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Student learning ecologies in online higher education: a model to support connected learning across contexts

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ABSTRACT

As individuals face the challenge of rapidly changing and increasingly diversified study and work environments, online higher education (OHE) has become a mainstream solution for pre-service teachers and working professionals. Both universities and students have had to navigate connected, collaborative and globally networked learning scenarios. Focus has been placed on how to meet the needs of students who are re-entering university as lifelong learners with varying learning trajectories, professional backgrounds and levels of readiness. Given that connecting university learning to the wider world has been a longstanding challenge in higher education (HE), the motivation of the current study is situated in the well-established problem of integrating formal and informal learning. The purpose of this study, therefore, is to present a model of student learning ecologies in OHE to support connected forms of learning across contexts. The findings present a model which is based on the results from a mixed methods exploratory sequential design, which features data integration through a joint-visual display. The article concludes with a discussion of the implications and value of the model for OHE research and program development, as well as the capacity for transfer to other educational contexts.

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Introduction

Online higher education (OHE)¹ has undoubtedly become a mainstream training solution for pre-service teachers and working professionals, particularly in the applied field of educational technology (EdTech) and digital education. Although OHE has a well-established history spanning multiple decades, the most recent period is set amidst rapidly changing and diversified study and work environments. Many learners are motivated to advance their career trajectories and employability through professional development. Fully online graduate programs attract students who need or desire to update their skills as lifelong learners. At the graduate level, online students often choose to combine academic work with professional commitments and family life.

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Moreover, as online students begin graduate studies they often have a broad range of educational and professional trajectories to draw from, including varying levels of academic readiness and capabilities.

Recent studies have demonstrated that both students and faculty use formal and informal networks to optimize learning, yet online course development is typically not designed to consider informal experiences of the students (Czerkowski, 2016). Given that connecting academic learning to the wider world has been a longstanding challenge in HE (Fung, 2017), the goal of the current study is understanding how processes of connected learning—from formal to informal—happen across a continuum of contexts and practices amplified by digital media.

Although online education has an impressive, robust and global research agenda, substantive findings and rigorous research about how students experience learning across multiple contexts in OHE has been limited, particularly in linking formal and informal learning. In response to this identified gap in the literature, the research is guided by the following research questions:

RQ1: How do students experience learning across multiple contexts —from a learning ecologies (LE) perspective— to support academic learning in OHE?

RQ2: What strategies and practices do students engage in to support their learning across contexts?

The purpose of the current study is to examine and expose learning strategies and practices that support and shape connected forms of learning in OHE. To this end, a model of student learning ecologies in OHE is presented. The purpose of the model is to serve as a framework for helping students to develop the capacity for connected forms of learning through program design in OHE, by providing them opportunities to learn to identify, expose and shape these connections for themselves. Using a mixed methods approach, the objective was to generate empirical evidence to develop an LE model for OHE based upon qualitative and quantitative results. After situating the current research with the existing literature on student learning in OHE, a lifelong learning ecologies theoretical framework is introduced which underpins the research design. The results section details the core components of the LE model based on an integration of the mixed methods results. The article concludes with a discussion of the implications of the model for OHE research and development, as well as the capacity for transfer to other educational contexts.

Literature review

The OHE literature, within the broader field of EdTech research, can be characterized as vast and global in character and reach (Bates, 2015; Bozkurt, 2020; Siemens et al., 2015). Previous work in the field has lamented the general inadequacy of the role of theory and theorization practices (Bulfin et al., 2013; Goodyear, 2020; Greenhow & Lewin, 2016). A recent review of the research concluded that much of the field relies on largely descriptive or instrumental research which fails to question theory and develop the field forward (Hew et al., 2019). At the same time, OHE is accelerating as education systems adapt sophisticated and powerful networked instructional tools. As institutions around the world aggressively adopt a blended or fully online model, particularly in the context of the 2020 shift to remote emergency teaching, which some observers call the ‘online

global era' of HE (Guo et al., 2020), few empirical studies have captured the lived experiences of online students. Authors such as Veletsianos (2020) argues there is a critical need to understand the experiences and needs of students for those involved in the development of OHE.

The paradigm of lifelong learning, the voluntary, ongoing, and self-motivated pursuit of knowledge for personal or professional development, is at the center of OHE. Accordingly, the balance of agency has shifted from the institution to the learner (Cendon, 2018), provoking student-centered designs which promote inquiry-driven, problem-based and active learning (Ellis & Goodyear, 2013). As Cendon (2018) articulates, the all-encompassing concept of lifelong learning 'shifts the focus from an institutional view to the learner and his or her learning, which includes lifelong, lifewide, and non-formal and informal learning processes' (p. 81). Focus, therefore, has not only been placed on how to meet the needs of students in uncertain and complex times, such as those amplified by the COVID-19 global pandemic, but how to meet the needs of students who are re-entering university as lifelong learners with varying learning trajectories, professional backgrounds and levels of academic readiness, capabilities and motivation.

