



TRENDS IN EDUCATIONAL TECHNOLOGIES ACCORDING TO ARTICLES PUBLISHED IN THE LAST 20 YEARS IN INTERNATIONAL LITERATURE

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Abstract

The aim of this research is to determine the trends in the field of educational technology by analyzing the bibliometric analysis of the articles about Educational Technology published in the Web of Science Core database in the last 20 years. In this framework, a bibliometric analysis of the articles on educational technology published 2000-2019 was conducted. As a result of the preliminary examination, 96 most used themes in the field of educational technology were reached. These themes are gathered under the headings of Application, Design and Environments, Measurement and Evaluation, Pedagogy and Teaching and Learning. As a result of the findings, a bibliometric analysis of a total of 25 themes was made for 5 main theme findings with the highest number of articles under each main topic. During these analyzes, the most used concepts were analyzed with each theme. VOSViewer version 1.6.13 was used for analysis.

Keywords: Educational technology, bibliometric research, vosviewer, trend analysis, literature analysis.

INTRODUCTION

Educational technology, as a dynamic and interdisciplinary field, has been influenced by constantly changing and developing technology and related learning theories and focused on different educational fields. For this reason, educational technology has been an intense field where researchers are constantly working on and producing scientific publications. Accordingly, it is important for practitioners, researchers, and educators, in the field of educational technology, to follow the academic developments and trends in educational technology (Thompson, 2005). The most used method for determining these orientations and interpreting the results obtained in the bibliometric analysis.

Bibliometric analysis has been defined as an approach to researching publication data within specific science categories or scientific communities (Ivanović & Ho, 2017). Breitenstein (2003, p.32) defined bibliometric analysis as a method of analysis that offers well-tested techniques to characterize the physical and intellectual structure of literature by subjecting the data to the quantitative and qualitative selection, summary, comparison, and analysis methods. Diodato and Gellatly (2013 p.7) stated that bibliometric analysis is a field that uses mathematical and statistical techniques from counting to computation to examine publishing and communication models in the distribution of information. According to the definitions, bibliometric can provide the necessary data for future research by statistically analyzing scientific studies. With the help of bibliometric, researchers can conclude their productivity, subjects, citations, authors, institutions, academic journals, and scientific activity regions



in their studies, enabling them to create scientific maps, construct models and understand scientific growth within the framework of these results (Jacobs, 2010). While Abt (1993) states that the number of published research articles and reviews can be used to assess the amount of science in a given category or community, Brace (1992) argued that citation count can effectively evaluate the quality of science. According to Jacobs (2010), the opportunity to examine the intellectual development of a discipline bibliometrically has become an indispensable research tool.

When the literature was examined, bibliometric studies on educational technology were encountered (Gallegos et al., 2019; Mishra, 2019; Saltan et al., 2018; Tokel & Cevizci-Karataş, 2014; Erdoğan & Çağıltay, 2016). However, due to the high number of publications in most of these studies, the date ranges were very limited. In this study, it was tried to reveal the trends in the studies conducted in the last 20 years by using the VOSViewer application. In this line, it was aimed to determine the orientations of the articles published in Web of Science indexed journals 2000-2019 in the field of educational technology by using VOSViewer application in terms of bibliometric. This study is aimed to cover the last 20 years. This study was carried out and completed in the first quarter of 2020. The WoS Core Database was selected to reach the necessary article information in the bibliometric analysis using the keyword list obtained. Since the journals browsed in WoS, SCI-EXPANDED, SSCI, A & HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI directories can be easily accessed, it was decided to perform keyword searches on this database.

In this study, it is aimed to determine the orientation of the articles published in Web of Science indexed journals published in the field of educational technology between 2000 and 2019 in terms of bibliometrics. In order to get this goal the following research questions were tried to be answered:

- What is the distribution of the articles published on the obtained keywords by years?
- What are the most used concepts with keywords?
- How is the citation analysis of the articles about the keywords in the context of the journal?

METHOD

Research Method

In this study, a bibliometric analysis approach was used. Bibliometric analysis approach is used as an experimental tool to analyze trends in researches, the scientific dimension, impact, and growth rate of researchers, publications, and journals, and to consider the intellectual status in the field (van Eck & Waltman, 2014). With bibliometric analysis, it is possible to analyze the literature numerically and holistically (Ball & Tunger, 2006).

