that the main influencers of how frequently a particular device is used for learning are:

- The location or environment of the student. Locations include private (such as home) and public locations (such as work, cafes or transport). Portable devices are used in more locations than fixed devices.
- The learning activity or goal to achieve. Students may perform a variety of different activities such as communication, consuming information, preparing assessments, checking or searching for information and other activities. Sometimes students may perform some of

these activities together at a time. Larger devices are used for a wider range of activities, while handheld devices are used for more specific activities.

- The devices the student accesses and uses for learning. These devices can include fixed devices as well as handheld devices. Students can either make use of their devices separately or together.

However, these are not the only influencers on how often a student uses a device. To a lesser extent, the use of a specific device for learning is also influenced by several other factors:

- The time available or needed to perform a learning activity. Students may want to quickly take advantage of a few minutes of spare time or set time aside for more complex learning activities.
- The perceived importance of the device to academic success. The greater the value of importance towards academic success, the more frequently the student will use the device.
- The level of digital expertise the student has. This is related to digital literacy skills. The higher the level of digital expertise, the more frequently the student will use the device. Furthermore, the routine use of specific devices for learning will in turn improve levels of digital expertise as students become more comfortable.
- The device affordances affect the use of the device. This includes uses relating to physical features (such as screen size, the associated software/apps and services) as well as the quality of the device and the type of internet access (cost, quality and available synchronisation services).

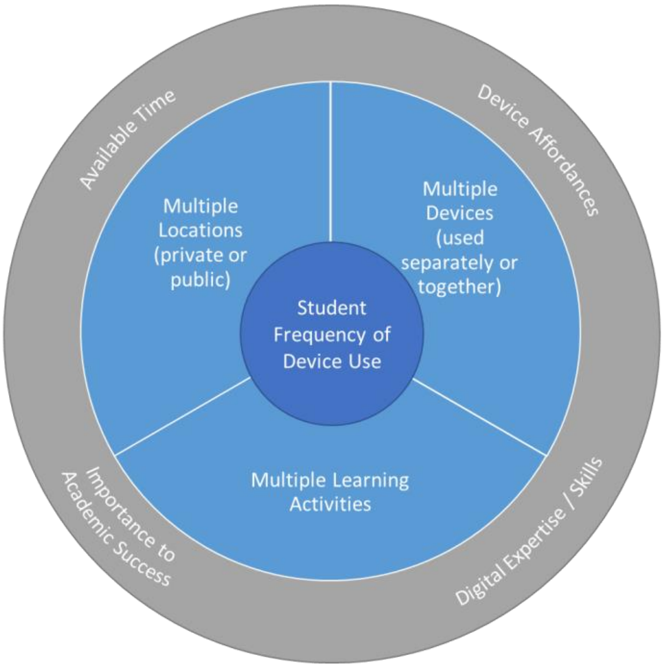

Figure 7.1: Framework for Student Use of Multi-Devices for Learning

The purpose of this framework is to assist educators to design more effective learning experiences or offer better learning support for ODL students using multiple devices. This framework can be applied by educators and universities to cater for changing study habits brought about by the use of multiple devices and the associated services (discussed in the next section (Section 7.7)). Educators can consider how, when and where their students perform the proposed learning activities. This information can be included in any course descriptions of the proposed learning activities. For example, a student taking a bus home from work, may use his/her smartphone to quickly check the VLE to see if an assignment mark has been posted. Or a student at home may wish to begin writing an assignment that is due shortly and will choose to use their laptop to perform this activity. More general descriptions of this sort can be included in any student orientation information or as part of the study skills information provided in counselling or guidance services.

This framework builds upon the work of Wong & Looi (2011) and their Mobile-assisted Seamless Learning (MSL) framework as it focuses on learners, pedagogy (learning activities) and technology (multiple devices). It specifically addresses how students can make use of multiple devices and the associated services (either formally or informally) to learn seamlessly. It also expands on how students perform multiple activities using their devices. All ten dimensions of seamless learning emerged in the findings from this study. Building on the MSL framework, the proposed framework considers how students learn across times and locations. It also considers the combined use of different device types to enable students to switch between multiple learning activities, supported by internet access to learning resources. Some of these activities are personal, some are social. This can lead to the knowledge synthesis described in the MSL framework. The proposed framework focuses on how frequently students use their devices for study due to the device types, locations and activities. It also considers the auxiliary influencers of device importance, level of digital expertise and device features. A benefit of this framework is that it can also be used within different pedagogical approaches.

The proposed framework also builds on the work of Koole (2009) and the Framework for the Rational Analysis of Mobile Education (FRAME) model. The purpose of the FRAME model is to assist educators to design more effective mobile learning experiences within an ODL context. This is done by considering three aspects: i) how mobile devices are used for learning activities; ii) how mobile devices enable communication and collaboration with multiple individuals and systems; and iii) how learners interact with the educator, other students and the materials. Although the proposed framework does not have a specific category for the social aspect, the findings have shown how ODL students communicate with educators, with other students and within informal networks. Students also sometimes work together on collaborative projects. This framework considers how different devices are used for different learning activities, but broadens the device aspect to include fixed technologies as well as handheld devices and also focuses on how devices are used separately or together.

7.7 Changes in Study Habits Due to the Use of Multiple Devices

The findings demonstrated that the use of multiple devices, supported by the associated software and internet services, is changing the study habits of ODL students. This section explores these changes. The use of multiple devices, together with cloud services has enabled the achievement of seamless learning, where students are able to study in more places and at more times and easily switch between different scenarios (Chan et al., 2006). Across both cases, the main changes in study habits were found to be:

- Students are able to study at more times (take better advantage of available time to perform learning activities).
- Students are more connected to courses and can more easily keep up-to-date with course activities.
- Students are increasingly flexible in how and when they study and make more choices (more autonomous in terms of decision making).
- Students are able to make use of different device features for study (e.g. make use of mobile devices to record presentations of themselves or create multimedia presentations).
- Students are reducing their usage of paper and increasingly reading digitally.
- Studies are increasingly more integrated into student lives (learning is no longer seen as needing to occur in set or separate times).
- Students adapt or change their study habits to what works for them in their contexts (such as the integration of newer technologies).

These changes highlight that the opportunities provided by multiple devices enables more seamless learning, leading to more extensive and combined use of technologies. Some of these changes in study habits are due to the specific affordances of different devices. Similarly, the Open University study found that students believed that study materials were more accessible from handheld devices (instead of students carrying books around) and that students used audio materials for reflection or voice dictation to record ideas (Cross et al., 2015). A follow-up 2016 study found that approximately half of students with access to handheld technologies indicated that their study habits had changed as a result of using their handheld devices for study. The researchers also found that students who perceived a change in study habits used their handheld devices in more locations (than those who did not) and performed a greater range of activities (Cross et al., 2016). Another study found that greater versatility in the use of different technologies was regarded to be beneficial for future professional prospects (Reid & Pechenkina, 2016).

There are a few implications from the findings about changes in study habits. Due to multiple devices and the associated services, students can be more connected and have more time to study. This means that students are more productive in their studies. Students are able to study at different times, thus achieving a better balance of studies and the management of other commitments. This may reduce student dropout. Some of the above changes in study habits have been observed in other studies, particularly regarding the use of handheld devices. However, a combination of different device types and internet services have amplified these changes. A 2013 study of undergraduates at The Open University found the most common benefits of using a handheld device for formal study to be (i) use in more places, (ii) greater portability and (iii) increased access. This indicated that handheld devices opened up more "spaces" for study and increased the number of study opportunities in a day. Students may not make use of this time, but an increase in study times provides students with more choices and therefore greater control of where and when they study. This could lead to a reduction in student anxiety and workload pressure (Cross et al., 2015).

The findings have shown that there is a blurring of formal and informal learning practices. Students are connected in terms of interacting formally with the university, educators and other students, while also interacting informally with other students as well as making use of online and personal networks (such as support communities and WhatsApp groups). Students make use of both formal institutional technologies, such as the VLE, as well as informal technologies (such as cloud services, browsers and other apps). These findings confirm that ODL students are connected (Andrews & Tynan, 2012). Many students also rely on finding supplementary resources such as YouTube videos, articles and online forums to help them understand concepts or topics better. These resources could be both formal (such as designed by other universities) or informal. There is also a social aspect to the learning of ODL students as they communicate with educators and other students. These findings are confirmed in the literature where mobile access increases support networks and communities (Kukulska-Hulme, 2010) as well as bridges formal and informal learning (Conole, 2014; Lai et al., 2013).

However, not all the associated changes with the use of multiple devices are necessarily positive. The constant connectivity and integration of learning with other aspects of ODL student lives means that the use of devices can be distracting for some students. This was echoed in the findings of a study at an Australian university where mobile devices were found to be distracting for some students in terms of constant connectivity and easy access to social media (Reid & Pechenkina, 2016). Similarly, a study at an English university found that there can be an element of "frazzlement" when combining studies with work and family responsibilities, together with the constant connection of technologies (Barden & Bygroves, 2017).