Research has linked formal learning – teacher-led, curriculum-bound, and credential awarding – with informal learning – everyday, self-directed, incidental, and tacit learning (Van Noy et al., 2016) – through social media and participatory digital cultures (Ito et al., 2013), however this work is commonly under theorized (Greenhow & Lewin, 2016). Less attention has been given in the context of OHE (Czerkawski, 2016) or online learning more generally (Veletsianos, 2020). In the context of traditional HE, informal learning spaces are recognized as diverse spaces in which learning takes place, becoming an important part of the university's identity (Berman, 2020). Some scholars (Greenhow & Lewin, 2016; Van Noy et al., 2016) have proposed frameworks for analyzing learning across a continuum of formality, recognizing that informal learning can and does occur within formal learning contexts, moving away from traditional and fixed notions of formal and informal learning that has dominated the literature. Networked and boundary-crossing activities reflect the notion that there are numerous influences on student learning that may lie outside of formal curricular experiences and academic assessment structures (Ellis & Goodyear, 2013).

Theoretical framework

A lifelong learning ecologies theoretical perspective has been adopted for the current study (Barron, 2006; Peters & Romero, 2019; Sangrá et al., 2019). An LE is a broad semantic construct which characterizes innovative ways of both lifelong learning across the lifespan, and lifewide learning, which is learning in different places simultaneously across the multiple contexts one inhabits (Barnett & Jackson, 2019). The LE construct has emerged in recent decades in social science research in the context of educational transformation, building upon a range of interrelated concepts and theories. In the current study, the analytical focus is built from a widely cited ontological characterization by Barron (2006) defining LE as 'the set of contexts found in physical or virtual spaces that provide opportunities for learning. Each context is comprised of a unique configuration of activities, material resources, relationships, and the interactions that

emerge from them' (p. 195). In this view, the interacting role of social interactions, practices and resources are emphasized across individual lifelong learning trajectories mediated through digital tools and technology across (lifewide) contexts (Barron, 2006; Ito et al., 2013).

The current theoretical framework is also shaped by connected and boundary crossing learning practices and informed by networked and connectivist learning approaches (Downes, 2012; Siemens, 2005). Connected learning has gained increased attention as a pedagogical approach linking formal and informal learning through networked technologies (Greenhow & Lewin, 2016; Ito et al., 2013; Kumpulainen & Sefton-Green, 2014). A connected learning approach draws on ecological and socio-cultural theories of learning, defined by Ito et al. (2013) as socially embedded and interest-driven learning that is oriented towards educational, economic or political opportunity. In parallel, a growing number of researchers are developing approaches to investigating learning as a series of boundary-crossing activities in and across social spaces (home, school, work, community) where knowledge from one domain (professional, personal or academic) is applied in another (Kumpulainen & Sefton-Green, 2014).

Networked learning is a complementary field of research and practice particularly suited for OHE. The NLEC (2021) defines networked learning as involving processes of collaborative, co-operative and collective inquiry which leads to knowledge-creation and knowledgeable action, supported by social connections, and motivated by shared challenge and enabled by social technologies. Closely related to networked learning is connectivism, an internet inspired learning theory which explains how learning occurs in digitally networked environments (Downes, 2012; Siemens, 2005). A core principle of connectivism is that knowledge extends across multiple nodes, and that learning is the active process of creating connections between these nodes (Siemens, 2005). Connectivist perspectives can help understand student approaches to learning which integrate formal and informal learning networks in HE.

The LE construct has been identified as a suitable analytical framework to explore connected forms of learning that draws together multiple contexts, spanning the boundaries of formal and informal practices. A LE approach conceptualizes lifelong learning throughout the lifespan and across the multiple settings that offer parallel and inter-related opportunities for lifewide learning. The strength of a LE perspective, therefore, lies in its ability to account for the multiple settings and interactions that support individual learning across contexts driven by the depth, quality and range of learner activity, social connection and available resources.

Research design

A mixed methods exploratory sequential design was adopted, using a case study approach. Qualitative and quantitative components were interrelated at various stages of the study (Creamer, 2018; Teddlie & Tashakkori, 2009). The study involved two phases with an intent to form an overall interpretation of the phenomenon by uncovering concepts from the qualitative methods that can be tested using the quantitative methods (Creswell & Plano-Clark, 2018). Field work took place during the 2017–18 academic year. The first sequence was qualitative and allowed for the exploration of a phenomenon from

the participants' perspective and to develop a quantitative survey instrument that is 'based on the culture and setting of the research participants rather than pulled off the shelf for use' (Creswell & Plano-Clark, 2018, p. 84). The initial qualitative phase was used because: (a) no instruments existed to examine learning across formal and informal digital contexts, therefore the qualitative findings informed questionnaire development and (b) student experiences of online learning are contextual and influenced by individual learning trajectories and previous professional experience, hence the qualitative phase helped to capture these contextual experiences.

