

E-Learning Research Report 2017

Analysis of the main topics in research
indexed articles



Credits

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Table of Contents

Foreword	7
Executive summary	9
Introduction	15
Top 20 most frequent topics	17
Topics grouped by subject categories	19
Article classification	25
By methodology	25
By stage of education	26
By type of access	27
Comparison of topics 2016–2017	28
Comparison between the topics identified in 2017 and the trend reports	30
Methodology	32
References	37
Appendix	39



Foreword

This new report primarily addresses the research community and organizations interested in e-learning research. Its main goal is to provide information about where research efforts in e-learning are being focused, identifying all the subject areas and determining their significance and trends. It also includes an analysis of the main topics and characteristics of articles on e-learning published in 2017 that made a notable impact. The intention of all this is to provide an overview of where the most promising lines of research are headed.

This report is promoted by the eLearn Center, a unit at the Universitat Oberta de Catalunya (Open University of Catalonia, UOC), an innovative fully online university. The eLearn Center's goal is to support applied research in e-learning, using data obtained from the institution's users, areas and processes, doing so to benefit innovation and improve the quality of teaching. The eLearn Center works in a variety of fields to offer students the best possible learning experience and to support academic staff in achieving this goal.

Among other services, it analyses and redesigns courses and programmes, organizes themed sessions, studies and selects learning resources, obtains data to improve teaching, and enables experiments and trials in real-life settings. Moreover, one of its strategic activities in the present context is that of monitoring trends in the field of e-learning.

This goal of observing and leading a change in the educational model is the motivation behind this report. In order to promote innovation, there must be a prior process in which existing initiatives are identified. Accordingly, the report includes a list of the topics that are of most interest to researchers and research centres around the world.

This knowledge of the existing reality provides the starting point for facilitating, redirecting and promoting innovative initiatives for integrating new trends in education. And also, above all, for increasing knowledge and making an impact on society.

Lluís Pastor
Director of the eLearn Center
Universitat Oberta de Catalunya



Nowadays there are a multitude of reports available on all sorts of trends: technology, education, economy, etc. They all play a very valuable role in organizations, helping decision makers in contexts where a single mistake can lead to losses, failure and even the disappearance of the organization. Therefore, money invested in a report can help save money in the future.

However, if so many reports are already available, why create a new one? Most of the reports are based on news and trends from the previous year, following the curve of Gartner's hype cycle. For most authors it is difficult to avoid media pressure and very often we will find the same keywords in almost every report. Most of the reports on 2017 will probably talk about artificial intelligence and virtual reality. It is like looking at the peaks, but not at the true background below those peaks. Therefore, a report written from outside the media trends of the last year would be a counterpoint. This is what we hope to provide.

How can a report look for the trends in the background while avoiding the influence of the popular keywords? The approach used in this report is to look at the research. Research is a long-term effort: usually it takes several months to prepare a research project, months or years to develop it, and then to publish the results yet more months or years still. Thus, when looking at trends in research, we smooth the peaks and look at the topics that are most important – not because of a 'fad' but because of their background.

Rather than reporting on important trends from 2017, this report provides information on topics that have been important over a number of recent years and have blossomed in 2017.

I hope you find it interesting.

Antoni Pérez Navarro
Deputy Dean of Research of the eLearn Center
Universitat Oberta de Catalunya

Executive summary

What do the articles on e-learning published in academic journals during 2017 talk about? To answer this question we analysed all the impact publications made during this period, with the aim of drawing a map that is useful for seeing where research efforts have been focused in recent years and what topics feature in indexed scientific publications.

The report has analyzed 855 articles obtained from the two main databases for scientific articles, Scopus and Web of Science¹.

All the results are summarised graphically below. Figure 1 shows the 20 most frequently featured topics according to the analysis of the articles, that is, the main topics covered in the publications analysed. Figure 2 shows these topics grouped in categories to give a clearer perspective. Articles were also classified in accordance with the research methodology used (Figure 3), the stage of education they focus on (Figure 4) and type of access to the publication, that is whether they are open access or not (Figure 5).

There is a comparison of the data obtained in this report with the data corresponding to 2016 (eLearn Center [eLC], 2017) (Figure 6). The report also compares the research topics from 2017 with the selected trend reports for the 2012–2017 period, *Horizon Reports and Innovating Pedagogy* (Adams Becker et al., 2017; Ferguson et al., 2017; Freeman, Adams Becker, Cummins, Davis & Giesinger, 2017; Sharples et al., 2012, 2013, 2014, 2015, 2016) as displayed in Figure 8.

¹ See the Methodology section for the search and sample selection criteria, a detailed explanation of the methodology and the coding and analysis procedure followed.

20 most frequent topics²



Figure 1. Topics ordered by frequency.

² See Appendix 1 for a detailed list of all the topics (codes) identified and their grouping by categories.

Topics grouped by subject categories

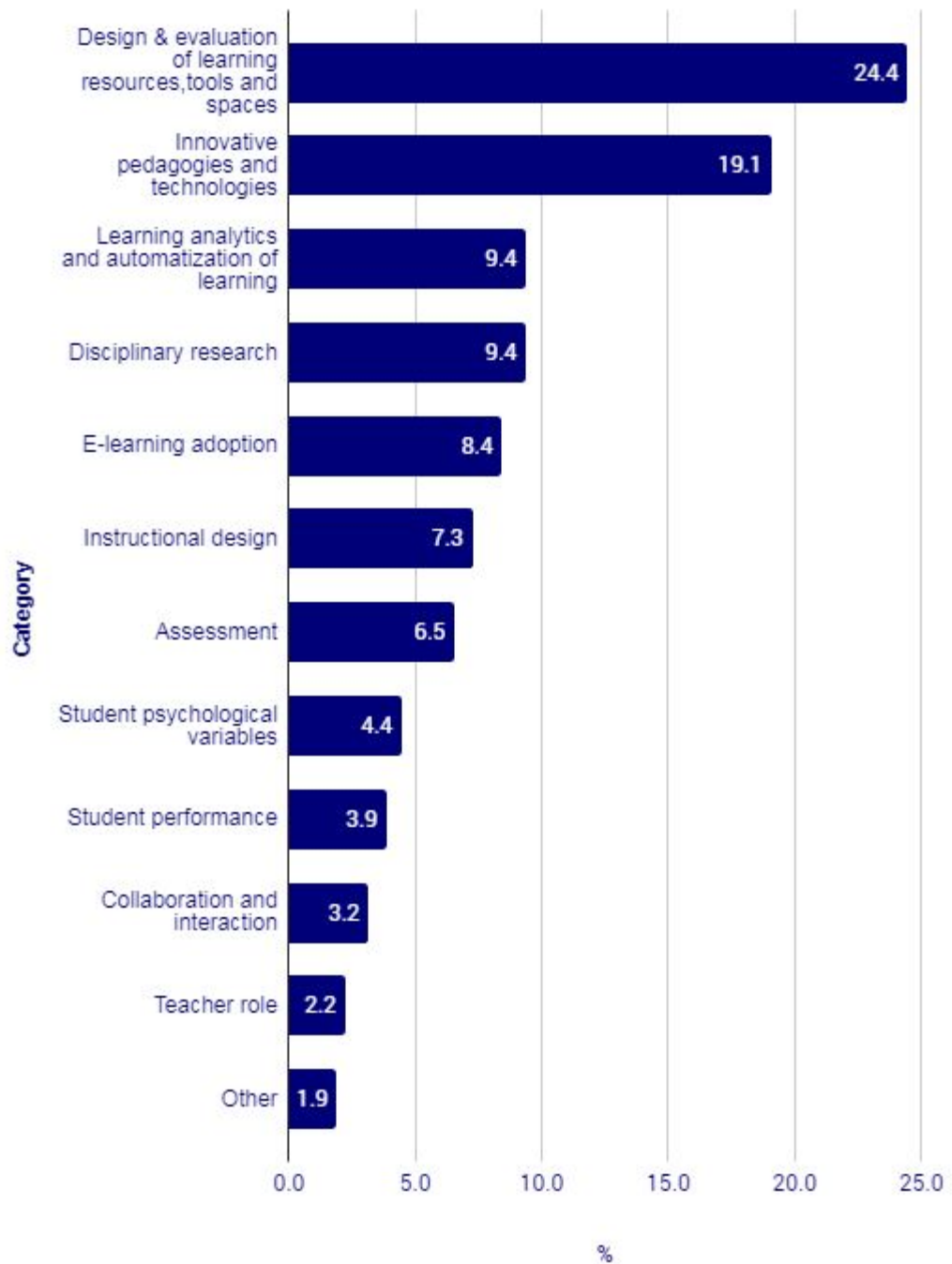


Figure 2. Categories (topic grouping) ordered by frequency.