The changes in study habits discussed above have implications for ODL university teaching and learning. One implication is that ODL universities should share these positive study habits with their students to help them further develop these study skills. Another implication is that as students change their study habits, universities need to reconsider their teaching and learning processes so that they can effectively support their students. The next section discusses the support needs of students and highlights some of ways that students using multiple devices can be effectively supported.

7.8 Academic and Technological Support Needs

This section considers the academic and technological support needs of ODL students using multiple devices. Due to the changes occurring in study habits because of the use of multiple devices, educators need to consider how learning experiences are designed and how ODL students are supported to meet their needs. According to student responses at UOC, most educators (67%) do not take students' use of multiple devices into account in the design, facilitation or support of learning experiences. This was similar to the feedback from Unisa students, with a slightly lower majority of educators (55%) not taking students' use of multiple devices into account. This confirms the finding of previous studies that very few educators take advantage of the affordances of mobile technologies in teaching and learning. For example, Farley et al. (2015) found no examples of educators actively enabling or facilitating mobile learning in their courses. Similarly, Ellaway et al. (2014) found a lack of engagement or the lack of expectations that educators should engage with their learners' educational use of handheld technologies. This is a major challenge as students often turn to educators for guidance and encouragement around the use of their devices for learning (Chen et al., 2015).

It can be concluded that the use of mobile devices and the associated connectivity has not yet extensively influenced the educational models of the ODL case universities. Although the majority of students view handheld devices as supplementary devices for learning, universities and educators can make greater use of these technologies in teaching and learning processes. While ODL universities have developed some mobile apps, and made their VLEs accessible from mobile devices, much more can be done to take advantage of the handheld devices (and the associated services) that students carry with them.

Although not many educators support students using multiple devices, some educators make use of different techniques to support students using different technologies. Some of the techniques identified by students in both case studies include:

- Resources are made available in different formats (e.g. html, text, PDF, epub) so that students can access and utilise the resources in the easiest way for them.
- Resources and learning activities are accessible from different devices (e.g. mobile versions of the VLE are available).
- Educators design learning activities that require students to work collaboratively using tools that support collaborative work (such as wikis, Google Drive, WhatsApp).
- Educators design learning activities that require students to develop multimedia projects (e.g. deliver a project using video, text and audio).

However, these techniques need to be implemented across the university to truly benefit students so that there is uniformity in student experiences that match their expectations. As noted in the literature review chapter, learner support needs to be integrated into the design of the learning experience. Some of the techniques suggested above by students for better support in the use of different devices have previously been identified in the literature for supporting students using handheld devices. For example, Farley et al. (2015) provided several recommendations for educators to support mobile learning. These recommendations included providing course materials in multiple file formats (such as text in html, .doc, PDF or epub formats) and ensuring VLEs are mobile-friendly so that students can access course materials from mobile devices. Another recommendation, to encourage students to form informal groups using social media (such as Facebook) to help students communicate and collaborate informally with their peers, was found to be in place in the case studies, with many students creating informal WhatsApp groups to support each other. Farley et al. (2015) proposed further recommendations for supporting students in using mobile devices that can also be applied to the use of multi-devices:

- Recommend mobile-friendly resources to students, such as supplementary video resources on YouTube.
- Recommend useful apps to help students with various study activities and the use of discipline-specific apps.

Learner support incorporates both academic/pedagogical and technical support. This support has to address the needs of learners. To obtain academic support, students in both cases make use of different means, both formal and informal. When faced with challenges related to studying, students make use of different strategies to obtain support. Usually, students try to help themselves first by reviewing all the provided materials. Students then rely on formal / university support mechanisms by using the VLE discussion forums or emailing the educator. Students also make use of informal support mechanisms such as personal networks to reach out to family, friends or other students. Usually this is done via WhatsApp, telephone calls or email.

Although many students are satisfied with the level of support provided by the university case studies, educators can better nurture seamless learners through providing appropriate academic support. Students from both cases recommend the following ways for ODL universities and educators to improve academic support:

- More use of short explanatory video tutorials.
- The use of synchronous web conferences (recorded and made available for students unable to attend).
- More personalised assessment feedback.
- Greater use of audio-visual materials.

Additionally, UOC students recommended the use of notifications of or subscriptions to receive course announcements and updates via handheld devices. Unisa students further recommended the improvement in the speed of communication services with educators. Some of these recommendations are supported in the literature. Increasingly, students are using video-sharing websites such as YouTube to find videos to supplement their study materials (Henderson et al., 2015), revealing the need for more audio-visual resources. The use of mobile device notifications have shown to be useful in the self-regulation of learning (Tabuenca et al., 2015).

Similar to academic support, students in both cases make use of different means of obtaining technological support (both formal and informal). Depending on the type of technical challenge, students look for support in different ways. Students very often try to help themselves by searching for information or "googling". Students then make use of formal university support mechanisms by checking discussion forums or emailing the educator. Or students choose to rely on personal networks to obtain help, reaching out to family, friends or other students. This finding reinforces results of previous studies that found learners make use of multiple sources of support, including online sources, fellow students, family and friends (Andrews & Tynan, 2012; Dahlstrom & Bichsel, 2014; Ellaway et al., 2014; Newman & Beetham, 2017).

Although many students are satisfied with the level of technological support provided by the university case studies, educators can better nurture seamless learners through providing appropriate technological support. Students recommend the following ways for ODL universities and educators to improve technological support:

- Improve the accessibility of the VLE from different handheld devices.
- The need for general improvements to the design and usability of the VLE.
- Offer discounted rates for devices, software or internet access (through greater purchasing power).
- Provide digital skills courses or information to help improve digital literacy skills.

Additionally, UOC students suggested a need for the improvement of the VLE mobile app, the need for particular support for using specific devices or tools to achieve course objectives and improvement of the awareness of formal university means of technical support. Unisa students raised the need for a VLE mobile app and for greater support in managing internet access and the associated costs.

ODL universities are endeavouring to constantly improve their VLEs. For example, UOC unveiled a new VLE interface in 2017 that is more accessible and responsive, to be better suited to mobile devices (UOC Internal Communication, dated 5 September 2017). In terms of skills in using devices and digital literacy skills, previous studies have noted that technological skills training needs to focus on more just than software or application knowledge and skills, but consider the use of different devices as well as security and ethical issues (Brooks, 2016). Adequate technical support is necessary for students to effectively use their devices for learning (Cheung 2012). Although most students were found to have good digital expertise levels in using their devices, universities can offer more or better technology training as part of student orientation (Brooks, 2016) as well as specific contextual support for various course activities. For example, students can be provided with examples of how and when to use specific technology within a course or for a particular assessment activity. If activities are designed that require the use of handheld devices, these need to be clearly linked to overall course outcomes (Reid & Pechenkina, 2016). Issues relating to the support of internet accessibility were discussed in Section 7.5.

In order to better support students using multiple devices, educators need to recognise that students make use of different devices and to understand which technologies students are using and how they are using them. For example, educators need to consider how students make use of their time and the realities of their lives (Kukulska-Hulme, 2010). This speaks to being aware of student experiences and expectations for using different technologies for learning. However, this is a process that requires regular review as both technologies and patterns of use will change over time. Educators can then design/facilitate learning experiences that enable students to make use of different devices. This does require an evaluation of current teaching and learning approaches. This finding was supported by two previous studies (Cross et al., 2016; Farley et al., 2015). Students' use of mobile devices requires educators to rethink their teaching and learning approaches and the (traditional) methods they use to teach students by exploring alternative pedagogies to meet their students where they want to learn. Educators also need to become skilled in mobile learning design and delivery (Farley et al., 2015). The greater integration of different devices in learning requires the development of appropriate and effective learning and assessment designs, pedagogical practice and learning resources (Cross et al., 2016). However, higher education institutions do need to balance the insights obtained from the behaviour and locations of online students using different devices with concerns of surveillance and privacy (Traxler, 2010).

There are three changes that educators can make to their pedagogical approaches to better support the needs of students using multiple devices: i) design learning activities that incorporate the affordances of different devices; ii) consider how students may use different devices together; and iii) design learning activities that consider the different locations frequented by students and the devices likely used in these locations. These changes are further described: Educators can design learning activities for students to make use of the features of different devices. For example, instead of requiring students to submit only written assignments, students can use their mobile phones to take pictures or video using the camera feature, or record audio using a voice recorder app. Educators can also design learning activities that enable students to use their devices together (either across or between devices).