Data Collection

The data used in this study were obtained with the help of the concepts used in the article titles published between 2000 and 2019. To determine these articles, firstly the concepts used in the field of educational technology were determined. For this, the keywords used to classify the articles published by two international journals (Computers & Education, British Journal of Educational Technologies), which have the highest impact factor in the field of educational technology, were used. A total of 54 keywords under ten main headings taken from Computer & Education - Journal and 250 keywords taken from the British Journal of Educational Technologies (BJET) were examined and combined under ten titles. Repeating words were selected and made singular during combining. A list of ten main headings and a total of 250 keywords was obtained. This list was examined by three Ph.D. experts in the field of educational technology and reshaped with expert opinions, the list was finalized with 154 keywords under five main headings.

To search within the scope of WoS, the root form of each keyword was entered one by one in the "Title" field and the searches were performed by entering the value "2000-2019" in the second search line, "Year Published". The wildcard character "*" is used to obtain more comprehensive results in each search and to reach the plural or different word conjugation of the root keyword. Besides, to make research more comprehensive, different words indicating the same concepts were used when necessary.



Abbreviations of more than one word and used words were also used in searches. To access more search results at the same time, the "OR" connector has been added among the criteria. Table 1 shows the keywords and different search texts used in the search.

Table 1. Sample keywords and search texts

Keywords	Search Texts
Facebook	"Facebook*"
Augmented Reality	"Augmented Realit*" OR "AR"
Email	"Email*" OR "E-mail*"
Massively Online Open Course	"Massively Online Open Course*" OR "*MOOC*"
World-wide web	"World-wide web*" OR "www*" OR "World wide web*"
Benchmarking	"Benchmark*"
Mobile Learning	"M-learning*" OR "Mobile Learning*" OR "M learning*"
Communities of practice	"Communit* of practice*"

The data obtained as a result of the search was filtered by selecting the "Article" option from the "Document Types" preferences and the "Education Educational Research" option from the "Research Areas" preferences. In this way, findings were obtained in the WoS system, which were published in the Education / Educational Research category in 2000-2019 and included the desired keyword. The number of different articles published for each keyword was found. Since it is thought that systematic and meaningful analysis results cannot be reached with keywords with less than 50 articles, these keywords have been removed from the list. Considering that the number of articles less than 50 would not show a clear trend in the study, these articles were not included in the study by the researchers. Also, keywords with ten thousand or more articles were removed from the list because there were no analysis reports on the WoS system. As a result, a list of five main titles and 96 keywords was created. This list is shown in Appendix A.

Data Analysis

Text documents obtained individually for each keyword are visualized by Vosviewer 1.6.13 version. During this visualization, five keywords with the highest number of articles in each main title (25 keywords in total) and the most used concepts were emphasized.

In order to reach the network analysis findings of the most used concepts with keywords, the Vosviewer application main screen; a) The "Create" button was clicked. b) Select "Create a map based on bibliographic data" from the window that opens and click "Next". c) The next step has been passed by selecting "Read data from bibliographic database files" in the newly opened window. d) At this stage, the file location of the text file containing the bibliometric information of the word is specified in the field in the "Web of Science" tab and the next page is reached by clicking the "Next" button. e) Here, the "Co-occurrence" and "Author keywords" options were marked and the next step was taken. f) The variable value field on this page has left the value given automatically by the application and proceeded with the "Next" button. g) In the same way, the analysis data were obtained with the "Next" button, leaving the values in the field in the new window as they are. h) The desired visual was reached by selecting the "Yes" option in the question window. In the findings obtained, the five most repetitive concepts for each theme in each main topic were selected and stated in the findings section.

FINDINGS

In this section, the findings obtained from 25 keywords under five main headings are presented one by one under their main headings. The main topics are: a) Application b) Design and Environments c) Evaluation and Measurement d) Pedagogy e) Teaching and Learning.

Application

As a result of the analysis, findings of five keywords in total were reached under this heading. These keywords and the number of articles and citations belonging to them between the years 2000-2019 are listed according to the number of citations and given in Table 3.



Table 2. Keywords and their article and citation numbers

Keywords	Number of Articles	Number of Citations
Game	3352	34809
Simulation	2244	28278
Facebook	374	6539
Massively Open Online Course	787	5776
Augmented Reality	369	5019

Game

Under the title of the application, one of the subjects that researchers mostly concentrate on is the game. With the help of the text-based data obtained from the WoS system, the concept map created by the Vosviewer program regarding the most used concepts with the game was given in Figure 1.