Article classification:

– By methodology

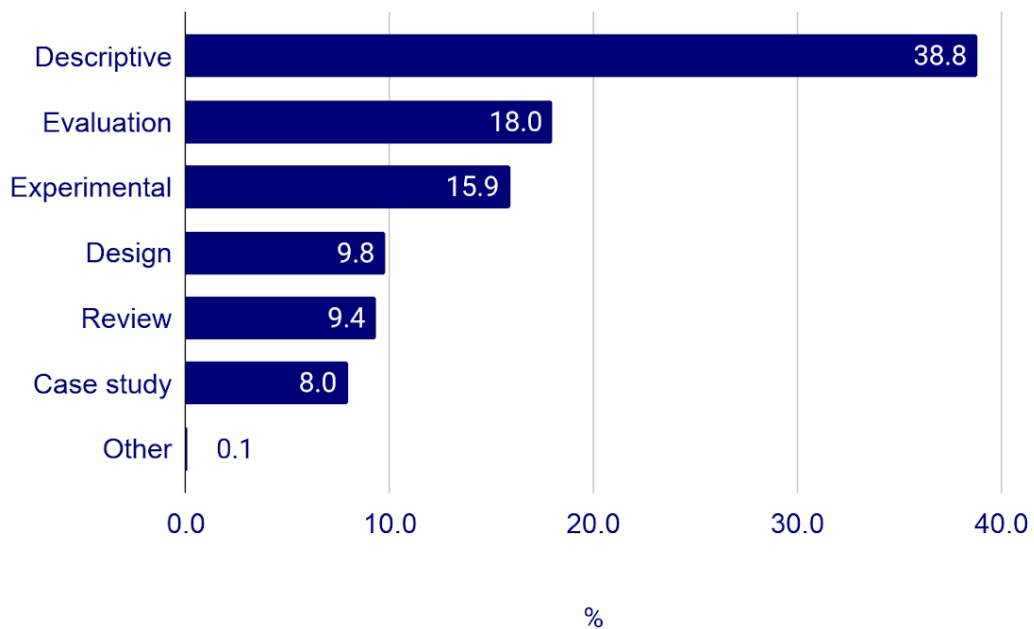


Figure 3. Article methodology ordered by frequency.

– By stage of education

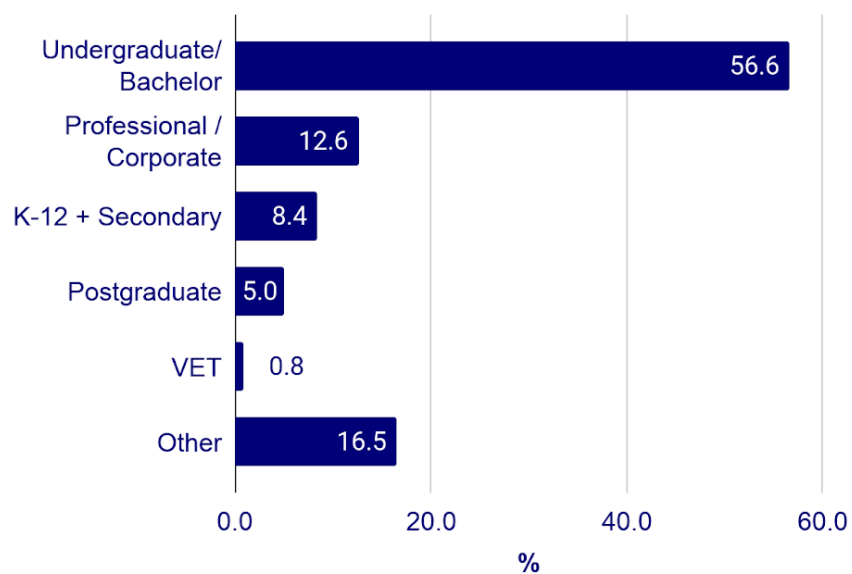


Figure 4. Stage of education ordered by frequency.

- By type of access. Depending on whether they are open access (OA) or non-open access (Non-OA) articles