For example, educators can design materials that have certain natural break points, where students can stop and then easily continue from where they left off at a later stage. Or students can record images and audio via their mobile phones and then transfer this data to laptops for further editing or integration with written information. Educators can design certain activities that enable students to learn in different locations. For example, the use of audio for when students use headphones with their handheld devices in public locations or the creation of audio content / podcasts for students in metropolitan areas to listen to during commutes (depending on student context). Educators could promote certain activities that do not require internet access that students can perform when they are in locations without internet access. The change of pedagogical practices to consider the features of technologies has been raised by different authors in the literature. For example, Murphy et al. (2014) and Newman & Beetham (2017) challenge educators to create learning activities that better utilise the multi-functionality of different devices, while Barden & Bygroves (2017) provide an example of a student using smartphone's camera to take photographs of images and edit the images using a graphic design app. Fidaldo & Thormann (2017) recommend the use of alternative assessment formats in addition to written assignments to promote better learning, while Laaser & Toloza (2017) suggest that student-generated video can document student contributions and environments.

One of the implications of the findings in this section is that universities need to support educators to develop skills in the design and support of learning for different devices (Farley et al., 2015). One of the areas that could be affected are staff development initiatives. Educators can also work with learning designers or support centres to redesign courses that take advantage of available technologies, as suggested by Brooks (2016).

7.9 Continuum of Seamless Learners

The concept of seamless learning usually refers to the use of mobile devices to enable the continuity of learning across different contexts (Chan et al., 2006). However, this study argues that the use of mobile devices by themselves will not be able to achieve the goals of seamless learning. This is because many students see handheld devices as supplementary, while valuing larger devices as central for study purposes. Therefore, the use of multiple devices (both fixed and handheld devices), supported by cloud services, have made it possible to achieve the aspiration of seamless learning. For example, this study found that learning takes place at home, at work and in other locations. Students are able to move between these physical places, as well as virtual spaces, such as the VLE. Students mainly learn individually, but also sometimes in groups. Students are supported by educators, other students, family members and wider online communities. Thus, the majority of students, supported by technologies, can learn in different contexts, but more importantly, are able to maintain or continue learning across contexts. However, this does mean there is a minority of students who currently cannot learn seamlessly.

The Mobile-assisted Seamless Learning (MSL) Framework (Wong & Looi, 2011) provided the dimensions that make up seamless learning. This research has confirmed these ten dimensions apply in an ODL context and that ODL students learn across times and locations, and that students are able to seamlessly switch between multiple learning activities due to the combined use of multiple devices and supported by ubiquitous access to learning resources.

The findings have also shown that ODL students develop their technology-based learning practices over time (as proposed by Sharpe & Beetham, 2010). This is the case for the use of multiple device use. Students have functional access to the technologies, resources and services they need. They are also developing their skills to use these technologies in different contexts. This has led to the development of learning practices (informed choices about how to use technologies) in response to their needs. There is also evidence of some learners being able to create their own learning environments (creative appropriation). As previously discussed, educators need to support their learners in developing these practices.

Although the MSL Framework provides an overview of the dimensions that support seamless learning, it does not consider the different characteristics and contexts of ODL students. The results from this study have led to the proposal of a continuum for seamless learners. ODL students do not neatly fit into a typology of "seamless learning", hence the proposal of the continuum in Figure 7.2 that shows the degree to which learners can learn seamlessly. Individual students may place themselves at a particular point along the continuum, rather than at one end. Some students are able to more easily achieve seamless learning (seamless learners), while the learning of other students has clear "seams" (discontinuous learners).

Figure 7.2: Seamless Learner Continuum

Some students are able to learn more seamlessly than others. In addition to device access, connectivity and other factors, learner characteristics and differences play a role. Students who are able to learn more seamlessly typically make use of three or more devices for study and make use of automatic synchronisation and cloud services to easily move across devices, locations, times and learning activities. These students may have high digital literacy skills. They may have greater capacity for multi-tasking as well as being more self-regulated learners. At this side of the continuum, internet access can be considered as a given. At the other end of the continuum, discontinuous students are not able to learn seamlessly and move with great difficulty across devices, locations, times and learning activities. These students typically have access to one or two devices. Internet access may be intermittent or expensive and so students rely on older technologies (like USB drives) to manually synchronise across devices. These learners may have lower digital literacy skills or are less autonomous learners. However, more representative of ODL learners is that their study habits are likely to exist at various points between these two ends of the continuum. Not only that, but the position of each student will move along the continuum, depending on their location, the learning objective they intend to achieve and the device(s) and tool(s) they are using at a particular point in time. In supporting students, educators and ODL universities need to recognise that students in a particular course may exist across this continuum and that students need to be supported in different ways. Students require different levels of support, those learners who are closer to the discontinuous side of the continuum will require greater support from educators.

7.10 Summary

This chapter has presented the general findings from this research study and connected the findings to the current literature. A table summarising the findings for each section was presented. The chapter began by discussing ODL students' access to and use of multiple devices. Most ODL students have access to three or four devices, with smartphones and laptops being the most accessed devices. Lack of access seems to no longer be an issue and universities need to focus more on how students use their devices for learning. Students mostly use their devices for learning, with the average student using three devices for learning. The majority of students believe they have high levels of expertise in using their devices for learning, while student value their fixed devices (laptops and desktops) as being important to academic success. The next section explored how students use their devices in multiple locations to undertake multiple learning activities. Students study in both public and private locations, with home being the most common location. The more portable a device is, the more locations it can be used in. Students make use of devices in different ways. Fixed devices (laptops and desktops) are used for almost all learning activities and are seen as central devices for studying, while handhelds (tablets, smartphones) are seen as supplementary devices and are used for fewer activities, mostly communication, consumption and checking. In addition to using devices separately, students sometimes use their devices together across times and locations. Students use their devices sequentially and simultaneously because of ease of use and to be efficient. Patterns of sequential and simultaneous usage were discussed.

The findings from this study were consolidated to propose a framework for the frequency of multi-device use for learning to assist educators to design more effective learning experiences for ODL students using multiple devices. Several changes in study habits were identified due to the use of multiple devices and the associated services. These changes highlight that students are more productive and are able to better balance study and other responsibilities, potentially reducing the risk of drop-out. Thus, ODL universities need to reconsider to their teaching and learning processes to better support student needs. The academic and technological support needs of students using multiple devices were discussed. Some of the pedagogical practices to change are designing activities using the affordances of different devices, considering how students use devices together as well as the learning contexts where students use their devices. The use of multiple devices (both fixed and handheld) supported by cloud services has enabled the achievement of seamless learning. The final section proposes a continuum of seamless learners that shows how easily students are able to learn seamlessly, based on their contexts and practices. The next chapter will specify the general conclusions from this research study.

Chapter 8

Conclusion

This chapter introduces the main conclusions of the study (Section 8.1) and then provides a summary of the research aims and processes (Section 8.2). The conclusions of the study are explained to address the research questions (Section 8.3), followed by an overview of the implications thereof for educational practices (Section 8.4). The next section provides the main contributions of this study (Section 8.5). This is followed by a consideration of the limitations of the study (Section 8.6) and possible future research directions (Section 8.7). A few final thoughts then conclude the thesis (Section 8.8).

8.1 Introduction

This chapter provides the general conclusions for this research study. The integration of emerging technologies affects emerging educational practices and vice-versa. This study has reviewed the use of multiple devices in ODL contexts in a nuanced way that recognises the complexities, and sometimes "messiness", surrounding emerging technologies and educational practices. A summary of the research aim and processes are provided, followed by the conclusions that summarise the main findings from this research related to each research sub-question and the overall research question. The next section discusses the implications of the research findings for educational practices. This is followed by a description of the main contributions to the research field. The next section offers an overview of the limitations of this study. This is followed by proposals of possible areas of future research. A few final thoughts about this study then conclude the thesis.

8.2 Summary of the Research Aim and Processes

The research problem addressed by this study was the lack of awareness of how students make use of multiple devices for learning and how ODL universities can effectively support them to do so. The purpose of this exploratory research study was to understand the learning habits and behaviours of ODL students using different devices for learning. This was in order to determine how students move between technologies, locations and learning activities and how students can be effectively supported. Therefore, the overall research question was: "How do students at ODL universities use multiple devices to seamlessly support their learning?". The socio-cultural theoretical perspective underpinned this research study. The theoretical framework explored the notion of seamless learning, together with aspects that considered digital devices, learner characteristics, study locations and learning activities. The relevant current literature was reviewed and trends and issues related to the integration of technology in ODL and mobile learning were analysed. Previous studies concerning the use of digital devices for learning in ODL contexts were examined. A case study approach was followed for the empirical work. The research was undertaken at two ODL universities, UOC in Spain and Unisa in South Africa. The study made use of a mixed methods approach, using a sequential explanatory strategy. A pilot study was first conducted to test the data collection instruments. Quantitative data (online surveys) were first collected at each case study, followed by the collection of qualitative data (semi-structured interviews) to build on the quantitative data and interpret or explain relationships. Quantitative data was analysed using descriptive, correlations and multiple regressions analysis and qualitative data was analysed using a grounded theory approach. Multiple data sources ensured that the findings could be triangulated. The results of each case were analysed and then the overall findings were synthesised.

8.3 Main Conclusions

This section addresses the answers to each of the three research sub-questions and the overall research question.