The case studies were developed across three sites of fully online graduate level programs (masters or 1st year doctoral course work) at the *Open University of Catalonia* (UOC), *University of Illinois Urbana Champagne* (UIUC) and the *University of Edinburgh* (U of E) in the field of educational technology. Study sites were chosen for a range of criteria such as (a) innovative program designs, (b) openly networked learning scenarios and (c) inquiry-driven, collaborative and student-centered approaches. Twelve students were selected (four at each site) through purposive, criteria and convenience sampling. Students represented a broad variability of professional and academic trajectories from a range of socio-cultural and geographic regions. The case study participants, see [Appendix 1](#) for socio-demographic characteristics, reflected a global profile of online learners unrestricted by age and geographic boundaries, entering graduate education at various phases of their professional lives.

[Figure 1](#) presents a procedural diagram which outlines the sequences of the study, including the instruments used, analytical procedures, and outputs of each phase.

Data collection procedures

The first sequence of qualitative data collection followed a sensitizing model technique (Van Den Hoonaard, 2012) in order to design an initial LE framework which allowed researchers to prepare potential lines of inquiry. The LE sensitizing framework was developed from the literature, principally influenced by Barron's (2006) ontological definition which identified learner activities, material resources, and social relationships as the core components of an individual's learning ecology. The sensitizing model enabled researchers to demarcate the units of analysis, including (a.) learner activities, (b) digital resources used to carry out core learner activities and (c) relationship interactions and peer support. These core components served to develop the rest of the instruments and protocols in the qualitative sequence. In-depth interviews allowed students to discuss experiences of learning across contexts with an emphasis on the above-mentioned LE components. Documentation from openly available program sites (i.e., program and course guides) and participant online observations were also used for qualitative data generation, including informing the interview protocols, viewable in [Appendix 2](#).

In regards to the second sequence of quantitative data collection, a survey was built from the qualitative strand, surveying the broader population of students at each site through an online questionnaire (n=178). The survey instrument, viewable in [Appendix 3](#), was constructed with the aim to capture student perspectives on their experiences and behavior of online learning across contexts – from formal to informal –

based on the three core components of the developed LE sensitizing model and results from the thematic analysis (i.e., learner activity, resources, and social interactions).

Data analysis procedures

Thematic network analysis (Attride-Stirling, 2001) was used to ensure rigorous interpretation and thematic development of the qualitative data, primarily through program documentation and participant interviews. A network approach to thematic analysis allowed reaching deeper levels of insight, interpretation and inference. Interviews were audio recorded, transcribed and coded using a hybrid approach allowing both data driven (inductive) and theory driven (deductive) forms of thematic development (Fereday et al., 2006). After initial open coding using Atlas.ti, a robust presentation of the thematic network analyses of the interview data was completed as an attempt to systematize the extraction of lowest order premises evident in the text (*basic themes*), to categories of basic themes grouped together to form *organizing themes*, in order to construct superordinate themes that encapsulate the principle meanings and richness of the data into *global themes*. In order to ensure credibility and trustworthiness of the qualitative analysis, triangulation occurred on a variety of levels, including (a) data triangulation across the different case participants, program documentation, and observations, as well as (b) methods triangulation, (c) participant checking and (d) researcher triangulation (Twining et al., 2017).

The quantitative data analysis plan included both descriptive and multivariate statistics. Survey respondents had to select from a range of categorical options across three central blocks: (1) learner activities; (2) digital resources used; and (3) relationship interactions to support academic learning. Principal components analysis (PCA) was used as a technique of data categorization and as a means to reduce data complexity, draw inferences and yield conclusions from the collected data (Babie, 2020). Researcher triangulation was used in the interpretation of the multivariate analysis for the PCA, including the reviewing, defining and naming of the component solutions.

Finally, mixed methods integration procedures occurred at various phases throughout the research, including at the design level, and at the interpretation and reporting level (Fetters et al., 2013; Moseholm & Fetters, 2017). Two principal forms of data integration were used, narrative account and a joint visual-display, relying on a pillar integration process (Johnson et al., 2019) to bring together data and draw insights from the qualitative and quantitative components. An added value of using a mixed methods design has been the development of a model to support connected learning across contexts in OHE through a visual joint-display which expands and complements an initial LE sensitizing model, something that has rarely been done in the EdTech literature (Figure 1).