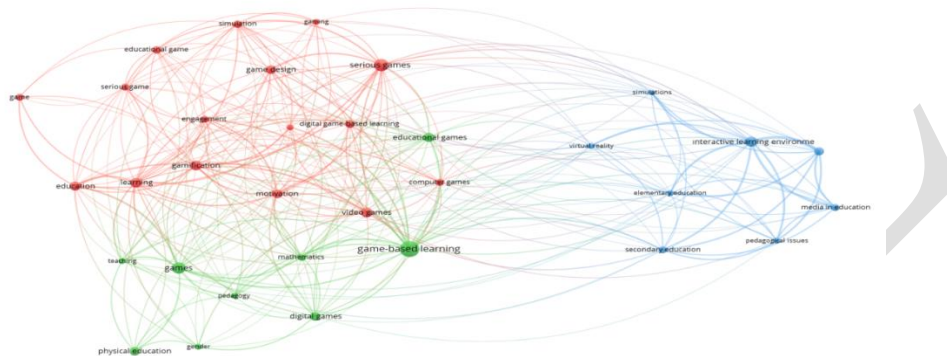


Figure 1. Concept map for the Game

The frequency values of the game (f=122) and the concepts used together were determined by the Vosviewer program. Accordingly, it can be said that game-based learning (f=240), serious games (f=145), interactive learning environments (f=93), video games (f=90) and gamification (f=87) are the most prominent.

Simulation

Under the title of the application, the other subject that researchers mostly focus on is the simulation. The concept map created by the Vosviewer program regarding the most used concepts together with the simulation keyword was given in Figure 2.

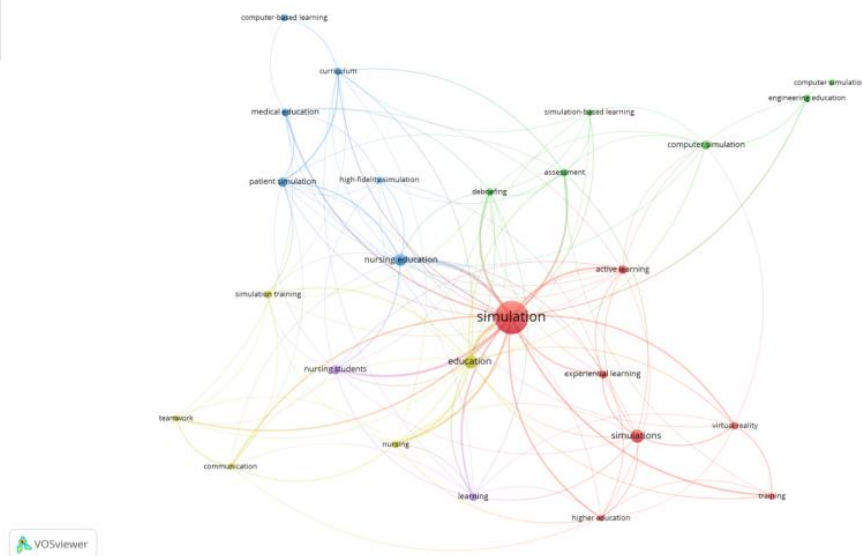


Figure 2. Concept map for the Simulation



The frequency values of the massively open online course (f=51) and the concepts used together were determined by the Vosviewer program. Accordingly, there are studies on MOOC (f=278), MOOCs (f=170), higher education (f=68), online learning (f=54), learning analytics (f=30), distance education (f=27) and e-learning (f=25).

Augmented Reality

Under the title of the application, one of the subjects that researchers mostly concentrate on is Augmented Reality. The concept map created by the Vosviewer program regarding the most used concepts with the keyword Augmented Reality was given in Figure 5.