8.3.1 Multiple Devices, Locations and Learning Activities

This section addresses the first research sub-question: *Which digital devices, and for which purposes and locations, are ODL university students using to perform their learning activities?*

Similar to previous studies, this study found ODL students to be diverse, connected, mobile and resourceful (Andrews & Tynan, 2012). ODL students are diverse in ages, while the majority work and balance other responsibilities with study responsibilities. Students make use of technologies for learning in different ways, according to their needs. The majority of ODL students have access to between three and four digital devices, with smartphones and laptops being the most commonly accessed devices. Other common devices include desktops and tablets. Less commonly accessed devices may include basic mobiles, e-readers, smart TVs, internet-connected game consoles and wearable technologies. This means that the ratio of students to devices is now clearly one to many. These findings suggest that access to devices is no longer an issue for ODL students.

ODL students mostly use their devices for learning, with the average student using three devices to support their studies. The most commonly used devices for learning are laptops, desktops, smartphones and tablets. Most students indicated high levels of expertise in using their devices for study, but students particularly valued fixed devices, such as laptops and desktops, as being important to academic success. This is because of the greater functionality provided by these devices and increased familiarity and confidence. The more important a device is valued for academic success, the higher the expertise level in using the device.

Students use their devices in a variety of public and private locations, yet home is still the preferred location for study. Other private locations used for study are the homes of family and friends, while public locations include work, public locations with Wi-Fi (libraries or cafes) and in-transit. A minority of students make use of regional university centres for study. The more portable a device is, the more locations it is used in. Desktops are used on average in one location (either home or work), while laptops or tablets are used on average in two locations. Students particularly valued their smartphones to be used in the most number of locations (three or more) due to their portability and constant connectivity.

Educators set learning tasks for students to achieve specific educational outcomes and students then undertake a variety of activities to achieve these tasks. ODL students make use of their devices in different ways and to undertake different learning activities, based on their contexts and needs. However, some patterns of use could be derived in this study. Fixed devices, such as laptops and desktops, are seen as central devices for study purposes and used for almost all learning activities (between 8 to 12 activities on average). They are particularly valued for assignment preparation. However, handheld devices, such as tablets and smartphones, are seen as supplementary devices for study and are used for fewer learning activities (between 5 to 7 activities on average). Tablets are mainly used for the consumption of information and communication activities, while smartphones are used for communication, checking information and the consumption of information. Nevertheless, it must be emphasised that individual uses of devices will vary from student to student. Although handheld devices are supplementary, they can be used as substitutes for larger devices when they are not available. These findings suggest that the lower adoption levels of handheld devices for learning, compared to fixed devices, will remain as long as the former are considered supplementary, while the latter are considered central to study. Not only do students use devices for different activities, the activities also differ slightly depending on the location of study. For example, students who use handheld devices for a wider range of activities are likely to use these devices in a greater number of locations.

8.3.2 Sequential and Simultaneous Device Use

This section addresses the second research sub-question: *How do ODL university students make use of handheld devices together with fixed devices to perform learning activities?*

While ODL students were found to usually use their devices separately (one at a time), they sometimes use their devices together across times and locations. Students use their devices together to be more efficient and productive. The use of devices together can be classified as sequential (moving from one device to another) or simultaneous (using two or more devices at the same time). Students who use devices sequentially for learning are likely to use them simultaneously for learning. The more devices students use for learning, the more likely they will use them together. For sequential use, students usually move from more portable devices to less portable devices. This is because students normally have their handheld devices with them on the move to perform quick tasks and then switch to more complex activities on larger devices when in a stationary environment. The main sequential patterns of use are: i) moving between locations; ii) moving between related learning activities; iii) pausing and continuing an activity later; and iv) moving because of device features. For simultaneous use, students normally use a handheld device together with a fixed device to perform complementary activities. This is a form of multi-tasking, but for an academic purpose. The main simultaneous activities performed using two devices together are: i) writing an assignment and searching for information or reading materials; ii) watching a video and making notes; iii) writing an assignment and communicating with other students; and iv) reading materials and searching for information.

The movement between devices is facilitated by cloud services that enable automatic synchronisation across devices, such as Google Drive and Dropbox. The institutional VLE also plays an important role in accessing or managing resources. Students are thus able to learn seamlessly because they can easily pick up their learning from where they left off. Where internet connectivity is not guaranteed, students rely on manual methods of synchronisation by emailing files or using a memory stick. The use of cloud services assumes constant or convenient internet access. This is not the situation for all students. Some Unisa students, particularly in rural areas and in some urban areas as well, struggle with expensive and limited quality or slow mobile internet access. However, students were found to be resourceful in making the best use of what they have or obtaining internet access when they had to. For example, students transferred assignments written on larger devices to their smartphones to upload them to the institutional VLE.

Several changes in study habits were identified because of the use of multiple devices and the associated services. These changes highlight that students are able to be more productive and efficient in their studies. The main changes identified in study habits are: i) studying at more times and in more places; ii) being more connected and better able to keep up-to-date; iii) greater flexibility and choice in how and where learning occurs; iv) making use of the different affordances of handheld devices for learning; v) increased on-screen reading; and vi) increasing integration between studies and other aspects of student lives. However, not all the associated changes are seen as positive for all students. Some students find that constant connectivity and the use of multiple devices (along with the associated services) to be distracting or leading to increasing the level of complexity in their lives.

There is a blurring in the distinction between formal and informal learning practices. Students interact formally within the university context (with educators and other students) and make use of formal technologies such as the VLE. Yet students also interact informally with personal networks and rely on informal or personal technologies for learning. In addition to university-supplied or suggested resources, students also make use of the internet to search for supplementary resources to support their learning.

8.3.3 Academic and Technological Support Needs

This section addresses the third research sub-question: *What academic and technological support do students learning with multiple devices require from ODL universities?*

Student support needs to be integrated into the design of learning experiences. However, the findings indicate that, similar to previous research (Ellaway et al., 2014; Farley et al., 2015), the majority of educators do not take students' use of multiple devices into account in the design, facilitation or support of learning experiences. Although some educators make use of different techniques to support students using different technologies, there is very little consistency across courses. Although ODL universities have made their VLEs accessible from mobile devices and developed some mobile apps, more can be done to take advantage of the personal devices that students carry around with them. It can be concluded that the use of handheld devices by students and the associated connectivity has not extensively influenced the educational models of ODL universities.

Students require different forms of support. Academic support enables the development of cognitive and learning skills. Some patterns of obtaining academic support were identified. To obtain academic support, ODL students rely on both formal and informal means. Formal means of support include using discussion forums or emailing the educator. Informal means of support include personal networks such as family, friends or other students. Students provided several suggestions for the improvement of academic support to better meet their needs: i) short explanatory video tutorials; ii) the use of synchronous web conferences; iii) more personalised assessment feedback; iv) greater use of audio-visual materials; and v) mobile device notifications or subscriptions.

Technological support enables the development of technical and technological skills related to learning. Some patterns of obtaining technological support were identified. Similar to academic support, ODL students rely on formal and informal means to obtain the necessary technological support. Depending on the type of technical challenge, students first attempt to solve the issue themselves through searching for information. Formal means of support include using discussion forums or emailing the educator. Informal means of support include personal networks such as family, friends or other students. Students provided several suggestions for the improvement of technological support to better meet their needs: i) improvements to mobile apps and accessibility of the VLE from handheld devices; ii) general improvements to VLE design and usability; iii) offer discounted rates for devices, software or internet access; iv) provide general information or courses to improve digital literacy skills; and v) offer support regarding specific devices or tools to use to achieve specific course objectives.

8.3.4 Overall Conclusions

This section addresses the overall research question: *How do students at ODL universities use multiple devices to seamlessly support their learning?*

The previous sections showed how students use multiple devices to perform multiple learning activities in different locations. These findings were used to propose a framework for student use of multi-devices (multiple devices) for learning. The purpose of the framework is to assist educators to design more appropriate learning experiences and/or offer improved support to students and caters to the changing study habits of students using multiple devices. Educators can consider how, where and when students perform their learning activities. The framework builds on the constructs in the Mobile-assisted Seamless Learning framework (Wong & Looi, 2011) and the FRAME model (Koole, 2009). It shows that the main influencers of how frequently a device is used for learning are the learning activity or goal, the location or environment (private or public) where the student is situated and the devices the student accesses and uses for learning (either separately or together). However, the frequency of how often a device is used for learning is also influenced, to a lesser extent, by the time available, the perceived importance of the device to academic success, the level of digital expertise and the device affordances (based on physical features, services, quality and internet access).