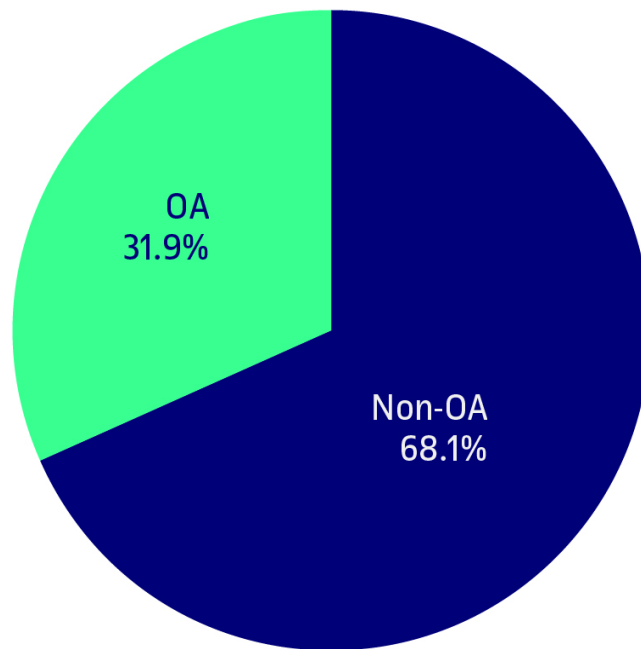


Figure 5. Open access or non-open access articles by frequency

2016 and 2017 topics comparison

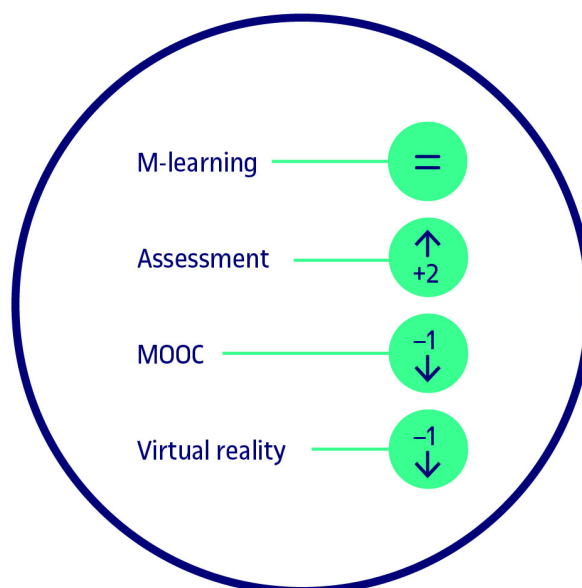


Figure 6. Trend among the topics identified in 2016 and 2017

Comparison between the topics identified in 2017 and the trend reports

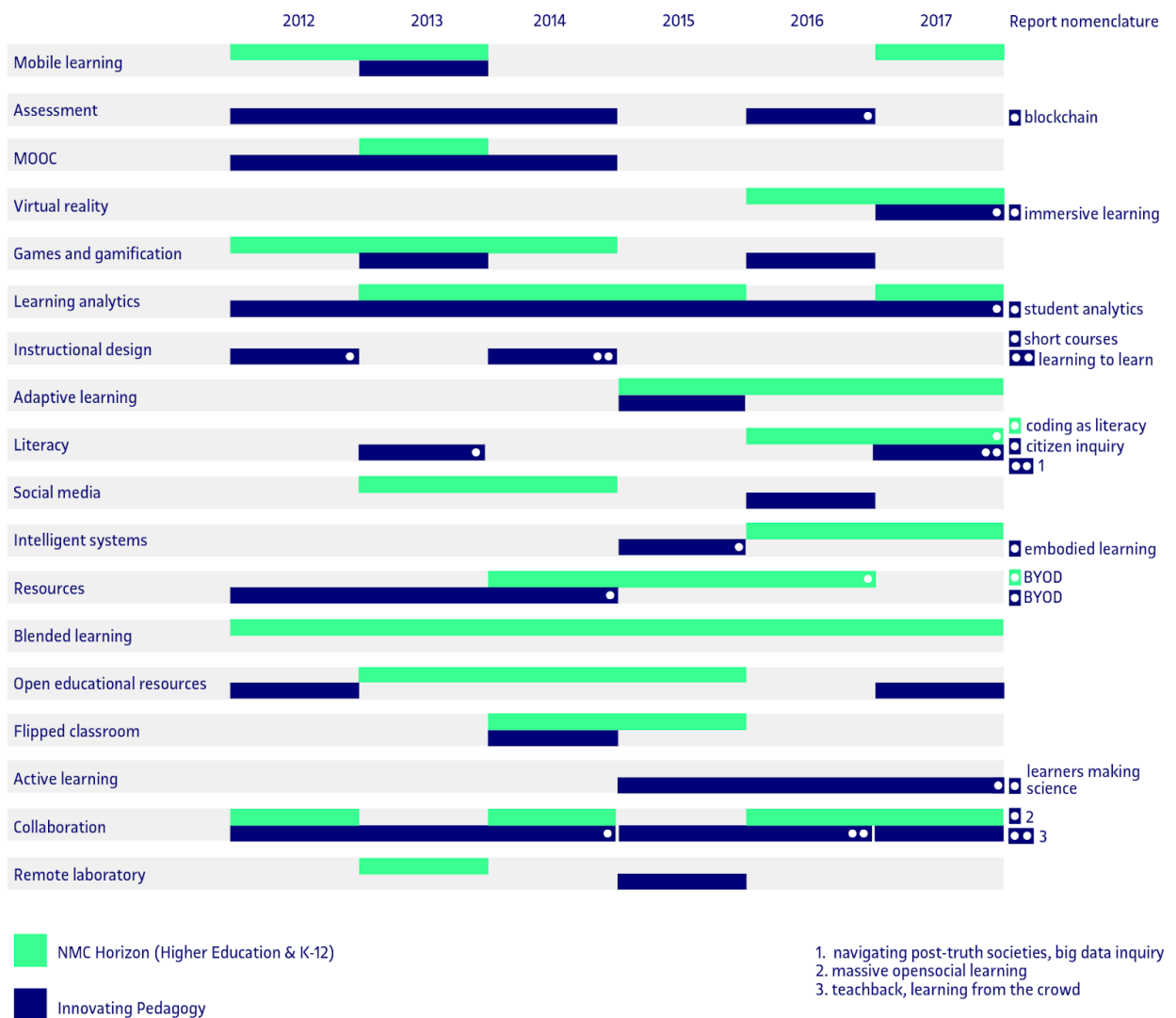


Figure 8. Comparison between topics and trend reports 2012–2017

Introduction

The E-learning Research Report 2017 was written by the Universitat Oberta de Catalunya's eLearn Center. Its primary goal is to report on the e-learning subject areas that have been most researched in impact publications during 2017. The information should be useful for researchers, research groups and educational institutions interested in e-learning and digital education.

E-learning is a growing field (Area & Adell, 2009; Bates, 2015; Docebo 2014, 2016). Traditionally it has referred to full-scale distance education (elements such as platforms, online classrooms, teaching roles, tutors, multimedia, interactive tools, resources, and computer-supported collaborative learning). Normally it has been practised in higher education and corporate and occupational training contexts as a part of lifelong learning. However, with the emergence of new open and mobile platforms and web apps, a range of possibilities has opened to facilitate teaching and learning processes in fully on-site or blended environments. As a result, e-learning has been implemented in all educational systems, transcending the traditional idea of distance education.

Technological innovations have led to the development of effective new methods – emerging pedagogies – that have been identified in reports on e-learning trends and have been taken to all stages of education (K-12, secondary education, vocational training, etc). Examples include experiences based on mobile learning, game-based learning, MOOCs, the flipped classroom, and learning analytics, all of which are becoming increasingly visible (Gros, 2016).

The information provided by this report shows where the resources and efforts for e-learning research are being focused. It also indicates characteristics of the types of article that pass indexed journals' review processes, namely, the type of methodology followed, the stage of education, and whether or not they are open access. Lastly, it also shows us whether the main research topics identified have featured in previous years' e-learning trend reports (Horizon Reports and Innovating Pedagogy).

Having information on the subject areas researched over a period of time helps analyse and monitor the emergence, consolidation or decline in interest of different topics related with e-learning.

The report has five sections:

- Top 20 most frequent topics.
- Topics grouped in subject categories.
- Classification of articles by methodology, stage of education and, lastly, whether the publication is open or non-open access.

- Comparison between the research topics identified in 2017 and those analysed in 2016.
- Comparison with reports on innovative, forward-looking trends. The main topics detected in the articles published in 2017 are compared with reports published over recent years focusing on future trends.

All of the information was obtained from the two leading databases for scientific publications, Web of Science (Thomson Reuters) and Scopus (Elsevier). An analysis was performed of the articles obtained. The data collection and analysis process is explained in detail in the Methodology section, at the end of the report.

Top 20 most frequent topics

After an iterative classification process, each of the articles making up the sample was identified with a topic. Of the 68 main research topics or subjects identified in the analysis of the impact articles related with e-learning and published during the 2017, the 20 most frequent are shown below (Figure 1)³.



³ See the Appendix for a list of all the topics identified.

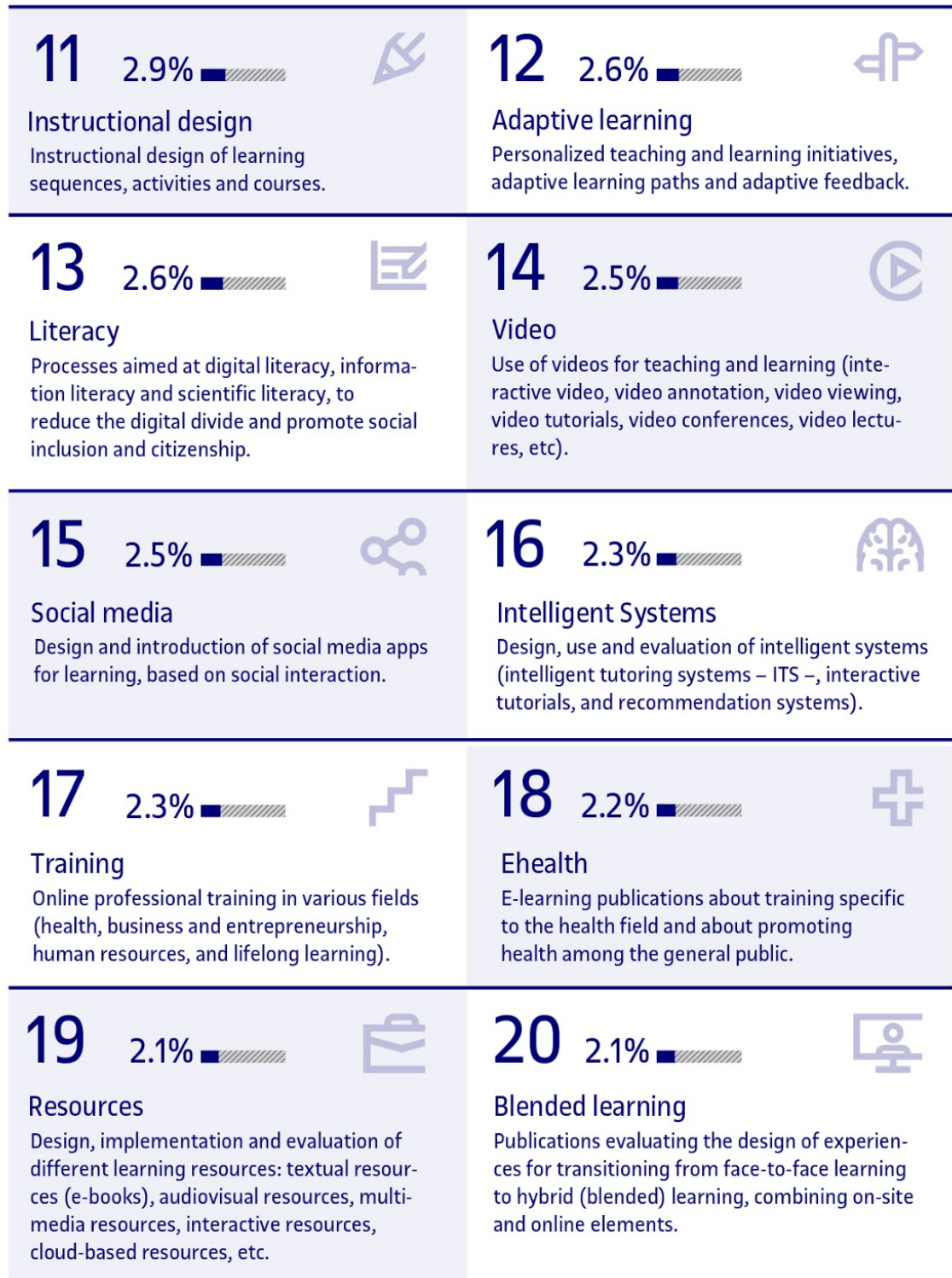


Figure 1. Topics ordered by frequency.