Results

Figure 2 presents a model to support connected learning across contexts, integrating mixed methods findings using a joint visual display. It features three central components of an individual's learning ecology in the innermost circle (a.) learner activity, (b.) digital resources and (c.) peer collaboration and social support. The model is informed from the extant literature, using Barron's (2006) ontological definition of the LE construct and

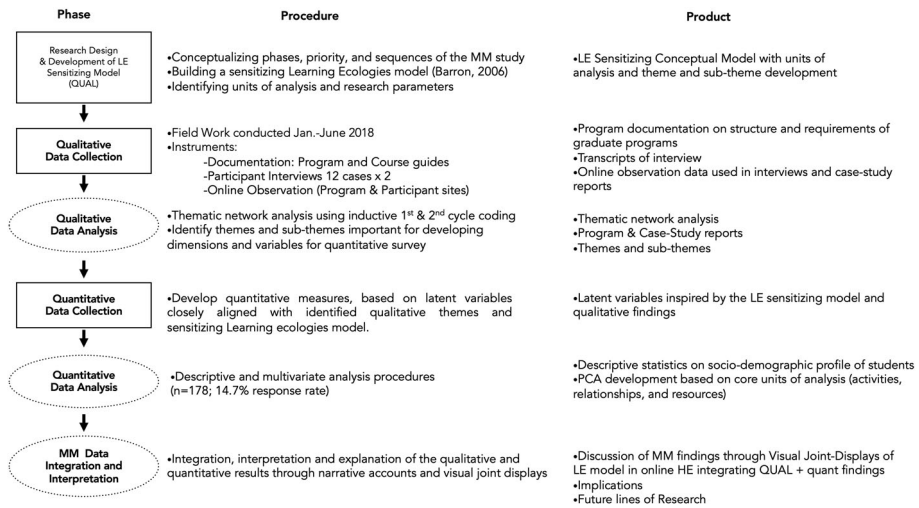


Figure 1 Procedural diagram for the mixed methods sequential exploratory design

Ellis and Goodyear’s (2013) ecology of university learning. The model emphasizes the centrality of learner activity – what the learner does as they complete academic tasks – relying on both social support and digital resources as core LE components. Peer collaboration and digital resources have been identified as powerful influences

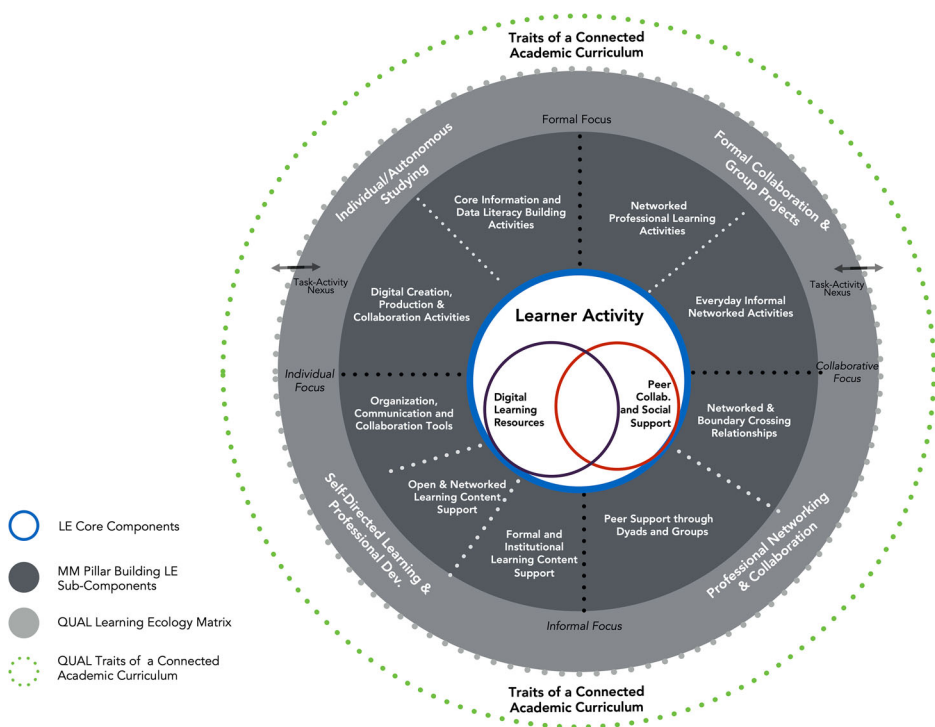


Figure 2 A model of student learning ecologies in OHE

which impact what a learner can do during any particular learning event, reflecting the situated and material nature of learning. The results are organized by an explanation at the four distinct levels of the model, beginning with the inner level: (a.) *Learning Ecology Core Components* and their associated (b.) *Sub-components*, followed by four conceptual zones of learning in the context of OHE identified in the (c.) *Learning Ecology Matrix*, and finally (d.) *Traits of a Connected Academic Curriculum*, which have a significant, yet not exclusive, influence on student learning.

LE core components and pillar building LE Sub-Components

The LE components and sub-components are presented below, integrating both quantitative and qualitative evidence using a pillar building technique. Here, the LE sub-components are developed by combining insights from the qualitative and quantitative strands, going beyond information gained from each.