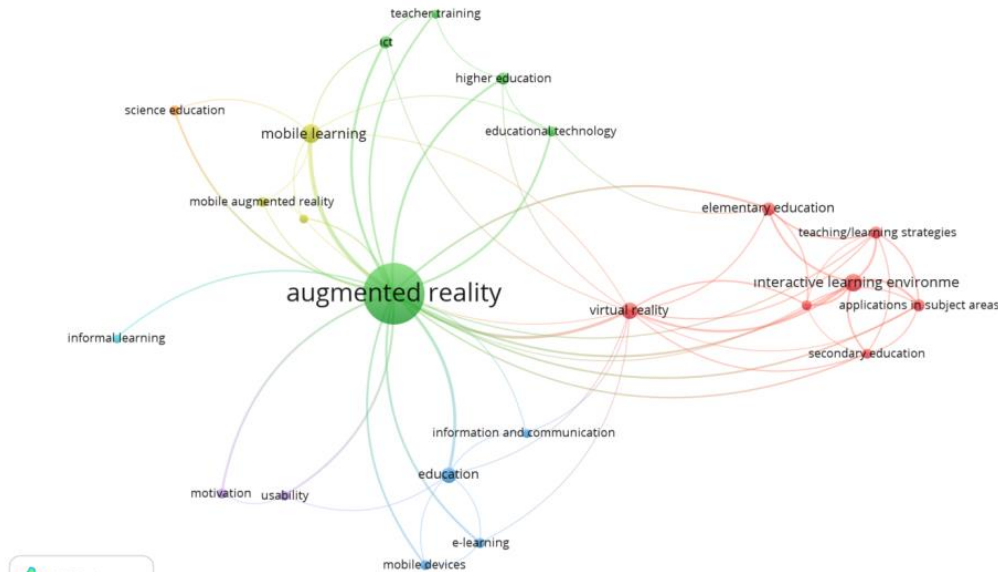


Figure 5. Concept map for the Augmented Reality

The frequency values of the augmented reality (f=229) and the concepts used together, created by the Vosviewer program, were specified. Accordingly, most studies have been conducted on mobile learning (f=22), interactive learning environments (f=19), virtual reality (f=18), education (f=16) and elementary education (f=11).

Design and Environments

Five of the 96 keywords obtained as a result of the analyzes made in the WoS system, with the highest number of articles, were taken from this main title. These keywords and the number of articles and citations belonging to them between 2000 and 2019 are listed according to the number of citations and given in Table 4.

Table 3. Keywords and their article and citation numbers

Keywords	Number of Articles	Number of Citations
Laboratory	3015	25763
Internet	1095	15120
Virtual World	264	3489
Hypermedia	138	3014
Design principles	83	1640

Laboratory

Under the title of Design and Environments, one of the most focused topics by researchers is Laboratory. The concept map created by the Vosviewer program related to the most used concepts with the laboratory keyword was given in Figure 6.

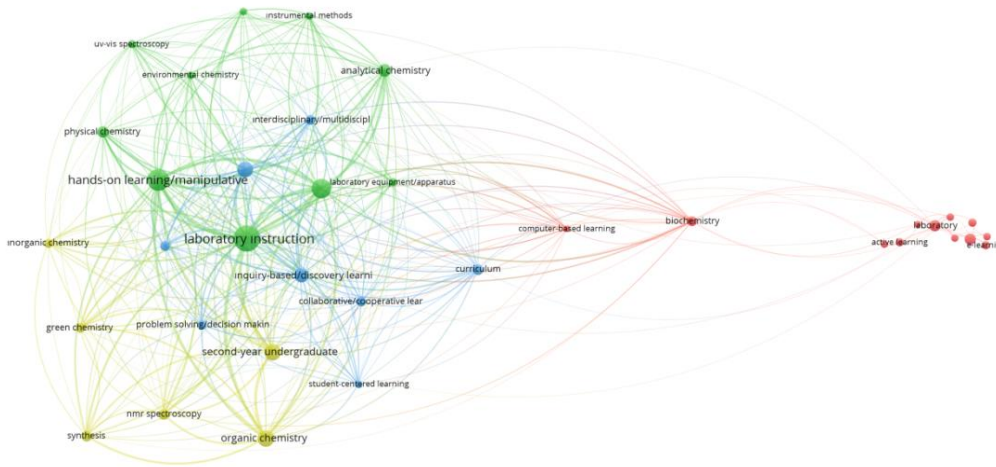


Figure 6. Concept map on the Laboratory

The frequency values of the laboratory ($f=80$) and the concepts used together were determined by the Vosviewer program. Along with the laboratory, laboratory instruction ($f=400$), hands-on learning / manipulatives ($f=277$), upper-division undergraduate ($f=225$), second-year undergraduate ($f=168$), and organic chemistry ($f=165$) are mostly handled concepts.

Internet

Under the title of design and environments, one of the most focused topics of researchers is the internet. The concept map created by the Vosviewer program regarding the most used concepts with the internet was given in Figure 7.