The use of handheld devices themselves will not achieve the aspiration of seamless learning, as students view handheld devices as supplementary devices for learning. However, the use of multiple devices, together with the associated services, make it possible to learn seamlessly. Students are able to learn across a variety of locations and learn either individually or in groups. Students are supported by educators, other students and by personal or online networks. Importantly, the majority of students are able to move between devices and contexts and continue their learning experiences. However, this does mean there is a minority of students who cannot learn seamlessly. These students may require additional levels of support. The mobile-assisted seamless learning framework does not consider the characteristics and contexts of ODL students. Therefore, the findings of this study have led to the proposal of a continuum of seamless learners. This continuum shows the degree to which learners can learn seamlessly. Individual students can be placed at a particular point along the continuum. Students who can easily learn seamlessly tend to make use of three or more devices, together with synchronisation services. They can easily move between different locations and may have high digital literacy skills. At the other end of the continuum, discontinuous learners struggle to learn seamlessly. They may use one or two devices and internet access is intermittent or expensive. However, individual students are likely to exist at various points along the continuum and the position of each student may change depending on the learning activity, location and the device(s) and tool(s) that are used. Seamless learning is thus very context-dependent.

8.4 Implications for Educational Practices

This section discusses the implications for educational practices based on the conclusions specified in the previous sections. It is expected that the results of this study can enhance the learning experiences of ODL students by helping to improve the effectiveness of learning design and support services. If educators are aware of what devices students have access to and how they use them, then they can design more appropriate learning experiences or provide better support. The results suggest that the lack of access to devices is no longer an issue for ODL students. Therefore, it is recommended that ODL universities focus their attention more on how their students use their devices for learning and consider the contexts of use. However, universities need to balance the insights obtained from student behaviours and locations with privacy concerns.

The results indicate that most students see their handheld devices as supplementary tools for learning, with larger devices being seen as central. This is part of the reason for the relatively lower adoption of handheld devices for learning. This does not, however, mean that educators need to limit their learning design focus to larger devices. On the contrary, this study has shown how handheld devices are valued for specific activities and provided some recommendations to increase the use of handheld devices in formal learning environments. Students are dependent, to some extent, on guidance from educators in how to use technologies for learning. Educators can integrate the use of handheld devices for specific course purposes and take advantage of the affordances of different devices. However, as speculated by Barden & Bygroves (2017), should the majority of students in the future begin to see their handheld devices as central, rather than supplementary, this would have more profound implications for teaching and learning.

As students increasingly rely on cloud services and synchronisation tools to support their learning, it is recommended that universities ensure that students have access to these services and know how to use them to support their learning. Furthermore, these services are reliant on convenient, affordable and high-quality internet access. This was found to be an issue for some students, mainly in rural areas, in the case of Unisa. It is recommended that ODL universities provide assistance, where possible, for students to overcome internet access challenges.

The changes in study habits identified due to the use of multiple devices and associated services mean that students are more productive and better able to balance their study responsibilities with other responsibilities. It is recommended that ODL universities further explore these emerging habits and disseminate best practices regarding study habits to their students so that all students are aware of different approaches to studying and are able to improve their study habits. Another implication of changing study habits is that ODL universities need to review their teaching and learning processes so that they can provide effective support to meet the needs of their students. For example, students often search for supplementary resources to support their learning. These are sometimes shared with other students. It is therefore recommended to support students to develop the skills to find and evaluate resources. The development of digital literacy skills need to focus on more than specific tools, but also on device, security and ethical issues. This information can be provided at a general level, such as part of student orientation, but it is also needed at a course-specific level. For example, educators can provide contextual support for specific activities within courses. The blurring between formal and informal learning practices means that students rely on both university and non-university systems and resources for learning. This shows that students exhibit agency and increasingly take control of their own learning, aided by personal technologies. This reduces the relative importance of the institutional learning environment in comparison to personal learning environments, which has implications for the nature of learning and knowledge and the role of the university educator.

It is recommended that educators take into account students' use of multiple devices in the design, facilitation and support of learning experiences. Not only do individual educators need to consider the use of devices in their course design, but universities as a whole need to promote this change in thinking across faculties and departments. In this way, ODL universities can better address the expectations of students in a uniform manner. Some of the suggested practical techniques to better support students using different devices are to: i) ensure resources are available in different formats; ii) ensure resources and activities are accessible from different devices; iii) promote collaborative activities and tools that support collaboration; and iv) recommend useful apps for learning, either general education or discipline-specific. It is recommended that ODL universities revise their pedagogical practices to provide the required academic support for students using multi-devices. The recommended changes to pedagogical practices are to: i) design learning activities that cater for the affordances of different devices; ii) design assessments that require multimedia formats or presentations; iii) update learning design processes to consider how students use different devices together; and iv) consider the contexts/locations where students use their devices.

In order to design learning experiences for different devices and provide students with the appropriate support, educators need to know how to provide this support. This has implications for staff development initiatives and for learning designers or support centres working with academics.

The proposed framework for student use of multi-devices for learning can be used by educators to support their students through providing information about how students can undertake learning activities. General information related to uses of devices and the associated services can be included in student orientation information or as part of study skills information provided in counselling or guidance services. However, contextual information for specific learning activities can be included in any descriptions of the learning activities. In supporting students, ODL universities and educators need to recognise that students in a particular course may exist across the continuum of seamless learners and that students require different levels of support.

8.5 Contributions

This research study makes three main contributions to the research field that focuses on the role of digital technologies in student learning. These contributions specifically relate to university students within an ODL context:

- This study has shown the trends in digital device access and use as well as the patterns of use in different locations and for different learning activities.
- This study has presented patterns of use of how and why students use multiple devices together, either sequentially or simultaneously.

- This study has demonstrated how universities can support their students who use multi-devices, both academically and technologically.

Research instruments were developed that can be used by other researchers to investigate these trends and patterns of multi-device use in other universities. Furthermore, this study has proposed a framework and continuum that consider students' use of technologies for learning in an ODL context that can be used by educators and institutions:

- A framework for the frequency of multi-device use for learning was proposed. This framework can be used by ODL educators to design more effective learning experiences and provide better support to ODL students.
- A continuum of seamless learners was proposed that shows the extent to which ODL students are able to learn in a seamless manner, based on their contexts and practices. This continuum can be used to identify the levels of support required by different students.

8.6 Limitations of the Study

There are some limitations of this study that need to be considered. The first limitation is the context of the study. This study has focused on students and universities in an ODL context. The findings from the case studies in two different contexts may apply to other ODL universities, although as only two cases were explored they cannot be considered representative of all ODL universities. However, the findings may not be generalised to all universities, particularly face-to-face universities. Although some of the trends and issues will undoubtedly be the same, there are major differences in the educational models of different modes of delivery that limit the application of the findings.

The study reported on the perceptions, experiences and behavioural patterns of students using different devices. As this was an exploratory study, the findings are considered exploratory and illustrative. Further research is required to assess particular causes and effects through the development of hypotheses. Other influencers not considered in this study, such as the socioeconomic backgrounds of students, may need to be considered. This study has focused on the development of an initial framework for students' use of multiple devices for learning, but this framework has yet to be validated. In terms of data collection, data was collected using surveys and interviews. This limits the study to self-reported information from the respondents. Additional data collection techniques would be useful to triangulate the findings. Further limitations regarding the methods used were discussed in the Research Methodology chapter (Section 4.6).

As noted throughout the different chapters in this thesis, the nature of digital devices and their patterns of use change over time. These results only provide a view of current student usage patterns at ODL universities. Thus, the results of this study may not be applicable for a significant time period.

8.7 Future Research Directions

This research study has generated findings that would benefit from further exploration and research. As one of the limitations highlighted above, this research focused exclusively on an ODL context. Future research can verify the findings from this study in other contexts. For example, similar research could be designed and conducted in face-to-face or dual mode institutions. Alternatively, a narrower focus could target a specific disciplinary context or study the similarities and differences between disciplines. As this study focussed exclusively on undergraduate students, another area of interest may be investigating the patterns of device use among postgraduate students.

The devices that students have access to as well as the associated patterns of use will likely change in the future. Newer technologies such as wearables or other technologies may be adopted by students for learning, requiring a regular review of patterns of technology use in university contexts. For example, ODL universities may wish to undertake annual or biennial student surveys. Another consideration for future research is the effect on study habits as the affordances of some devices merge or the devices themselves become more interchangeable (such as tablets and laptops). A suggestion for future research is the tracking of students over the course of their studies to determine how patterns of use are developed and change over time. Although more difficult to implement, a longitudinal study that tracks the patterns of technology use for students from the first semester of enrolment until graduation would be able to identify trends and issues over time.

A key finding that emerged from this study was that the use of multiple devices and associated services can improve the efficiency and productivity of students and that they can better balance study and other responsibilities. It would be useful to investigate this finding in relation to any effects on student engagement and whether there is an effect on reducing student drop-out. Another area of interest would be to assess whether the frequency use of different devices, together with the associated services, has an effect on academic performance.

This study focused on learning in a formal learning environment. However, the findings from this study indicated that there is an increasing blurring of the distinction between formal and informal learning contexts. Future research can look in more detail at learning in informal contexts or investigate how formal and informal learning patterns are merging.

One of the aims of this research was to develop a framework to assist ODL educators to design learning experiences and support students using multiple devices. It was not within the scope of this study to validate this framework. Future research will look at evaluating or validating the proposed framework by empirically evaluating the framework in different contexts or through the consideration of how the framework is adopted or used by educators.