Topics grouped by subject categories

After identifying the articles' topics (see Figure 1 and Appendix), the 68 topics were grouped into 12 categories or subject families. With this grouping, as seen in Figure 2, the two most frequent categories are related with innovation aspects; in first place is the design and development of resources, tools or spaces, and this is followed by articles referring to innovative pedagogies and technologies:

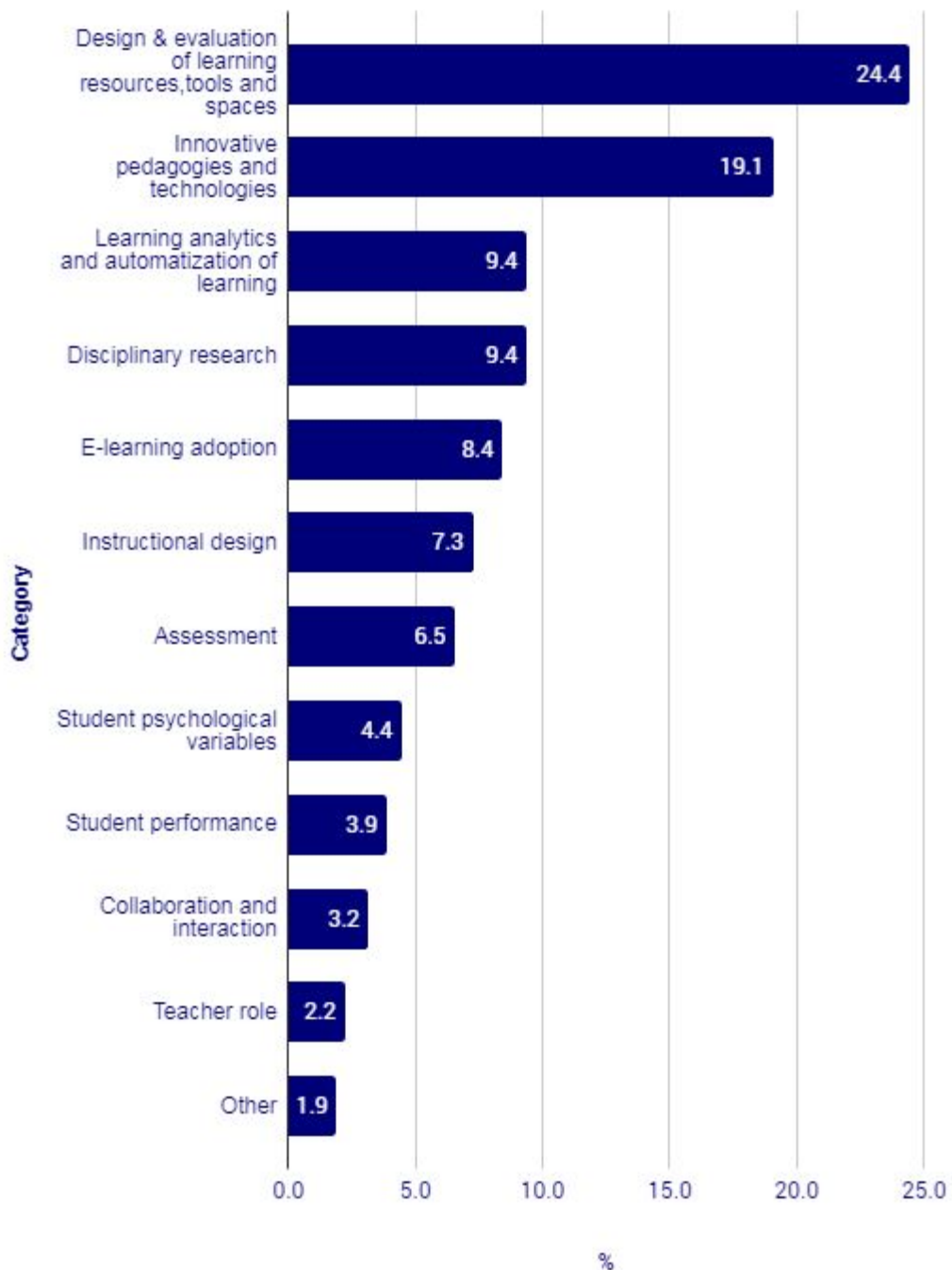


Figure 2. Categories (topic grouping) ordered by frequency.

In the following tables, a description is given of each category and the topics included in it are listed, indicating the corresponding percentages within the category:

Table 1. Frequency and percentage of articles about each topic within the category ‘Design and evaluation of learning resources, tools and spaces’

Design and evaluation of learning resources, tools and spaces		
Design, develop and evaluate resources. Validate designs. Describe the functioning and assessment of the resources' effectiveness.		
Topic	Freq	%
MOOC	37	17.7
Platform	26	12.4
Course evaluation	26	12.4
Tool evaluation	25	12.0
Video	21	10.0
Social media	21	10.0
Resources	18	8.6
Open educational resources	17	8.1
Remote laboratory	14	6.7
Library	4	1.9
TOTAL	209	100.0

Table 2. Frequency and percentage of articles about each topic within the category ‘Innovative pedagogies & technologies’

Innovative pedagogies & technologies		
Implement innovative methodologies in education.		
Topic	Freq	%
Mobile learning	54	33.1
Virtual reality	34	20.9
Games and Gamification	32	19.6
Flipped classroom	17	10.4
Active learning	16	9.8
Augmented reality	8	4.9
Narrative	2	1.2
TOTAL	163	100.0

Table 3. Frequency and percentage of articles about each topic within the category ‘Learning analytics and automatization of learning’

Learning analytics and automatization of learning		
Describe and predict behaviours or emotional states from the analysis of data generated in e-learning environments. Provide support for teachers' decision-making. Facilitate the adaptation and personalization of learning and the automation of processes.		
Topic	Freq	%
Learning analytics	25	31.3
Adaptive learning	22	27.5
Intelligent systems	20	25.0
Computer-aided instruction	5	6.3
Prediction	4	5.0
Emotion recognition	2	2.5
Gesture recognition	2	2.5
TOTAL	80	100.0

Table 4. Frequency and percentage of articles about each topic within the category ‘Disciplinary research’

Disciplinary research		
Design, implement or evaluate e-learning proposals related with a specific field of knowledge. The most relevant aspect here is the knowledge area.		
Topic	Freq	%
Literacy	22	27.5
Training	20	25.0
ehealth	19	23.8
Language learning	5	6.3
Special education	5	6.3
Prison	2	2.5
Preschool	2	2.5
Feminist pedagogy	2	2.5
E-leadership	2	2.5
Artistic pedagogical technology	1	1.3
TOTAL	80	100.0

Table 5. Frequency and percentage of articles about each topic within the category ‘E-learning adoption’

E-learning adoption		
Integrate e-learning initiatives in areas where none existed, replace or update proposals, measure the acceptance of tools and platforms, and evaluate satisfaction or the variables defining success and efficiency.		
Topic	Freq	%
E-learning adoption	33	45.8
Acceptance	14	19.4
Satisfaction	14	19.4
E-learning success factors	7	9.7
E-learning efficiency	4	5.6
TOTAL	72	100.0

Table 6. Frequency and percentage of articles about each topic within the category ‘Instructional design’

Instructional design		
Research on the design of distance or blended instructional materials, curriculum or courses.		
Topic	Freq	%
Instructional design	25	40.3
Blended learning	18	29.0
Course design	13	21.0
Curriculum design	3	4.8
TPACK	3	4.8
TOTAL	62	100.0

Table 7. Frequency and percentage of articles about each topic within the category ‘Assessment’

Assessment		
Evaluate learning (use of rubrics, formative assessment, e-assessment) or teacher feedback.		
Topic	Freq	%
Assessment	42	75.0
Feedback	13	23.2
Cheating	1	1.8
TOTAL	56	100.0

Table 8. Frequency and percentage of articles about each topic within the category ‘Student psychological variables’

Student psychological variables		
Study the influence of students' psychological and cognitive aspects on their learning process.		
Topic	Freq	%
Motivation	9	23.7
Self-regulation	9	23.7
Learning style	8	21.1
Cognitive load	7	18.4
Student psychological variables	5	13.2
TOTAL	38	100.0

Table 9. Frequency and percentage of articles about each topic within the category ‘Student performance’

Student performance		
Ascertain and evaluate students' performance, skills and behaviour.		
Topic	Freq	%
Student performance	12	36.4
Skills	11	33.3
Dropout	6	18.2
Learner support	3	9.1
Agency	1	3.0
TOTAL	33	100.0

Table 10. Frequency and percentage of articles about each topic within the category ‘Collaboration and interaction’

Collaboration and interaction		
Address collaboration and aspects related with communication or interaction between people involved in education.		
Topic	Freq	%
Collaboration	15	55.6
Communication	9	33.3
Interaction	3	11.1
TOTAL	27	100.0

Table 11. Frequency and percentage of articles about each topic within the category ‘Teacher role’

Teacher role		
Study the teacher's role in e-learning, focusing particularly on teaching strategies, the role of the tutor and the perception of social presence.		
Topic	Freq	%
Teacher	13	68.4
Social presence	6	31.6
TOTAL	19	100.0

Table 12. Frequency and percentage of articles about each topic within the category ‘Other’

Other		
Non-groupable research devoted to studying research methodology or trend analysis, among others		
Topic	Freq	%
Research methods	8	50.0
Trends	4	25.0
Surveillance	2	12.5
Class formation	1	6.3
Decolonisation	1	6.3
TOTAL	16	100.0

Article classification

By methodology

To classify the articles by the methodology used, seven labels were chosen for their ability to take into account the main approaches to the different types of social science research. Each of the 855 articles was associated with a single research methodology. Figure 3 shows the distribution of the articles based on the research methodology used⁴:

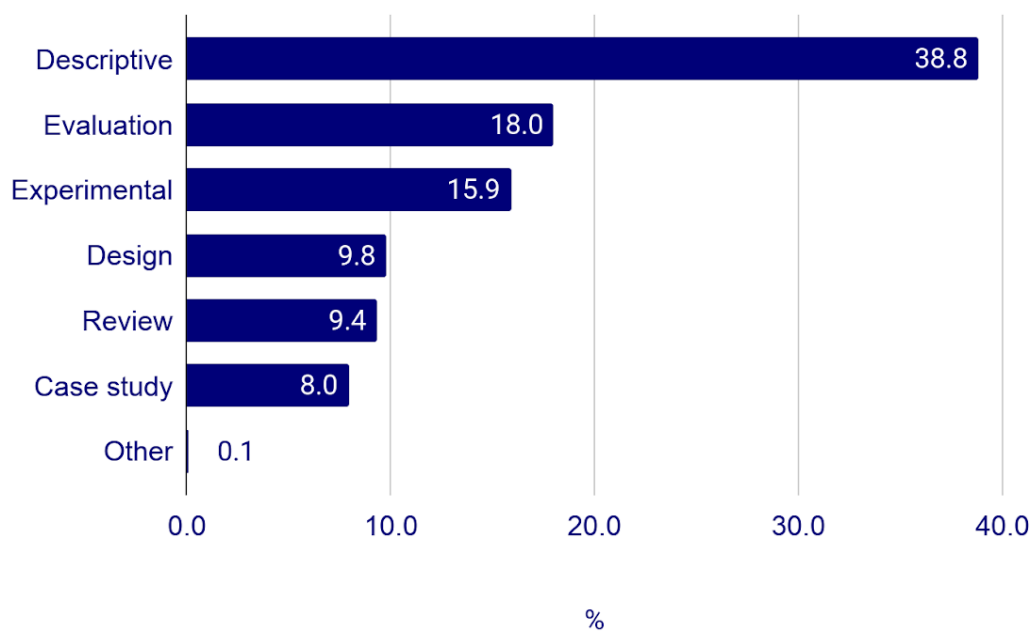


Figure 3. Article methodology ordered by frequency.

Descriptive research accounts for the largest proportion (almost 39%), ahead of experimental or quasi-experimental research methodologies (almost 16%). Case studies only account for 8%. Although the case study is considered a type of descriptive research, we decided to differentiate it because it is a particularly characteristic approach used in the social sciences. However, if we add it to descriptive research, it would account for a total of 46.8% of the publications analysed. Evaluative research also has a significant presence, as many of the studies analysed (categories: e-learning adoption, tool evaluation, course evaluation) were undertaken to evaluate initiatives. Research in which designs are presented account for almost 10% of the articles analysed.

⁴ See the Methodology section for a detailed description of what is included in each code.

By stage of education

Five labels were defined to identify the stages of education studied in each case. The sixth ('Other') groups research articles involving more than one stage or where the stage is not specified⁵:

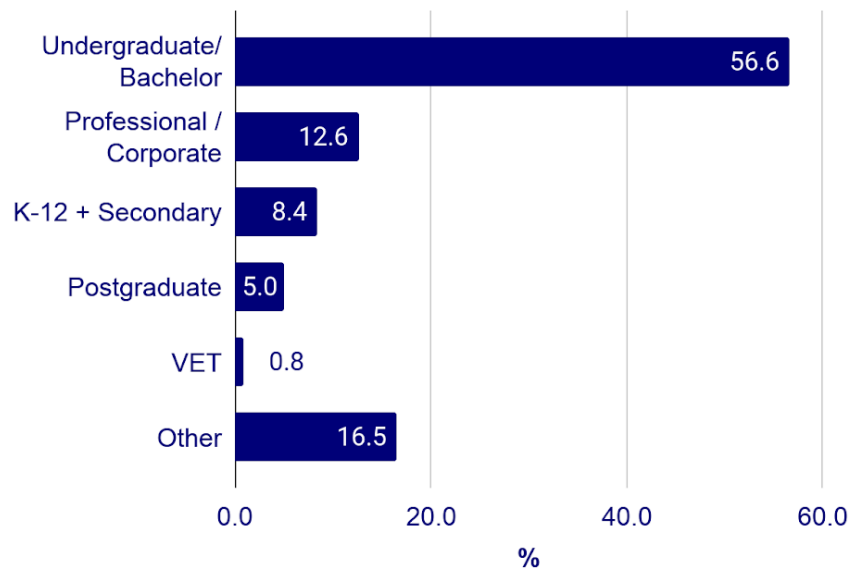


Figure 4. Stage of education ordered by frequency. .

There is a clear dominance of research focused on undergraduate studies (56.6%), with the other stages having much lower percentages. Publications on pre-university research (K-12 and secondary) account for less than 8.5%, in spite of being stages that attract a growing number of innovative proposals and projects related with e-learning. The second context with most research is the professional context but, with 12.6%, it lags far behind undergraduate research. Postgraduate research accounts for a very small percentage (5.0%), while published research on vocational education and training (VET) is residual (0.8%). The code 'Other', which is given as the second most frequent category, includes theoretical review publications, those that refer to more than one stage of education, longitudinal studies or articles in which the stage of education is not specified.

⁵ See the Methodology section for a definition of each stage.

By type of access

Depending on whether they are open access or non-open access articles

In this section all the articles were classified by what type of access they allow. Open access is understood to include publications that are freely accessible at no charge, allowing barrier-free reading, downloading or distribution. There are numerous initiatives and supports with the purpose of facilitating a transition toward a model of scientific communication based on open access to publications (Budapest Open Science Initiative, 2002; CRUE, 2004; Max Planck Gesellschaft, 2003).

Our analysis is confined to the gold open access option, where the author publishes directly in an open access journal (an option also known as diamond access), or alternatively chooses to pay the journal for the article to be made available in open access. We did not include the green open access option. This is a self-archival option in which the authors publish the article in free-access repositories (personal or institutional).

A total of 31.9% of all the articles analysed are open access and 68.1% are non-open access (subscription). Thus, the publications made under the umbrella of open science are still in a minority. However, if we look at the official data on open access publications over the years, without confining ourselves to social sciences research, the trend is for the percentage to increase. The data published by the European Union's Open Science Monitor (2016) on gold open access indicate a steady increase, from 3.84% in 2005 to 15.76% in 2015. To gain a clearer picture we will need to watch the data closely over coming years to see what the specific trend is for articles about e-learning.

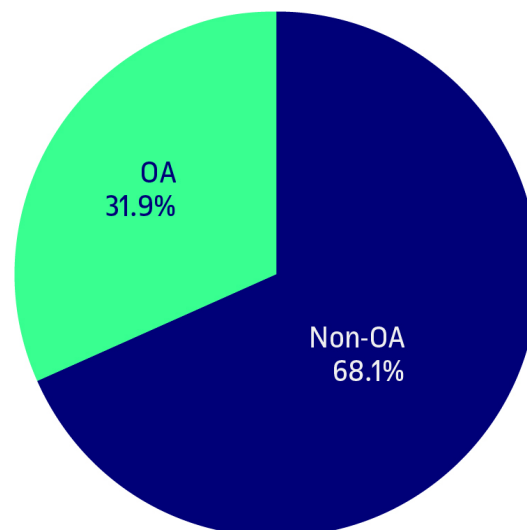


Figure 5. Open access or non-open access articles by frequency.

Comparison of topics 2016–2017

At the end of 2016, the eLC performed a preliminary identification of e-learning research topics, based on journals indexed in Web of Science and Scopus during that year (eLC, 2017). This observation enables a number of comparisons to be made with the topics described this year. It should be understood that this comparison is based on topics and not on grouped categories. In some cases, the journals' interests in certain topics increased, in particular the top four topics which, albeit in a different order, were the same in both 2016 and 2017.

Mobile learning' was the most frequent topic during 2016 and this leadership is consolidated during 2017. 'Assessment' moved up two places while 'MOOCs' and 'Virtual reality' both dropped one place. If we use position as our reference and not percentage, Figure 6 shows whether there was an increase or decrease in each of the trends between 2016 and 2017.