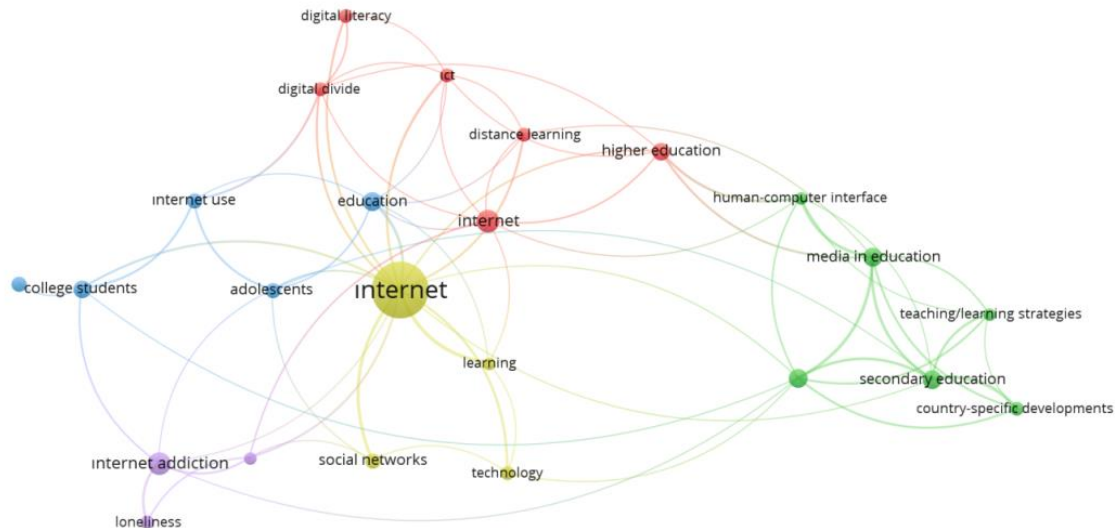


Figure 7. Concept map for the Internet

The frequency values of the Internet ($f=202$) and the concepts used together by the Vosviewer program were specified. Accordingly, mostly handled with internet addiction ($f=30$), secondary education ($f=20$), computer-mediated communication ($f=19$), education ($f=19$), media in education ($f=19$).

Virtual World

Under the title of design and environments, one of the most focused topics by researchers is the virtual world. The concept map created by the Vosviewer program regarding the most used concepts together with the virtual world was given in Figure 8.

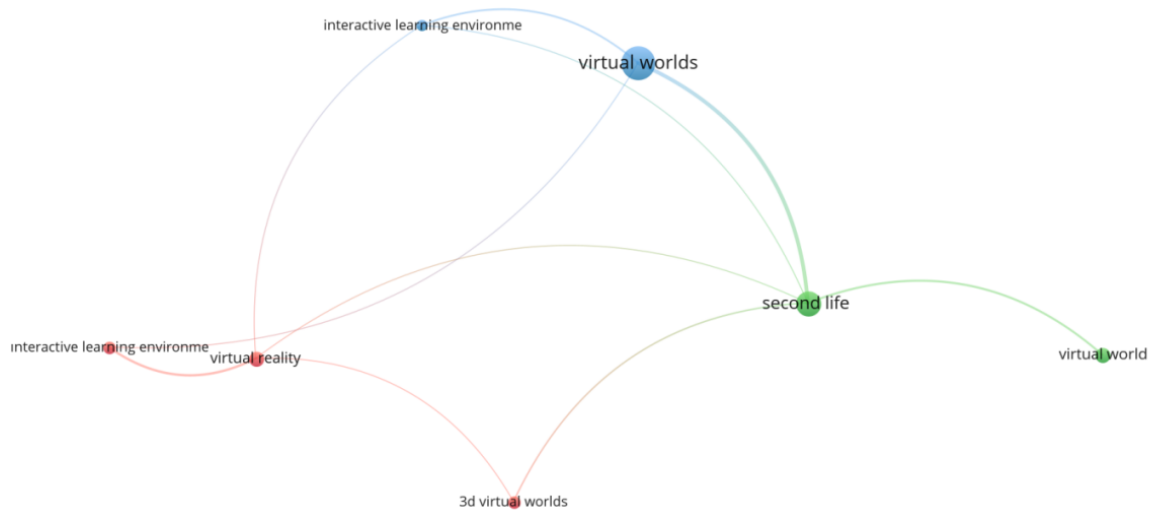


Figure 8. Concept map for the Virtual World

The frequency values of the virtual world (s) (f=55) and the concepts used together were determined by the Vosviewer program. Accordingly, mostly worked on Second Life (f=25), virtual reality (f=10), interactive learning environments (f=12), 3D virtual worlds (f=7).

Hypermedia

Under the title of Design and Environments, one of the topics that researchers focus on is Hypermedia. The concept map created by the Vosviewer program for the most used concepts with the Hypermedia keyword was given in Figure 9.