This study focused on the viewpoints of students. One of the recurring findings was that ODL educators can do more to design learning experiences that enable students to make use of different technologies. It has also alluded to the changing roles of educators where students have near instant access to multiple resources and means of support. Future research would be useful that compare these findings with the views of educators and explore how educators are changing their teaching and learning practices to incorporate the uses of different technologies and considerations of student context.

8.8 Final Thoughts

The aim of this research was to explore how ODL students move between technologies, locations and activities in order to achieve their learning goals, in an effectively supported manner. The use of multiple devices, supported by the associated services, means that students are able to achieve seamless learning. Seamless learning is dependent on context, but technologies enable students to easily switch between learning activities and learn across different contexts to achieve their learning goals. This means that students can be more efficient and productive learners. The integration of technologies into teaching and learning is never going to be seen as a solved problem as new technologies and educational practices emerge and change. However, the successful integration of technologies into teaching and learning to meet the needs of students may result in the role of personal technologies in learning becoming so seamless that they become invisible (Wagner, 1991, as cited in Chan et al., 2006). Therefore, the focus needs to remain on enhancing educational practices to improve student learning experiences.

Appendix F contains a list of the publications and presentations derived from this study.

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Appendices

Appendix A Research Instrument: Email Invitation for Student Questionnaire

Dear Student

You are invited to participate in a survey conducted by Greig Krull, under the supervision of Dr Josep Duart, Professor in the Department of Education, towards a PhD at the Universitat Oberta de Catalunya (UOC).

The survey you have received has been designed to study undergraduate student learning habits and behaviours around using multiple devices for learning in open and distance universities. You were selected to participate in this survey because you are a current undergraduate student at [Unisa]. In order to be eligible to complete the survey, you will need internet access. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.

Survey link: ________________

It is anticipated that the information we gain from this survey will help us to provide a framework to enhance student engagement for the changing learning habits of students using different devices. You are, however, under no obligation to complete the survey. Any identifying information that is obtained in connection with this survey will remain confidential and will be disclosed only with your permission or as required by law. If you choose to participate in this survey it will take up no more than 15-20 minutes of your time. You will not benefit from your participation as an individual, however, it is envisioned that the findings of this study will help universities improve the design and support of student learning experiences when using digital devices. We do not foresee that you will experience any negative consequences by completing the survey. The researchers undertake to keep any information provided herein confidential, not to let it out of our possession and to report on the findings from the perspective of the participating group and not from the perspective of an individual.

The records will be kept for seven years for audit purposes where after they will be permanently destroyed (electronic versions will be permanently deleted). You will not be reimbursed nor receive any incentives for your participation in the survey.

The research was reviewed and approved by the Unisa Research and Innovation Ethics Review Committee (URIERC) and the UOC Ethics Committee. The primary researcher, Greig Krull, can be contacted at gkrull@uoc.edu or you can contact his supervisor Dr Josep Duart at jduart@uoc.edu if you have any questions. Should you have any questions regarding the ethical aspects of the study, you can contact the chairperson of the Unisa Research and Innovation Ethics Review Committee (URIERC) at urerc@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the University's Toll-Free Hotline 0800 86 96 93.

Thank you.

Kind regards

Greig Krull

Appendix B Research Instrument: Student Questionnaire

The purpose of this questionnaire is to gather data to inform my PhD study regarding your use of technology for your learning. The objective of this study is to understand student learning habits and behaviours around using multiple devices for learning. Please note the following:

- Your participation in the survey is voluntary. You can choose to discontinue participation at any time.
- All responses are confidential. Your personal information will be treated in accordance with relevant privacy policies and laws.
- The results derived from this PhD survey may be made available in the form of a thesis, and/or journal articles and conference presentations.
- You can contact the researcher (gkrull@uoc.edu) if you have any questions about the research.

We would be very grateful if you could complete this questionnaire by checking the boxes corresponding to your answer or entering an appropriate text response where indicated. You will not need to answer the questions on all the pages, as the survey will customise the questions based on your previous answers.

We would also like to identify potential participants for a follow up future interview or survey. There is a section at the end of this questionnaire where you can enter your email address so that we can contact you if you would be willing to take part.

[*] Before we start, please confirm that you freely give your consent to participate in the research survey?

Yes, I consent to participate.	☐	
No, I do not consent to participate.	☐	[goes to thank you page]

[* = mandatory question]

SECTION A: PERSONAL DETAILS

1. [*] What is your age?

25 and under	☐
26-35 years	☐
36-45 years	☐
46-55 years	☐
56-65 years	☐
66 and over	☐

2. [*] What is your gender?

Female	☐
Male	☐

3. [*] What is your subject area/discipline?

Arts, Humanities or Languages	☐
Business or Economics	☐
Education	☐
Engineering or Technology	☐
Environmental or Life Sciences	☐
Information or Communication Science	☐
Law	☐
Physical Sciences or Mathematics	☐
Social Sciences (Politics, Psychology, Social Work, Sociology)	☐
Healthcare	☐

4. [*] What is your study status?

Full-time	☐
Part-time	☐

5. [*] In addition to studying, are you currently employed?

Not working	
Employed part-time	
Employed full-time	

6. [*] What is your national status?

Local student	
International student	

7. [*] How long have you been studying towards your current qualification?

Less than 1 year	
1-2 years	
2-3 years	
3-4 years	
More than 4 years	

8. [*] In which area do you live?

Urban	
Rural	

9. [*] Is your home language the same language used in your studies?

Home and language of study are the same	
Home and language of study are different	

SECTION B: USE OF DIGITAL DEVICES IN STUDIES

10. [*] Which of the following digital devices do you own or have regular access to?

	I have my own	**I use someone else's**	**I do not have access**
Desktop Computer (e.g. Mac, PC)			
Laptop/Notebook			
Tablet (e.g. iPad)			
Smartphone (typically has a touchscreen, internet access and runs apps)			
Basic Mobile Phone (typically does not have apps, mainly used for calling and messaging)			
e-Reader (e.g. Kindle device)			

***Note**: Selecting "I do not have access" in the online survey removes those options from the remaining Section B questions.*

11. If you own the device(s), what was the main purpose for purchasing it (please tick as many as apply)

	Purchased to support university study	**Purchased for another purpose**
Desktop		
Laptop		
Tablet		
Smartphone		
Basic Mobile Phone		
e-Reader		

12. [*] Please indicate the age of devices (if you do not know the age, indicate how long you have used the device)?

	Less than 1 Year	**1-2 Years**	**2-3 Years**	**3-4 Years**	**More than 4 Years**
Desktop					
Laptop					
Tablet					
Smartphone					
Basic Mobile Phone					
e-Reader					

13. [*] Please indicate the extent to which you use these devices for **studying or learning purposes**?

	Daily	**Weekly**	**Monthly**	**Never**
Desktop Computer				
Laptop				
Tablet				
Smartphone				
Basic Mobile Phone				
e-Reader				

Note*: Selecting "Never" in the online survey removes those options from the remaining Section B questions.*

14. [*] In which locations are you using devices for study purposes (please tick as many as apply)?

	Desktop	**Laptop**	**Tablet**	**Smartphone**	**Basic Mobile**	**e-Reader**
Home						
Work						
Homes of family/friends						
University Centre						
Public location with internet (café, library)						
In-transit/public transport						
Other						

15. [*] Which of the devices have you used **to perform the following learning activities** in the last semester (please tick as many as apply)?

	Desktop	**Laptop**	**Tablet**	**Smartphone**	**Basic Mobile**	**e-Reader**
Communicate with educator						
Communicate with students						
Read text/materials						
Listen to audio						
Watch video						
Participate in forums						
Complete test/quiz						
Write an assignment						
Participate in online meeting/lecture						
Search for information						
Complete an examination						
Access virtual library						
Review assignment feedback						
Plan study time						
Check news/announcements						

16. [*] Within the context of learning, what is your level of expertise / comfort when using these devices?

	Very High	**High**	**Neutral**	**Low**	**Very Low**
Desktop					
Laptop/Notebook					
Tablet					
Smartphone					
Basic Mobile					
e-Reader					

17. [*] How important is each device to your academic success?

	Very High	**High**	**Neutral**	**Low**	**Very Low**
Desktop					
Laptop/Notebook					
Tablet					
Smartphone					
Basic Mobile					
e-Reader					

18. [*] What is the size of the laptop?

Small size (11”-12”)	
Medium size (13-14”)	
Large size (15-16”)	
Very large size (17-18”)	

19. [*] What is the operating system on the laptop?

Microsoft Windows	
Mac OS X	
Linux/Ubuntu	
Other (please specify)	

20. [*] What is the size of the tablet screen?

Small size (7”-8”) (e.g. iPad Mini)	
Standard size (9”-10”) (e.g. iPad)	
Large size (>10”) (e.g. iPad Pro)	

21. [*] What is the operating system on the tablet?

Apple iOS	
Google Android	
Microsoft Windows	
Other (please specify)	

22. [*] Do you have a separate keyboard to use with the tablet?