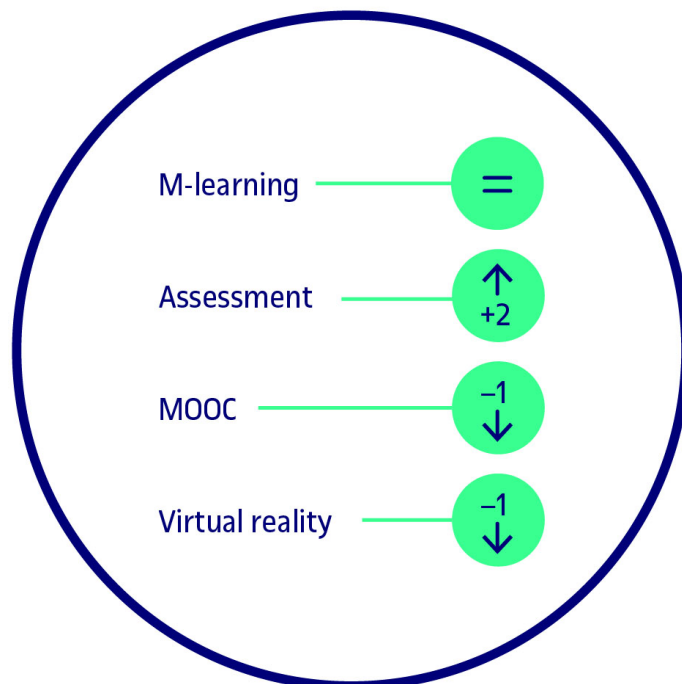


Figure 6. Trends among the topics identified in 2016 and 2017

If we perform the same comparison considering the 20 most frequent topics in 2017, we can see that there are 12 that are also included in the top 20 in 2016, although with different growth trends.

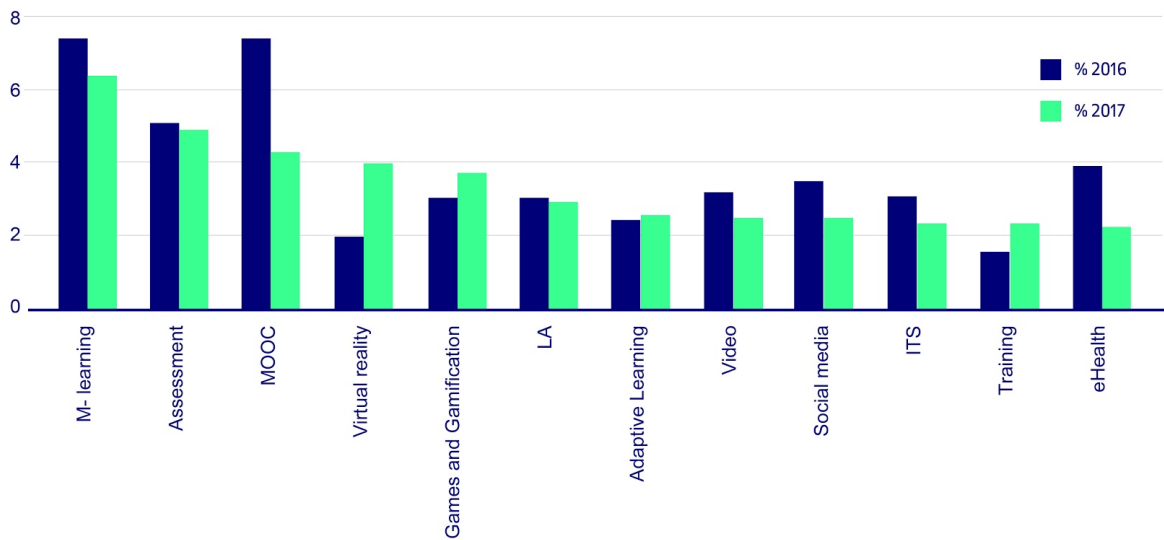


Figure 7. Comparison between most frequent topics 2016–2017.

Table 13. Comparison of the frequency and percentage of the most frequent topics in 2016 and 2017

Topic	2016		2017	
	Frequency	%	Frequency	%
M-learning	19	7.4	54	6.3
Assessment	13	5.0	42	4.9
MOOC	19	7.4	37	4.3
Virtual Reality	5	1.9	34	4.0
Games and gamification	8	3.1	32	3.7
Learning analytics	8	3.1	25	2.9
Adaptive learning	6	2.3	22	2.6
Video	8	3.1	21	2.5
Social media	9	3.5	21	2.5
ITS	8	3.1	20	2.3
Training	4	1.5	20	2.3
eHealth	10	3.9	19	2.2
Total	258		855	

Compared with 2016, 2017 saw an increase in the percentage of publications related with virtual reality, games and gamification, adaptive learning and training. It should be remembered that the 2017 analysis had a greater diversity of topics and the sample was broader, which meant that most of the percentages were lower than the previous year.

Comparison between the topics identified in 2017 and the trend reports

In this section, a comparison is made between the main research topics of the publications made in 2017 and the trends identified in popular reports such as Innovative Pedagogy and Horizon Reports (Adams Becker et al., 2017; Ferguson et al., 2017; Freeman et al., 2017; Sharples et al., 2012, 2013, 2014, 2015, 2016).

The New Media Consortium's (USA) Horizon Reports point to trends in the adoption of educational technologies both in higher education and at lower levels (pre-school and compulsory education) in the short, medium and long term. These reports draw their conclusions from a systematic review of the general literature (grey literature too), with subsequent discussion by a panel of experts. The Innovating Pedagogy reports are a series of annual publications that began in 2012 and are produced by the Open University's Institute of Educational Technology (UK) in collaboration with different research centres. Their goal is to identify ten innovations that are already observed but which may go on to become increasingly influential in the field of education.

The difference between our report and the trend reports are, first, the sources analysed, and second, the goal (see Table 14).

Table 14. Difference between the trend reports and this research report

	E-learning Research Report 2017	Reports on trends: Horizon Reports & Innovating Pedagogy reports
Source	Indexed journals (Web of Science & Scopus)	General literature and expert panels
Main goal	Determine the topics on which researchers are focusing their work. Draw a map of the present situation of completed publications.	Determine the educational technologies that are being adopted. Make a forecast of future developments.

Below we list the main trends in e-learning research in 2017, relating them with the years that were included in recent years' editions of NMC Horizon Reports and Innovating Pedagogy (Adams Becker et al., 2017; Ferguson et al., 2017; Freeman et al., 2017; Sharples et al., 2012, 2013, 2014, 2015, 2016):