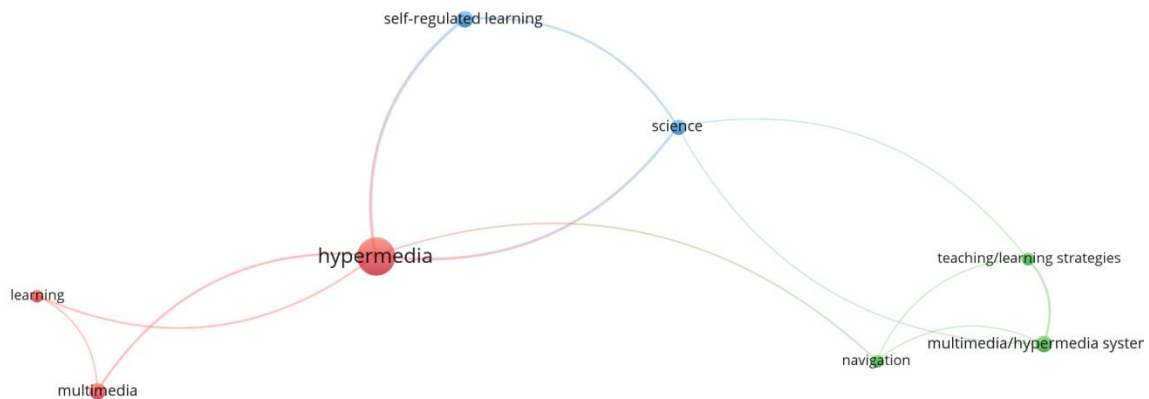


Figure 9. Concept map for the Hypermedia

Hypermedia (f=40) and the frequency values of the concepts used together by the Vosviewer program were specified. Accordingly, studies were mostly carried out on multimedia (f=8), multimedia / hypermedia systems (f=8), self-regulated learning (f=8), adaptive hypermedia (f=7), science (f=7).

Design Principles

Under the title of Design and Environments, one of the most focused topic is the Design Principles. The concept map created by the Vosviewer program regarding the most used concepts together with the Design Principles was given in Figure 10.

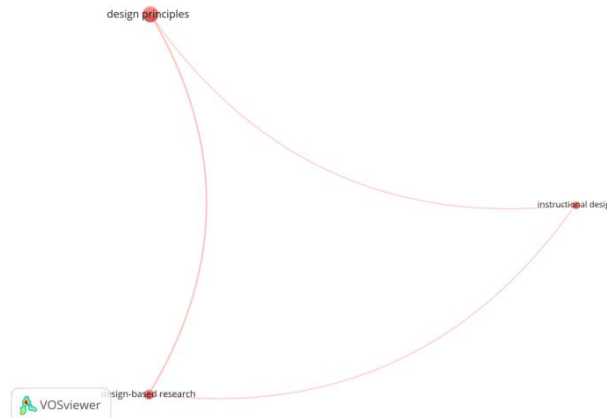


Figure 10. Concept map for the Design Principles

The design principles (f=12) and the frequency values of the concepts used together by the Vosviewer program were specified. Accordingly, these studies were mostly conducted on design-based research (f=5) and instructional design (f=3).

Evaluation and Measurement

Five of the 96 keywords obtained as a result of the analyzes made in the WoS system, with the highest number of articles, were taken from this main title. These keywords and the number of articles and citations belonging to them between 2000 and 2019 were listed according to the number of citations and given in Table 5.

Table 4. Keywords and their article and citation numbers

Keywords	Number of Articles	Number of Citations
Feedback	2354	31449
Competences	3335	26845
Reflection	3753	24437
Systematic Review	245	9696
Questionnaire	804	9349

Feedback

One of the subjects that researchers focus on most under the title of measurement and evaluation was the Feedback. The concept map created by the Vosviewer program was given in Figure 11.

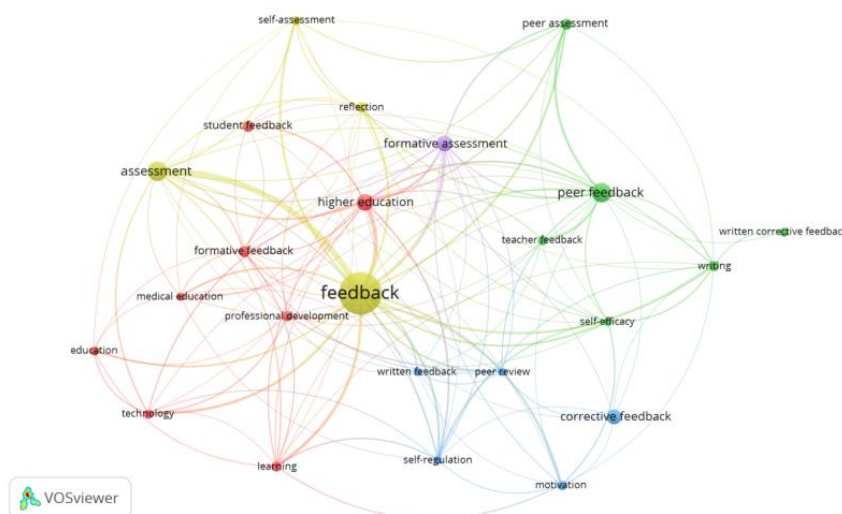


Figure 11. Concept map for the Feedback



Feedback (f=550) and the frequency values of the concepts used together by the Vosviewer program were specified. Accordingly, mostly handled together with assessment (f=122), peer feedback (f=113), higher education (f=83), formative assessment (f=77), corrective feedback (f=72).