Yes	
No	

23. [*] What is the size of the smartphone screen?

Small size (less than 4")	
Standard size (4”-5.1”) e.g. iPhone 6, Galaxy S6	
Large size (5.2” or more) e.g. iPhone 6 Plus	

24. [*] What is the operating system on the smartphone?

Apple iOS	
Google Android	
Microsoft Windows	
Other (please specify)	

SECTION C: USE OF MULTIPLE DEVICES IN STUDIES

25. Are there any other digital devices (not mentioned before) that you use for learning? If so, please give examples of how you use these devices for learning.

26. [*] Please rate your level of agreement with the benefits to using multiple devices for learning (please tick all that apply)?

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Able to study at more times					
Able to study in more places/spaces					
Able to move between locations					
Able to stay connected					
Easier access to information					
Manage logistics and organising studies					
Able to multi-task					
Other (please specify) _________					

27. [*] Please rate your level of agreement with the drawbacks to using multiple devices for learning (please tick all that apply)?

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Distractions from other devices					
Having to move between devices					
Never being switched off (always on)					
Different content formats or software incompatibility					
Lack of expertise/comfort in use					
Other (please specify) _________					

28. [*] In an average week during a semester, how many hours to do you spend studying in total?

0 – 5 hours	
6 – 10 hours	
16 – 20 hours	
> 20 hours	

29. [*] In an average week during a semester, how many hours to do you spend **online** for studying?

0 – 5 hours	
6 – 10 hours	
16 – 20 hours	
> 20 hours	

30. [*] What influences you to choose a device or devices for studying at a particular time (please tick all that apply)?

Amount of time I have or need	
Learning goal or activity	
My location/environment	
My state of mind/attitude	
Device interface / screen size	
Whatever device is closest to me	
Other (please specify) ______	

31. [*] What technical challenges do you face in learning using multiple devices (please tick all that apply)?

Disrupted internet connection	
Limited battery life of device	
Lack of technical expertise	
High cost of internet access	
None of the above	
Other (please specify) ______	

32. [*] Which tools do you use to access or store resources on your devices (please tick all that apply)?

Learning Management System	
Google Drive	
Dropbox	
Microsoft OneDrive	
Note Tool e.g. Evernote	
USB/Flash Drive	
Other (please specify) ______	

33. [*] What are the most useful applications or apps that you use for your learning? Please provide at least 2 examples.

34. [*] How often do you start a learning activity on one device but continue it or finish it on a different device?

Very Frequently	
Frequently	
Sometimes	
Occasionally	
Never	

***Note**: Skip question 35 if answer is "Never".*

35. Please select which device you usually start the learning activity on and then which device you continue/end on (please tick as many as apply)?

	End on Desktop	End on Laptop	End on Tablet	End on Smart-phone	End on Basic Mobile	End on e-Reader
Start on Desktop						
Start on Laptop						
Start on Tablet						
Start on Smartphone						
Start on Basic Mobile						
Start on e-Reader						

36. [*] How often do you use multiple devices for learning purposes **at the same time**?

Very Frequently	
Frequently	
Sometimes	
Occasionally	
Never	

Note*: Skip Question 37 if answer is "Never".*

37. Please select which devices you usually use at the same time for a learning activity?

Desktop	
Laptop	
Tablet	
Smartphone	
Basic Mobile	
e-Reader	

38. [*] When using your devices for learning at the same time, is it more for multi-tasking (each device for a separate learning activity) or to complement each other (each device to do the same or related learning activity)?

Mainly multitasking (each device for a separate learning activity)	
Mainly complementary use (each device for the same or related learning activities)	
A combination of multitasking and complementary use	

SECTION D – ATTITUDES TOWARDS TECHNOLOGY AND DEVICES

39. [*] Which of the following best describes how frequently you **would like** to use digital devices for studying?

I would like to use digital devices more often when I study	
I am currently using digital devices at just the right amount for studying	
I would like to use digital devices less often when I study	

40. [*] To what extent do you agree or disagree with the following statements about using devices like laptops, tablets and phones for learning?

I want to be able to learn anytime, anywhere

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

My internet access is too limited to effectively use mobile learning

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Using mobile devices for learning is too expensive for me

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

I am concerned about data privacy or security using my mobile device for learning

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

41. [*] To what extent do you agree or disagree with the following statements about learning in the future?

Digital devices will change the way I will learn in the future

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Digital devices will help me to study more efficiently

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Digital devices will help me to perform better in my studies

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

SECTION E – LEARNING SUPPORT

42. [*] Are your lecturers designing or facilitating learning experiences in your courses that allow you to make use of different digital devices?

Yes	
No	

***Note**: Skip Question 43 if answer is "No".*

43. Can you provide any examples of how your lecturers are designing or facilitating learning experiences to make use of different digital devices?

44. [*] Are the university Learning Management System (LMS) web pages mobile-friendly or responsive to device screen size?

Yes	
No	
I do not know	

45. How do you think the university could provide better academic support to you in using multiple devices for learning? (e.g. support related to communication, progress or feedback)

46. How do you think the university could provide better technological support to you in using multiple devices for learning? (e.g. support related to the LMS, software, devices)

47. Any general comments:

SECTION F – FURTHER PARTICIPATION IN THIS STUDY

48. Please enter your email address if you are interested in contributing further to our study by participating in an online interview or follow up survey about your use of technology.

Thank you for taking the time to complete this questionnaire.

Appendix C Fieldworker Research Agreement

Dear <Fieldworker Name>

We invite you to assist us in collecting data in a study entitled "Students' usage of multiple devices for seamless learning experiences at open and distance learning universities" by assisting us with the collection and translation of interview data at the Universitat Oberta de Catalunya (UOC).

PURPOSE OF THE STUDY

We are conducting this research to find out about student learning habits and behaviours around using multiple digital devices for learning in open and distance universities. It is anticipated that the information we gain from this survey will help us to provide a framework to enhance student engagement for the changing learning habits of students utilising digital devices. The benefit of this study is that it is envisioned that the findings of this study will help universities improve the design and support of student learning experiences when using digital devices.

NEED FOR FIELDWORKERS

The researcher needs to interview a sample of +- 20 UOC undergraduate students (who previously completed a survey for this research study) in their preferred language (either Spanish or Catalan). The researcher does not have proficiency in these languages. You have been invited to participate because you a) volunteered to act as a fieldworker in the collection and translation of data, b) you are a current PhD student at UOC and c) a native Spanish/Catalan speaker. We require two fieldworkers: one interviewer/translator for Catalan respondents and one interviewer/translator for Spanish respondents. Please note that there is no payment or reward offered (financial or otherwise) for participating in this study. Your contributions as fieldworkers will be acknowledged in any publications resulting from this research. However, you will not be co-authors in this research study.

FIELDWORKER RESPONSIBILITIES IN THIS STUDY

Your involvement is required for the semi-structured online interviews. These interviews will be audio recorded. You will ask questions open-ended questions about what digital devices students use for learning and the learning tasks performed, the benefits and challenges of using digital devices for learning and the kinds of support they need. The duration of each interview will take about 20 minutes. It is expected there will be +-10 Catalan and +-10 Spanish interviews. Interviews will be conducted online (using Skype or Hangouts).

The main function of your role as interviewer is to collect information from respondents through the interviews. This entails the following duties:

- Attend the interview training and ensure you understand all concepts and processes
- Confirm with the researcher a specific date and time for each interview (once the researcher has agreed dates with each interviewee)
- Conduct each interview at the specified date and time using the interview protocol.

The researcher will be present (virtually or in person) for all interviews in case you need assistance. You should follow the instructions established during interviewer training.

After the interviews have been completed, you will need to transcribe and translate each interview. The main function of your role as translator is to transcribe each interview and then translate the interviews into English. This entails the following duties:

- Attend the translator training and ensure you understand all processes.
- Agree a timeframe with the researcher for each interview to be transcribed and translated.
- Carry out the translation according to the translation protocol.

- Save the transcriptions and translations in the appropriate folder.

SECURITY AND CONFIDENTIALITY OF INTERVIEW PARTICIPANTS

The security and confidentiality of personal information provided by participants is vital. You will only share the information obtained during the interviews with the researcher and no-one else. Interviewee privacy is to be maintained. After each interview, any transcriptions or translations will be given a code number or a pseudonym and will be referred to in this way in the data.

The security of information will be maintained by following the interview and translation protocols. After this research study is completed, you will permanently delete all the interview and translation files from the hard drive of your computer.

RELATED/SUPPORTING DOCUMENTS

Please ensure that you are familiar with the following documents:

- UOC Student Interview Protocol
- UOC Student Interview Translation Process Protocol

ETHICS APPROVAL

This study has received written approval from the UOC Ethics Committee. A copy of the approval letter can be obtained from the researcher if you so wish.

SUPPORT

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Greig Krull at gkrull@uoc.edu. Should you have concerns about the way in which the research has been conducted, you may contact his supervisor Dr Josep Duart at jduart@uoc.edu.