Learner activity sub-components

The below [Table 1](#) represents the core learner activities identified through the PCA solutions in the quantitative strand, integrated in a joint display with associated qualitative results, including student quotes (codes) extracted from interview data. The four Learner Activity Sub-components emphasize a range of activity domains which sustain learner activity in meeting the demands of the academic curriculum, from digital production, creation and communication skills, to a range of new literacies (digital/data/information) as well as interactive activities which develop and enable professional learning networks.

Peer collaboration and social support sub-components

Peer collaboration and social support sub-components are featured in [Table 2](#). They represent the social collaboration categories developed through quantitative PCA integrated with learning strategies identified from the qualitative thematic network analysis. Through both prescribed and emergent forms of online collaboration, students were required or encouraged to engage in a range of relationship interactions, detailed below. Such processes can be understood through the integrated pillar building themes of *networked and boundary crossing relationships* and *peer support through dyads and groups*.

Digital resources sub-components

[Table 3](#) presents a range of digital resources for multimodal and multimedia knowledge making, with an emphasis on collaborative communication and social networking systems. Relatedly, the integrated pillar building theme for digital tools is *organization and knowledge co-creation tools*. In relation to digital content, two broad categories emerged through the PCA factor solutions, integrated with qualitative categories yielded through thematic network analysis. When browsing, researching and evaluating digital content through self-directed inquiry, learners engage across a continuum from more institutionally sourced, to more openly networked content, depending on the demands, scale and scope of the task as well as the interests, motivations and needs of the learner. Accordingly, the integrated pillar building themes identified for digital



Table 1 Learner Activity Sub-Components

Quantitative Data	Quantitative Categories	Pillar Building Themes	Qualitative Categories	Qualitative Codes
Factor Scores	PCA Solutions for Block 1: Learner Activity		Associated Strategies	Student Quotes
-Integrating and elaborating digital content that others have created (0.827) -Creating and Developing your own digital content (0.812) -Creatively using digital technologies by applying different tools and resources (0.796) -Identifying technological needs and solving problems (0.792) -Collaborating in the cocreation of resources and knowledge (0.708)	<i>Creative and Collaborative Activities</i>	Digital Creation, Production & Collaboration Activities	<i>Engaging in interest driven new media production</i>	<i>'I started a podcast outside work because I heard someone on a podcast say it was quite easy. So I was always quite self-directed if I'm interested in learning something.'</i>
-Searching and evaluating information and digital content (0.847) -Managing information and digital content (0.721) -Communicating and sharing resources and content (0.713)	<i>Browsing, Managing, & Sharing Information and Knowledge Activities</i>	Core Information and Data Literacy Building Activities	<i>Building Information and data literacy skills</i>	<i>'I've come to really value the skill I've picked up doing a literature review, or even accessing relevant articles and following a thread, being able to scope what's out there'</i>
-Searching and filtering digital content (0.799) -Sharing Content (0.698) -Communicating with peers and peer groups (WhatsApp, messenger, discord etc.) (0.535) -Interacting informally across Social Networks (0.532)	<i>Everyday Browsing, Communicating and Sharing Activities</i>	Everyday Informal Networking Activities	<i>Engaging in academic/professional twitter and social network engagement</i>	<i>'Twitter I tend to use much more for academic work in that sense. I didn't originally, but I do now. I use Twitter in a much more academic way.'</i>
-Engaging in Mentoring and/or Coaching (0.840) -Interacting more formally across Professional Networks (0.832) -Interacting with Online Interest Groups and Communities (0.798) -Communicating with peers and peer groups (0.545)	<i>Intentionally Networked Activities</i>	Networked Professional Learning Activities	<i>Engaging in peer mentoring and community building</i>	<i>'We all decided that we want to start a mentor program to pass down what we know within the system ... about how to use the LMS.'</i>

Table 2 Peer Collaboration and Social Support Sub-Components

Quantitative Data	Quantitative Categories	Pillar Building Themes	Qualitative Categories	Qualitative Codes
	PCA Solutions for Block 2: Peer Collaboration and Social Support			
Factor Scores			Associated Strategies	Student Quotes
-Interactions across Personal Social Networks (0.866) -Interactions with peers outside of school and work (0.792) -Interactions across Professional Social Networks (0.782) -Interactions within Online Interest groups and communities of practice (0.688) -Interactions with work colleagues (0.553)	<i>Networked Relationships Across Contexts</i>	Networked & Boundary Crossing Relationships	<i>Using social networks to engage with course themes once formal course has finished</i>	<i>'So I'll follow people on Twitter for example, who I know will be posting things that I am interested in.'</i>
-Interactions with Teacher(s) (0.779) -Small group interactions with university peers (0.777) -One to one interactions with university peers (0.737)	<i>One-to-One and Small Group Relationships in Formal Contexts</i>	Peer Support through Dyads and Groups	<i>Engaging in Peer-review and peer-feedback experiences</i>	<i>'Without question peer collaboration supported my learning. In many cases, the contribution of my peers with greater knowledge than myself who worked in groups together'.</i>