Competences

Under the title of measurement and evaluation, one of the subjects that researchers mostly concentrate on is the concept of reflection. The concept map created by the Vosviewer program was given in Figure 12.

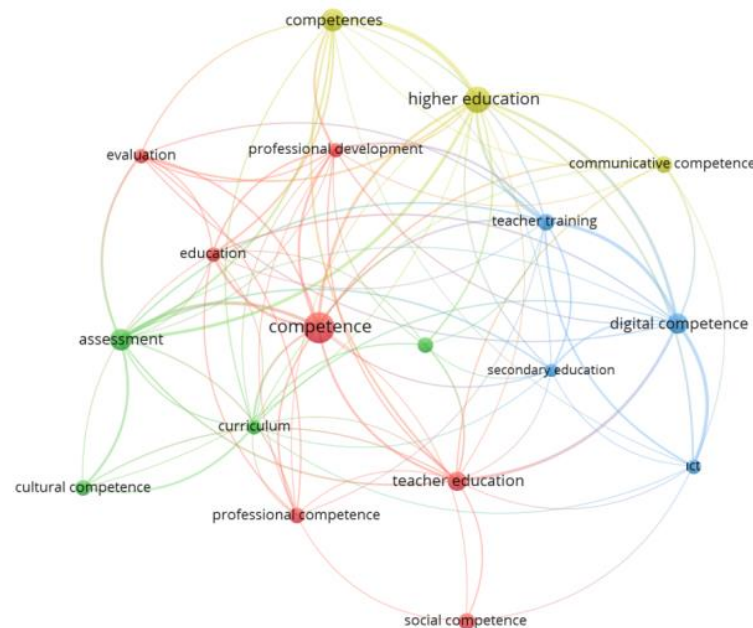


Figure 12. Concept map for the Competences

The competence (s) (f=300) and the frequency values of the concepts used together by the Vosviewer program were indicated. According to these findings, it can be said that it is mostly handled with the concepts of higher education (f=140), assessment (f=96), digital competence (f=82), teacher education (f=73) and communicative competence (f=59).

Reflection

One of the subjects that researchers mostly concentrate on under this main topic is the concept of reflection. The concept map created by the Vosviewer program was given in Figure 13.

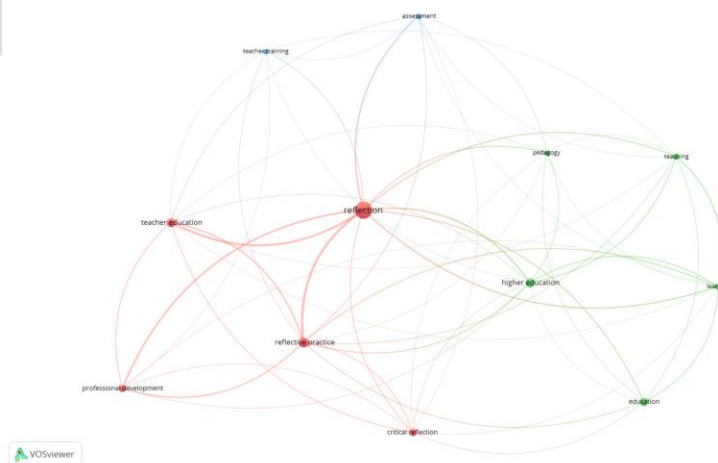


Figure 13. Concept map for the Reflection



Reflection (f=353) and the frequency values of the concepts used together by the Vosviewer program were specified. Accordingly, it can be said that reflective practice (f=125), teacher education (f=105), higher education (f=104), education (f=92) and Professional development (f=66) were mostly studied.

Questionnaire

One of the subjects that researchers focus on most is the Questionnaire. The concept map created by the Vosviewer program was given in Figure 14.