Thank you for providing your assistance in this study.

By signing below, you confirm to act as a research fieldworker in this study. Your signature affirms that you:

- Have read and understood your role and responsibilities as outlined in this agreement as well as the supporting documents.
- Agree to conduct the research in a way that aligns with the UOC research and ethics processes.
- Agree to protect the security and confidentiality of the research participants.

Fieldworker Name & Surname………………………………………… (please print)

Fieldworker Signature………………………………………….. Date…………………

Researcher Name & Surname……………………………………… (please print)

Researcher Signature………………………………………….. Date…………………

Appendix D Research Instrument: Student Interview Information and Consent Form

Dear Prospective Participant

My name is Greig Krull and I am doing research with Dr Josep Duart, Professor in the Education Department, towards a PhD at the Universitat Oberta de Catalunya (UOC). We are inviting you to participate in a study entitled “Student’s usage of multiple devices for seamless learning experiences at open and distance learning universities”.

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to find out about undergraduate student learning habits and behaviours around using multiple digital devices for learning in open and distance universities. It is anticipated that the information we gain from this survey will help us to provide a framework to enhance student engagement for the changing learning habits of students utilising digital devices. The benefit of this study is that it is envisioned that the findings of this study will help universities improve the design and support of student learning experiences when using digital devices.

WHY AM I BEING INVITED TO PARTICIPATE?

You have been invited to participate because you previously participated in an online survey for this research project. During the online survey, you indicated your willingness to participate in an interview and provided your email address. We have selected a random sample of interviewees from the students who indicated their willingness to be interviewed and provided a valid email address. The approximate number of participants to be interviewed is 20.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves semi-structured online interviews. These interviews will be audio recorded. The sort of questions to be asked will be open-ended questions about what digital devices you use for learning, examples of how you use digital devices for learning and the learning tasks performed, the benefits and challenges of using digital devices for learning and the kinds of support you need. The duration of participation is to complete one interview that will take about 30 minutes. Interviews will be conducted online (using Skype or Hangouts) or via the telephone.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time during the interview and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

You will not benefit from your participation as an individual, however, it is envisioned that the findings of this study will help universities improve the design and support of student learning experiences when using digital devices.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There are no expected negative consequences for participating in this research project. The only foreseeable risk of harm is the potential for minor emotional discomfort or inconvenience from responding to the questions. This is a very low risk as the researcher will be sensitive to the needs of participants and the data collected will not be of a sensitive nature. There is no risk of others identifying a person’s participation in the research.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and the supervisor, will know about your involvement in this research. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. Your answers may be reviewed by people responsible for making sure that research is done properly, such as members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. A research report, journal article or conference proceedings from the study may be submitted for publication, but individual participants will not be identifiable in such reports.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Electronic information of your answers will be stored by the researcher for a period of seven years in a password protected computer in a restricted access building. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After seven years, the information will be destroyed, electronic records will be permanently deleted through the use of a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There is not payment or reward offered, financial or otherwise for participating in this study. For online interviews, participates may have to cover the costs of internet data.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from UNISA Research and Innovation Ethics Review Committee (URIERC) and the UOC Ethics Committee. A copy of the approval letters can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Greig Krull at gkrull@uoc.edu. The findings are accessible for a period of two years. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Greig Krull at gkrull@uoc.edu. Should you have concerns about the way in which the research has been conducted, you may contact his supervisor Dr Josep Duart at jduart@uoc.edu. Contact the research ethics chairperson of the UNISA Research and Innovation Ethics Review Committee (URIERC) at urerc@unisa.ac.za if you have any ethical concerns. Alternatively, you can report any serious unethical behaviour at the University's Toll-Free Hotline.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

<Signature>

Greig Krull

Date:

CONSENT TO PARTICIPATE IN THIS STUDY

I, __________________ (participant name), confirm that the person asking my consent to take part in his research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I confirm that:

- I have read (or had explained to me) and understood the study as explained in the information sheet.
- I have had sufficient opportunity to ask questions and am prepared to participate in the study.
- I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.
- I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential, unless otherwise specified.
- I agree to the recording of the interview through audio recording.
- I have received a signed copy of the informed consent agreement.

Participant Name & Surname………………………………………… (please print)

Participant Signature………………………………………….. Date…………………

Researcher Name & Surname……………………………………… (please print)

Researcher Signature……………………………………….. Date…………………

Appendix E Research Instrument: Student Interview Protocol

Student:	Interview Date/Time:
Interviewer:	Interview Tool:

Opening the interview:

- Introduce yourself and purpose of the interview (To provide additional information about the use of multiple devices for learning and types of study behaviours. To gather student interpretations and insights around their learning habits)
- Check if the consent form has been understood and if there are any questions.
- Ask for permission to audio record the interview.

QUESTIONS	GUIDELINES/EXAMPLES
1. Which digital devices do you have access to?	Could be your own or shared devices.
2. A) If you learn with a laptop or desktop, please give me one or more examples of how you use it for your learning? B) If you have it, but do not use it for learning, why not?	Examples of how specific devices are used for study. Why are those devices used? What are the most important learning tasks?
3. A) If you learn with a mobile phone or tablet, please give me one or more examples of how you use it for your learning/? B) If you have it, but do not use it for learning, why not?	Examples of how specific devices are used for study. Why are those devices used? What are the most important learning tasks?
4. In what contexts (places) do you use your different devices?	Places: work, home, travel/transport, coffee shop etc. How do you use devices differently in those locations? Why those locations?
5. How do you access the internet for your studies?	Access types: mobile data, Wi-Fi, ADSL Any challenges?
6. If you use more than one device for learning, can you explain why you choose a specific device to perform learning tasks?	What is your thinking around selecting a device? What influences your choice? Could be specific task, location, device size, time etc.
7. Please give one or more examples of how you continued a learning activity on a different device or moved from one device to another to complete a learning activity?	Examples of sequential device usage for learning. E.g. start reading article at work, finish at home or read forums on mobile, but post using laptop. Why these devices and these tasks?
8. Please give one or more examples of how you completed a learning activity using two or more devices (at the same time)?	Examples of simultaneous device usage for learning. E.g. watch video on tablet, make notes on laptop. Why these devices and these tasks?

9. When you have a challenge or issue completing a learning task or while studying, what do you do?	How do you get help or support? From who or what? Why use that approach? Example: email lecturer, post to forum, phone another student.
10. When you have a technical problem related to your studies, what do you do?	How do you get help or support? From who or what? Why use that approach? Example: use Google, phone IT support. (If cannot access the VLE or cannot get software to work).
11. What do you see as the most important tools, technologies or services for your learning?	Open question… what is most important for learning?
12. If you think about your study habits, how have they changed since you started using the different devices that you have available to you?	How have your study habits changed? Why do you think they have changed? How do you feel about the changes?
13. Any general comments?	Open question… anything related to the topic of multiple devices for learning.

Closing the interview:

- Thank the participant after the interview.
- Check if there is anything else they want to say before ending the interview.
- End the interview.

General Guidelines for Interviewers

- If a student does not understand a question, try to explain it using different words and only then give examples.
- The order of questions is not important, but make sure to cover all the topics.
- You do not need to use the exact wording for each question, the aim of the interview is to have a conversation about devices and learning.
- If an answer is too short or not explained, ask a follow up question for further explanation. The aim is to gather rich descriptions from students.
- Do not be too worried about the specific examples above, it is fine if the student wants to talk about their relevant interests or issues.
- If there is a technical problem with the interview, be patient and understanding. If the quality of the call is too bad or call keeps dropping, then we can reschedule the interview.

Appendix F Publications and Presentations Derived from this Study

Conference Presentations

Krull, G.E & Duart, J.M. (2017). *Moving to Seamless Learning: Online Students' Usage of Multiple Devices for Learning*. Presented at the 27th ICDE World Conference, 17 to 19 October 2017, Toronto, Canada.

Krull, G.E & Duart, J.M. (2016). *Not Yet Seamless: Distance Students Usage of Multiple Devices for Learning*. Paper presented at the 8th annual e-Learning Update Conference, 6 to 8 September 2017, Johannesburg, South Africa.

Krull, G.E & Duart, J.M. (2015). *Research Trends in Mobile Learning in Higher Education: A Review of 2011-2015*. Presented at the 26th ICDE World Conference, 14 to 16 October 2015, Sun City, South Africa.

Publications

Krull, G.E and Duart, J.M. (2017). Research Trends in Mobile Learning in Higher Education: A Systematic Review of Articles (2011 – 2015). *The International Review of Open and Distributed Learning, 18*(7). http://dx.doi.org/10.19173/irrodl.v18i7.2893.

Krull, G.E & Duart, J.M. (2017). Moving to Seamless Learning: A Framework for Learning Using Multiple Devices. In R. Power, A. Palalas, M. Ally and D. Cristol (eds.) *IAmLearning: Mobilizing and Supporting Educator Practice*. International Association for Mobile Learning.