Table 3 Digital Resources Sub-Components

Quantitative Data	Quantitative Categories	Pillar Building Themes	Qualitative Categories	Qualitative Codes
	PCA Solutions for Block 3: Digital Resource Use			
Factor Scores			Associated Strategies	Student Quotes
-Multimodal/Media Editing and Sharing tools (0.801) -Social Networking Systems (0.788) -Communication tools (0.764) -Data Gathering and Analysis tools (0.687)	<i>Digital Tools for Academic Production, Communication and Networking</i>	Organization, Communication and Collaboration Tools	<i>Developing organizational skills using new tools/ technologies</i>	<i>'When I started studying this time I bought a reference manager (paperpal.) And, I have everything on there, it's organized in that, and it's really helped me because in previous years I've cried over my references.'</i>
-Content accessed on Social Media (.820) -Personal websites, Blogs, and Wikis (.776) -Online Games & Virtual Worlds (.719) -Mass Media (.677) -Open Educational Resources (.600)	<i>Networked and Openly Sourced Content</i>	Open & Networked Learning Content Support	<i>Engaging with Social Networks to Support Academic Coursework</i>	<i>'I would use google scholar, and sometimes other search engines. They are open, probably pick up twitter there as well, for interesting articles.'</i>
-Content accessed in Scientific Knowledge Databases (.832) -Content facilitated by the academic program (.775) -Content accessed on Institutional Websites (.566)	<i>Formal and Institutionally Sourced Content</i>	Formal and Institutional Learning Content Support	<i>Building Information and Data Literacy Skills</i>	<i>'Will use google scholar, which brought me to sites such as dial.net, sites I am not used to visiting, in order to search for more information that interests me.'</i>

content include *open and networked learning content support* and *formal & institutional learning content support*.

Learning ecology matrix: integrating formal and informal learning

Figure 3 presents the organizing categories, identified within a Learning Ecology Matrix in OHE according to collaboration (x axis) and formality (y axis). Findings are yielded through thematic analysis of the interview data, characterizing student learning practices. Each quadrant is identified here as a *conceptual zone of learner activity*, as learner activity is the central feature of a student's LE. The LE Matrix serves as a conceptual tool for integrating and guiding student experiences of learning across a continuum of contexts and practices—from formal to informal (Figure 3).

Key strategies emerged fairly evenly across the four conceptual zones of learner activity. However, as formal strategies have more direct relation to assessment structures, these practices had more observed incidence in the analysis. Although the extremes between formal learning (highly linked to the curriculum and assessment structure) and informal learning (everyday, self or co-directed and interest driven; outside of assessment structure) may be quite different, adjacent elements at the boundary between formal and informal strategies may not be that distinct (i.e., engaging in Academic Twitter).

Students' experiences reflect a non-linear and iterative process as they integrate learning across different conceptual zones. Accordingly, the top left quadrant has

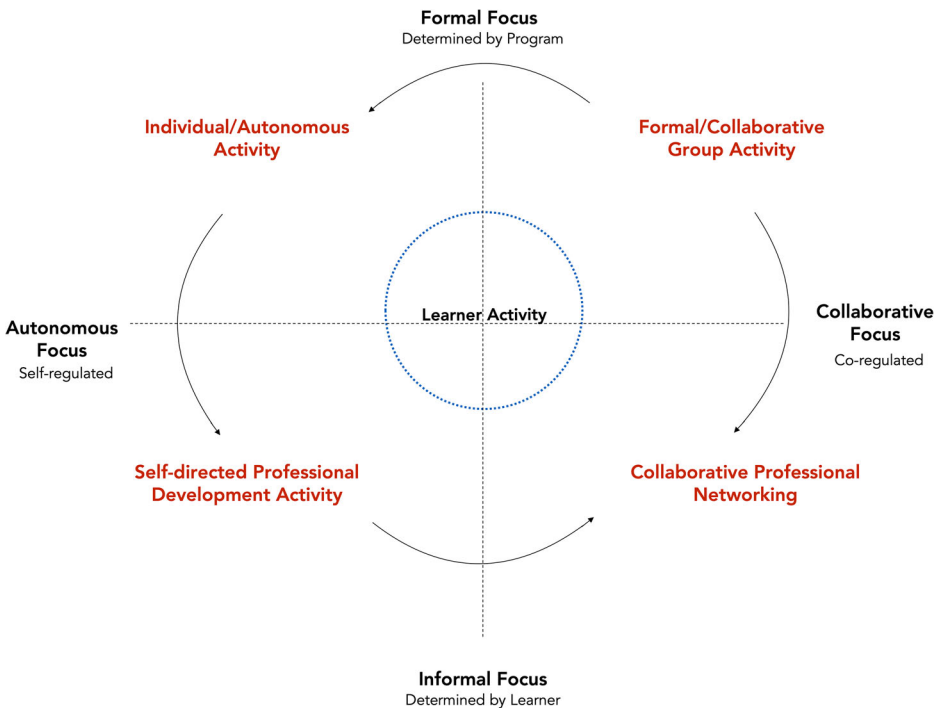


Figure 3 Learning Ecology matrix in OHE with conceptual zones of learning

been named the zone of '*individual/autonomous activity*' as it refers to practices that students develop mostly autonomously, directly in service to the formal curriculum. In summary, in this conceptual zone of learner activity, students' experiences are characterized by:

- developing information and data literacy skills
- managing and producing new knowledge in digital contexts
- course planning and self-regulation (meta-cognitive strategies)
- time management (i.e., scheduling regular study sessions)
- critical thinking and self-directed inquiry.