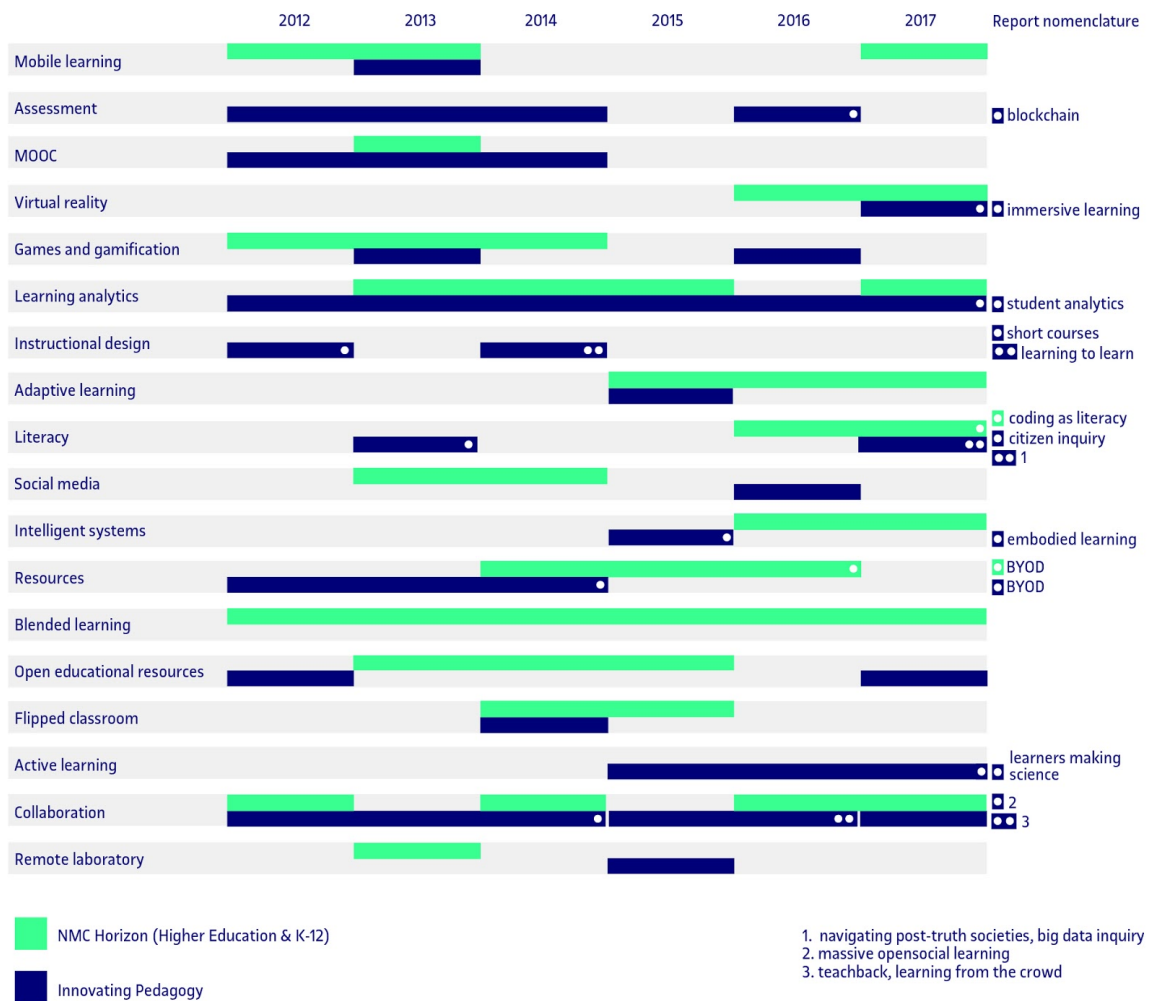


Figure 8. Comparison between topics and trend reports 2012-2017

We can see that there are 18 topics identified in our report that also appear in the reports on e-learning trends. The research trends we consider to be most consolidated are those that are mentioned in both reports during most years. This is the case of ‘learning analytics’, ‘gamification’ and ‘collaboration’ (collaborative learning), which have been found from 2012 to 2017. ‘Mobile learning’, ‘adaptive learning’ and ‘open educational resources’ are also present, although to a lesser degree. We also highlight those trends that, in the last two years, are featured in both reports, such as ‘virtual reality’, ‘literacy’ (digital and information literacy) and ‘smart systems’.

Methodology

This report's objectives can be defined as follows:

Objective 1. Identify the main topics of e-learning research publications and their distinctive features, based on the analysis of articles published during 2017, in English and in journals indexed in Web of Science and Scopus.

For the first general objective, four specific objectives were defined:

- 1.1. Identify a keyword for each article that defines its main subject area.
- 1.2. Identify the stages of education the research focuses on.
- 1.3. Identify the research methodology used in each publication.
- 1.4. Differentiate the articles published in open access format from those that require subscription.

Objective 2. Compare the main topics of the research articles published in 2017 with the topics identified in 2016.

Objective 3. Compare the main topics of the research articles published in 2017 with the innovative trends in e-learning featured in leading reports such as Horizon Reports (New Medium Consortium) and Innovating Pedagogy (The Open University) during the period 2012–2017.

In order to meet the objectives proposed, a series of general criteria were established for choosing the sources for the sample of articles to be analysed. Two databases were used, Web of Science (WoS) and Scopus. These are the main international databases of bibliographical references and citations from periodical publications. Web of Science is owned by Thomson Reuters and Scopus belongs to Elsevier. They are only accessible through the subscriptions made by universities and other research and innovation centres.

This report did not consider any specific parameter related with the articles' quality. The fact that the publications were indexed in these databases guarantees a sample of articles that have undergone a review process, the most common being the double-blind peer review. This is not a bibliometric review, as it does not take into account the journals' impact factor but only the publications' frequency, organized in accordance with the criteria that have been defined.

The data processing consisted of an initial coding phase, in which units for textual analysis were identified and converted into codes. The code associated with each article is simply a descriptive label of each publication's topic. First of all, the main topic of each article was identified. This topic identification phase was iterative, refining the codes until

a single code was obtained for each article. Subsequently, the topics were organized and grouped in categories, in other words, the codes were simplified in accordance with more general subject categories, with the goal of summarizing them and making them easier to represent and interpret (Creswell, 2012). Second, a coding process was carried out to identify the methodology used in each article. Third, the publications were grouped by six codes defining the stage of education. Finally, they were coded dichotomously (open/non-open) depending on the type of access to the publication.

Description of the data collection and analysis process

The search criteria used to obtain the articles in the two databases were as follows:

- Keywords: articles that contain ‘elearning’, ‘e-learning’, ‘distance education’ or ‘digital education’ as keywords, in the title or abstract. Boolean search formula: ‘elearning’ OR ‘e-learning’ OR ‘distance education’ OR ‘digital education’.
- Publication period: January to December 2017.
- Document type: articles (books, book chapters, congress papers and reviews, letters, editorials, notes, surveys and business articles were excluded).
- Area of knowledge: social sciences.
- Language of the articles: English.

After entering the search criteria in the two databases, 748 results were obtained in Scopus and 699 in WoS, giving a total of 1,477 documents.

The results were exported as a spreadsheet. To facilitate analysis, the results from both platforms were combined into a single spreadsheet. This enabled articles that were repeated in the two databases (272) and those that did not meet the requirements (they were not articles or were not written in English) (320) to be identified and removed, giving a total of 855 articles that made up the final sample.

Table 15. Make-up of the sample

Scopus articles	748
WoS articles	699
TOTAL	1477
Repeated articles	272
Excluded articles	320
TOTAL	855

In order to identify their individual topics and features, the following descriptors were used to analyse the articles:

- Each article's keywords.
- Methodology: case study, descriptive, experimental, design, review, evaluation, other.
- Stage: K-12 & secondary, undergraduate/bachelor, VET, postgraduate, professional/corporate, other.
- Journal type depending on access restriction to its contents: open access or non-open access articles.

In order to carry out the coding process, two experts in e-learning and e-learning research systematically read each article's abstracts and keywords, complementing this with a more extensive reading when necessary. The coding and categorization process was supervised by a third researcher, also an expert in e-learning.

The identification and classification of data was an open, flexible process, involving a mixed (inductive-deductive) code construction procedure. It started with certain pre-established codes that were modified and expanded to adapt them as the process advanced. For example, for 'method', a decision was made to combine experimental and quasi-experimental in a single label based on the comparison of one or more groups in which one of them acts as control, and the code 'evaluation' was added for evaluative studies. For 'stage', a decision was made to add 'postgraduate', 'vocational education and training' and 'professional/corporate'.

In choosing the articles' topics, the proposals made by the authors and the system were taken into account, as was the [Thesaurus](#) ERIC database. However, the selection was not confined to just these, as this limited scope would not encompass the diversity of topics that are currently the subject of research. At the end of the process, all of the articles were labelled with a main keyword that defined them. In all cases, the keyword chosen had to be the one that represented the article's most significant topic.

Once the articles had been coded, they were grouped with identical or similar topics. Initially, 97 topics were obtained that encompassed several keywords related with e-learning. In a second coding iteration, the number of topics was reduced to 68, merging those that were identical even though they had different names (for example, 'm-learning' and 'mobile learning' or 'flipped classroom' and 'flipped learning').

The different topics were then grouped by frequency of appearance and the infrequent topics ($n < 5$) were included in a separate category called 'Other'. Subsequently, the topics were classified into a total of 12 subject families or categories, ordered by frequency of appearance and including the associated codes and descriptors. To obtain

the list of more popular topics, no limit was placed on the number of infrequent ($n < 5$) topics.

At the same time, the frequencies and percentages were calculated in order to describe the types of article by research methodology used, stage of education, and whether or not they were open access.

As regards the research methodology used in the articles, the classification was based on seven categories:

Table 16. Description of the types of research methodology used in the articles analysed

Descriptive research	This category includes research that describes the study variables at a specific moment or over a period of time by means of surveys, interviews, focus groups, correlations or comparisons, among others.
Evaluative research	Evaluative research evaluates results obtained in the implementation of a course, teaching programme, platform or tool.
Experimental and/or quasi-experimental research	This research involves the existence of a control group and a test group in which the independent variable has been manipulated so that results can be compared across groups.
Design and design-based research	This category includes research focused on the design of courses, programmes, platforms or teaching tools.
Review	These studies are reviews of the existing literature to ascertain a specific subject's state of the art. Systematic reviews are included in this category.
Case study	Even though this is a type of descriptive research, we wanted to differentiate it because it is in-depth, 100% qualitative research focused on a specific context, often with small samples (the case under study) and based on observation and interviews.
Other	This category only had one article, which talked about a different methodology, based on a speculative method and related with the study of emerging technologies in education.

For the stage of education, six codes were established and used to classify each of the articles analysed. They are described below:

Table 17. Description of the stages of education in the articles analysed

K-12 and Secondary	Primary and secondary education, understood as all education prior to higher education. Above all in the first stage and depending on the country, it is a compulsory stage of education.
Undergraduate / Bachelor	Post-secondary stage prior to postgraduate education. Depending on the geographical area, it is known as 'undergraduate' or 'bachelor'. This education is normally offered by higher education institutions such as universities.
VET (Vocational Education and Training)	Education that prepares people for their professional career. Depending on the region, it may be given after the secondary education stage or in higher education.
Postgraduate	Studies to obtain specific academic or professional qualifications after obtaining the bachelor's degree. The structure varies from country to country but, in most cases, it includes master's and doctoral degrees.
Professional / Corporate	Training for working people, aimed at improving their professional development. It can include both training provided by the organization itself to cover specific training needs or training provided by other educational institutions to accredit knowledge and skills.

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Appendix

Summary table of categories, codes, frequency and keywords.