In the top right quadrant, the zone of '*formal/collaborative group activity*' represents student experiences that requires forms of social interaction linked to the academic curriculum and assessment structure. The strategies used here are more formally constituted and structured within courses or across an entire program. In summary, in this conceptual zone of learner activity, student experiences are characterized by:

- peer-feedback, peer-review and collaborative activities
- help seeking and community building through course forums
- motivation and accountability through program peer group
- informal side-chats and study groups for informal peer-feedback
- use of social networks for academic purposes (i.e., Academic Twitter).

The zone of '*self-directed professional development activity*' in the bottom left quadrant represents a space for autonomous learning where students connect and navigate a range of learning experiences largely outside of the curriculum. Due to its informal nature, many of the strategies and practices evidenced are linked with professional contexts of learning or based on interest-driven self-directed inquiry and can be characterized by:

- stretching learning across multiple contexts (i.e., formal to workplace learning)
- selecting courses based on impact in professional practice
- connecting formal course assignments to professional practice
- applying course experiences and knowledge into their professional domain
- engaging in interest-driven learning processes through social media.

In the zone '*collaborative professional networking*', strategies and practices are more determined by the learners' interests and goals than by the academic curriculum. Here, learners build relationships and connections that further their professional goals and intentions. Experiences here can be summarized by:

- connecting with 'like-minded' colleagues through common interests
- applying academic topics to discussions with colleagues in their professional domain
- engaging with course themes once the formal course has finished
- searching for training/employment opportunities through online communities and groups.

Table 4 Identified Traits of a Connected Academic Curriculum

Task-design traits	Description
Inquiry-Driven and Discussion-Based	<ul style="list-style-type: none"> ● Focused on a range of constructive research-based activities, such as critical thinking and active learning, as well as through case-study, problem solving and project-based approaches. ● Includes collaborative community building, reflective practice and co-construction of knowledge through formal and informal dialogue, interaction and meaning making.
Student-Centered	<ul style="list-style-type: none"> ● Develops learner autonomy, active learning and promotes independent problem-solving, where learners are encouraged to make clear connections between academic work and the wider world context.
Individual and Collaborative	<ul style="list-style-type: none"> ● Characterized by both individual work completed in relative autonomy from peers and tasks that require higher levels of collaboration, interaction and teamwork.
Alignment of Micro and Macro Scale Tasks	<ul style="list-style-type: none"> ● Micro and Macro scale are distinguished by complexity, scale and scope where micro tasks build developmentally to larger macro-scale tasks.
Connected, Wider-world Designs	<ul style="list-style-type: none"> ● Designs which intentionally link academic activity to professional contexts and the wider world using open and networked approaches

Traits of a connected academic curriculum

It is important to consider the influence of the academic curriculum as a resource and context which shapes students' experiences of learning, including prescribed learning resources and environments, as well as emergent forms of learner activity. Table 4 presents the core traits of the academic curriculum which have a significant influence on operationalizing the integration of formal and informal student learning in OHE. Results are from the qualitative component of the study identified through thematic analysis of program documentation (i.e., program and course guides), as well as observation of the program learning environments across three distinct graduate programs.

Task-Activity Nexus

Lastly, an important concept in the LE model is the task-activity nexus (see Figure 1) which is a notion for describing what is happening when students translate teacher-defined tasks into actual learning activity (Ellis & Goodyear, 2013). The task-activity nexus is influential in shaping the range of strategies and practices students use to support formal learning as they interpret teacher-designed tasks into learner outcomes.

Discussion

The LE model in OHE contributes to the knowledge base of EdTech and HE research, both complementing and extending previous empirical research (Barron, 2006; Ellis & Goodyear, 2013). The study aimed to examine student experiences of online learning across contexts, exposing and examining a range of student practices and strategies that shape connected forms of learning across a continuum of experiences (Sangrá et al., 2019; Van Noy et al., 2016), often ignored in previous research. The LE model emphasizes networked, boundary crossing and connected forms of learning by using an ecological metaphor which reflects the integrated, dynamic and fluid process of contemporary learning. It is an example of a 'middle-range theory' that can help explain empirical findings in a clear way and frame research in order 'to conceptualise the research design, inform data manipulation and interpret the result' (Hew et al., 2019,

p. 13). The model also responds to the long-held claim by critics who argue that the field of EdTech is under-theorized, lacking theory-advancing research as many studies seldom go beyond descriptive or comparative approaches (Hew et al., 2019).

In relation to RQ1, participants reported having more control and autonomy over their learning process, reflecting a shift in the balance of agency (Cendon, 2018). By way of example, students often need to actively define and explore the problems and projects they would like to address in each course, integrating their learning across domains according to collaboration and formality. Students may begin working on a task autonomously, and be asked to connect learning experiences across a range of collaborative contexts, enabling students to apply knowledge and processes from one domain (i.e., formal/individual study, self-regulated) into another (informal, co-regulated, networked), reflecting boundary crossing learning (Kumpulainen & Sefton-Green, 2014).

In relation to RQ2, the model reveals evidence-based strategies and practices highly relevant for OHE, providing guidance for identifying and shaping integrated learning experiences—from formal to informal—when enabled through intentional curriculum design. Online and distance graduate education is a fertile context to support forms of lifewide learning as participants regularly combine full time professional work with part-time study. However, the LE model may also enable student learning in different ways across distinct HE cohorts, such as undergraduate and foundation level programs. Opportunities for connectivity between academic and practical knowledge may also be present as students engage in part-time work, volunteer or service experiences outside of the formal curriculum, perhaps in a less ‘professional’ sense. Building connected designs across distinct HE cohorts enhances the conceptual potential of the LE construct, raising learner awareness of their own learning ecologies while empowering and encouraging agentic practices (Sangrá et al., 2019).

Research on the interconnections between formal and informal learning in OHE has been limited. The current study proposes examining and shaping the links between such forms of learning as a promising focus for program development. Empowering students to develop the capacity for connected and boundary-crossing forms of learning could equip them to adaptively respond to the known and unknown challenges in the field of digital education. Programs could shape connected forms of learning by using the model as an analytical tool to guide the design of tasks across formal/informal and individual/collaborative boundaries, recognizing that online learners regularly blend formal and informal learning networks in OHE (Czerkowski, 2016). A pedagogical implication of the study is that learners should be encouraged to apply knowledge and experiences from formal academic settings to practical domains in the wider world, openly share what they know, support open access to knowledge, and invite feedback from peers, teachers and expertise from others in order to generate new opportunities for learning. Developing and encouraging peer mentorship networks, both within cohorts and across alumni networks (Fung, 2017), may be a productive approach for integrating formal and informal learning, supporting student development and achievement.

Conclusion

The current research has presented a Student Learning Ecologies model to support, enhance and shape connected forms of learning in OHE. The model was developed by

analyzing student experiences of navigating the academic curriculum in tandem with other learning contexts and everyday practices in their lives, grounded in the LE construct. An emphasis was placed on how students translate academic tasks into learning outcomes across formal and informal contexts through learner activity and agency. Drawing on socio-cultural, connectivist, networked and connected learning theories, the proposed model can contribute to the development of OHE with an emphasis on shaping the student experience, developing valued academic competencies and integrating learning across boundaries, building capacities for both lifelong and lifewide learning and professional development.

An individual's LE can be considered a dynamic entity characterized by the depth and diversity of learner activities, agentic practices and resources shaped by formal instruction and social support. As a contribution to practice, the current study proposes exposing and examining the links between formal and informal learning as a productive approach to connecting academic and practical forms of knowledge and experience. The value of a model to support connected learning in OHE is in identifying, exposing and shaping the connections between academic learning, professional practice, and everyday interest-driven learning. To this end, program development could be focused on providing opportunities for students to learn to identify, expose and shape these connections for themselves, equipping them to respond to the collective challenges posed by digital education and networked societies. Connected curriculum designs can inform OHE development across a range of social science disciplines in order to make learning more relevant to the professional futures of students, linked with real-world applications and the ability to solve complex social problems.

The LE construct has many potential applications in HE research and development unrestricted by disciplinary lines, although particularly relevant for applied fields such as education, nursing or business. Future research could be conducted across disciplines with a focus on the relationship between formal and informal learning aiming to understand the complexities, barriers and enablers involved in such entangled forms of learning. Future research could focus on understanding how learning can be empowered and shaped through a connected perspective in online education. As a limitation, theoretical and methodological complexity must be recognized as a challenge and potential limitation as the LE construct has been used and applied in social research over the last 20 years in fragmented and diversified ways. To mitigate potential limitations of the study, special attention was paid to coherence of the construct throughout all phases of the research design, including alignment between the ontological, methodological and epistemological dimensions of the study.

Note

1. OHE is defined as an approach to university teaching and learning where all of the course delivery is facilitated through the internet and networked technologies, in the broader field of educational technology. Educational technology can be considered an umbrella term that covers the activities and field of study where education and learning technologies intersect (Czerniewicz, 2008).

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