Design and evaluation of learning resources, tools and spaces	Resources	18	Digital learning materials, multimedia learning materials, e-learning resources, webinar, interactive courseware, google trends, homework, alternative formats, computer animations, cross-media learning, cross-media learning, e-textbook adoption, e-book, digital artifacts, cloud computing, cloud-based m-learning
	Open educational resources	17	Open educational resources, open source, open content, linked open data, reusable learning objects, resource interoperability, open education, open distance learning quality, open courseware, online learning resources, learning objects
	Tool evaluation	25	Tool evaluation, usability, tool validation, tool, testbed, software evaluation, tagcloud, smart pen, quality assurance, PLE, perceived usefulness, Online homework software system, podcast, ipad, internet tool, interactive learning objects, e-learning tool, blog, concept map, concept mapping, concept mapping tools
	Platform	26	Online campus, moodle, e-learning platform, platform evaluation, e-learning platform evaluation, VLE, rich media, scratch, learning management system, interface design, e-learning modelling, e-learning website selection, Intercultural mediation
	Course evaluation	26	Course development, service quality, scale development, distance education challenges, effectiveness, internationalization, self-efficacy, talent management, course evaluation
	Video	21	digital video, automatic captioning, educational video, interactive video, online video, video annotation, video feedback, video lectures, video podcast, video tool, video tutorial, video viewing, skype, videoconference, Lecture recording
	Social media	21	social learning platform, social network, wikipedia, social learning, social media
	Remote laboratory	14	Virtual laboratory, hands on laboratory, remote laboratory
	MOOC	37	Mooc, Mooc design, Mooc evaluation
	Library	4	Digital library, library integration, library services
	TOTAL	209	

Innovative pedagogies and technologies	Active learning	16	Active learning, authentic task, constructivism, Project Based Learning, case-based learning, e-cases, community of inquiry, inquiry-based learning, Problem solving learning
	Flipped classroom	17	Flipped classroom, Flipped learning, inverted classroom
	Mobile learning	54	Mobile learning, m-learning, mobile application, mobile augmented reality, mobile technology, touch screen apps, ubiquitous learning, ubiquitous eTeaching
	Games and gamification	32	Gamification, Game application, game based learning, serious game, simulation game, videogame, digital game, digital card game, educational game, MMOG, digital badges
	Virtual reality	34	Virtual reality, virtual classroom, virtual learning simulations, virtual machine, virtual patient, virtual school, virtual teaching dispositions scale, virtual world, simulation, immersion, 3D
	Augmented reality	8	Augmented reality
	Narrative	2	storytelling, narrative approach
	TOTAL	163	
Learning analytics and automatization of learning	Prediction	4	prediction, core self-evaluation, performance prediction
	Computer-aided instruction	5	CAI, Computer Assisted Instruction, computer-aided instruction, computer-aided learning (CAL), computer-aided software
	Learning analytics	25	Learning analytics, Big data, data visualization, data mining, educational data mining, text conversation analysis, natural language processing, semantic web
	Intelligent systems	20	artificial intelligence, intelligent tutor, Intelligent tutorial system, intelligent tutoring, intelligent tutoring system, ITS, recommendation system, recommender system, Programming Tutoring System, programming online judges (POJ), interactive tutorial, fuzzy logic
	Adaptive learning	22	adaptive learning, adaptive feedback, adaptive navigational support, adaptive systems, computer adaptive tests, adapted education, adapting e-learning system, learning adaptation, learning paths, personalization, personalized learning, personalized learning system, personalized prompting, navigation paths, e-learning ecosystem
	Emotion recognition	2	Emotion recognition
	Gesture recognition	2	Gesture recognition, Facial authentication
	TOTAL	80	

Disciplinary research	ehealth	19	ehealth, medical education, health education, health promotion, healthcare students' perspectives, telehealth, medical studies, nurse education, nurse training, oncology learning, TEL, Technology Enhanced Learning
	Training	20	business training, computer-based training, corporate training, health staff training, nurse training, teacher training, training satisfaction, design thinking, professional e-learning, patient self-management support, new media, lifelong learning, job security, job demand, internship, entrepreneurial university
	Language learning	5	Foreign language Education, language learning, language teaching, sign language
	Literacy	22	Computer literacy, digital literacy, ICT literacy, information literacy, reading literacy, scientific literacy, Digital citizenship, digital divide, digital immigrant, digital inclusion, reading and writing, online writing, note taking, net neutrality, interactive online learning
	Prison	2	mobility, prison education
	Artistic pedagogical technology	1	artistic pedagogical technology
	Preschool	2	Distance education technologies, distance learning technologies in preschool
	Feminist pedagogy	2	feminist pedagogy
	E-leadership	2	e-leadership practices, technology leadership practices
	Special Education	5	disadvantaged students, intellectual disability, special education needs, accessibility, deaf and hard hearing
	TOTAL	80	
E-learning adoption	E-learning success factors	7	e-learning success, e-learning barriers, e-learning success factors, successful factors
	E-learning efficiency	4	e-learning efficiency, e-learning performance,
	Acceptance	14	acceptance, acceptance of learning technology, e-learning acceptance, m-learning acceptance, technology acceptance, technology acceptance model, TAM, technology acceptability
	Satisfaction	14	user satisfaction, student perception (course), satisfaction level, perception, student satisfaction, mentor satisfaction, media preferences, e-learning satisfaction, e-learning strategies, relational coordination model
	E-learning adoption	33	student's e-learning adoption, e-learning adoption, technology integration, e-learning social representation, e-learning level of use, E-learning perception, e-learning practice, organization improvement, organizational change, organizational studies, online vs face to face, online teaching evaluation, e-resources, maturity model, Physical education, mathematics, STEM, e-learning awareness, e-learning demand, learning effectiveness, e-learning integration, governance, government e-learning system, faculty improvement, attitudes, affordances
	TOTAL	72	

Instructional design	Course design	13	Course design, e-learning course design, educational road map, universal design for learning
	Blended learning	18	Blended learning, blended learning assessment, blended learning transition
	Instructional design	25	Instructional design, Instructional setting, e-learning design, course performance, design, learning sequence, experiential learning, evidence based practice, learning process, co-creation, geo information, SPOC
	Curriculum design	3	curriculum design, digital curriculum
	TPACK	3	Pedagogical content knowledge, TPACK
	TOTAL	62	
Assessment	Feedback	13	Feedback, automated feedback, e-feedback, immediate feedback, mentor feedback, students feedback
	Assessment	42	Assessment, Assessment rubrics, e-learning resources assessment, Automatic assessment, Course assessment, Delay assessment, Dynamic assessment, e-assessment, formative assessment, institutional assessment, neurologic assessment, numeracy assessment, peer assessment, readiness assessment, usability assessment, badges, e-exam management, identity authentication, proctor, information security, electronic tests
	cheating	1	cheating
	TOTAL	56	
Student psychological variables	Learning style	8	Learning style, Student learning profile, digital annotations, online student profile, learning strategies, learning algorithms, learner personality
	Motivation	9	Motivation, Engagement, Motivational regulation strategies, user engagement
	Self-regulation	9	Self-regulation, Self-regulated, self-regulated learning, self-learning, self-directed learning,
	Cognitive load	7	workload, cognitive load
	Student psychological variables	5	Stress measurement, social anxieties, attention levels, flow, flow experience
	TOTAL	38	

Student performance	Dropout	6	dropout, dropout prediction, student retention, retention, high enrollment
	Student performance	12	student performance, learning performance, performance, performance measurement, behavior sequence analysis, behaviour forecasting, learning behaviors, learner behaviour
	Learner support	3	learner support, patient self-management support, Student Support Services
	Agency	1	agency
	Skills	11	clinical skills, coaching skills, critical thinking skills, decision-making skills, professional skills, oral presentation skills, skills assessment, professional skills, Competence oriented practice, competency learning, ethical competency
	TOTAL	33	
Collaboration and interaction	Collaboration	15	collaboration script, collaborative learning, collaborative work, online collaborative learning, online collaborative work, network learning, peer learning, learning communities, Interactive networks, e-learning quality
	Communication	9	communication, modes of communication, technical communication, booklet, online discussion, service learning, computer mediated communication
	Interaction	3	online interaction, Interaction
	TOTAL	27	
Teacher role	Teacher	13	teaching strategies, teaching aid, teacher development, instructors, Instructor participatory role, instructor readiness, Tutor, Tutor evaluation, online tutoring, Teaching competence, Tutor competence
	Social presence	6	social presence, software agents, online presence, sense of community
	TOTAL	19	
Other	Class formation	1	class formation
	Decolonisation	1	decolonisation
	Surveillance	2	supervision, surveillance in schools
	Trends	4	trends, distance education, learning quality, online learning
	Research methods	8	design based research, eResearch, research methodology, workshop, virtual ethnography, PLS-SEM, methodology, cross-cultural
	TOTAL	16	