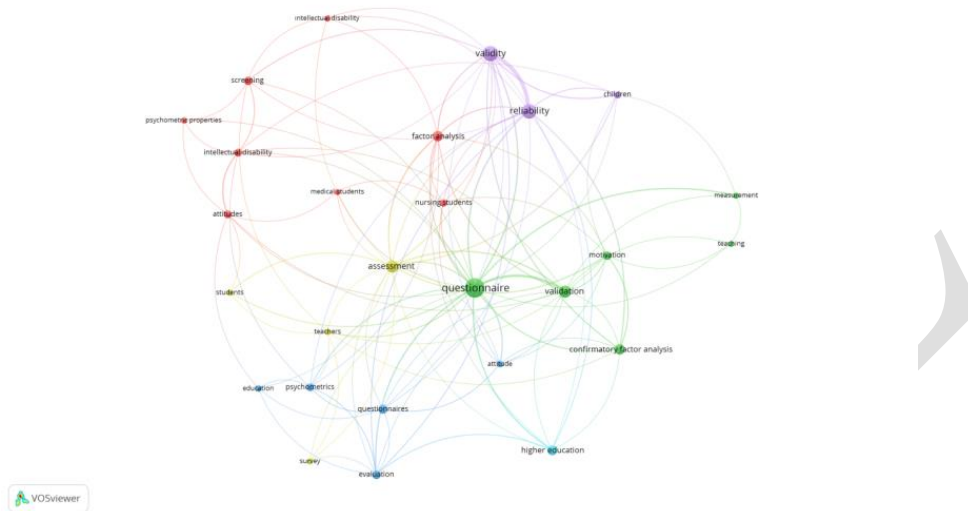


Figure 14. Concept map for the Questionnaire

The frequency values of the Questionnaire (f=82) and the concepts used together were indicated. And most studies have been conducted on validity (f=50), reliability (f=45), assessment (f=33), validation (32), factor analysis (f=24).

Comparative Study

The comparative study theme is one of the subjects that researchers focus on most under the measurement and evaluation. The concept map created was given in Figure 15.

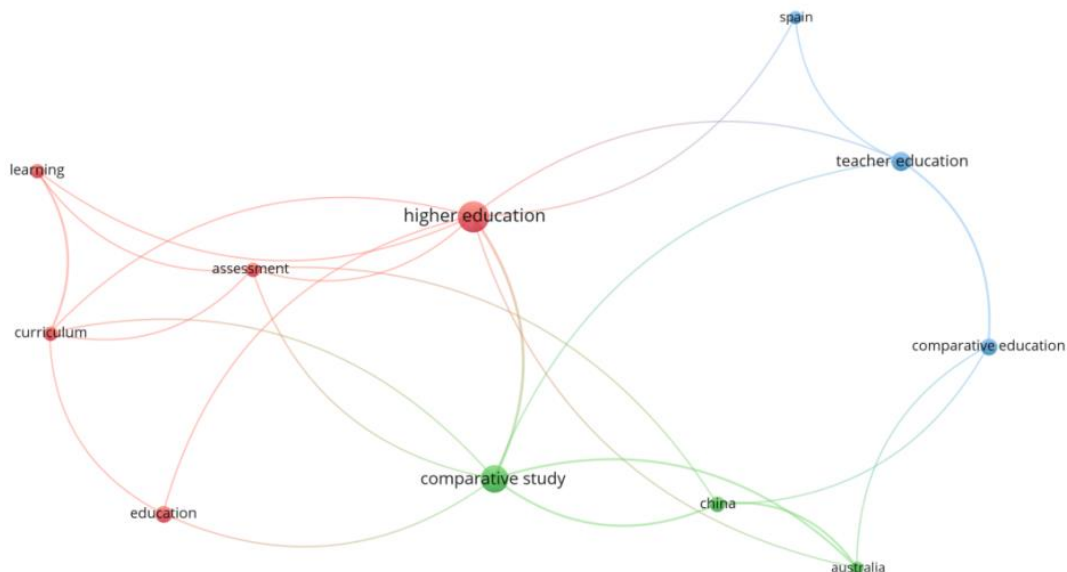


Figure 15. Concept map for the Comparative Study



The frequency values of the comparative study ($f=31$) and the concepts used together were determined by the Vosviewer program. The studies are mostly conducted on higher education ($f=40$), teacher education ($f=15$), comparative education ($f=13$), education ($f=12$), China ($f=10$).

Pedagogy

As a result of the analysis, findings of five keywords in total were reached under this heading. These keywords and the number of articles and citations belonging to them between the years 2000-2019 were listed according to the number of citations and given in Table 6.

Table 6. Keywords and their article and citation numbers

Keywords	Number of Articles	Number of Citations
Experiment	3554	28024
E-learning	1511	22814
Language Learning	1368	12147
STEM	1465	8172
Professional Learning	955	6710

Experiment

Under the title of Pedagogy, one of the subjects that researchers focus on is the experiment. The concept map created by the Vosviewer program was given in Figure 16.

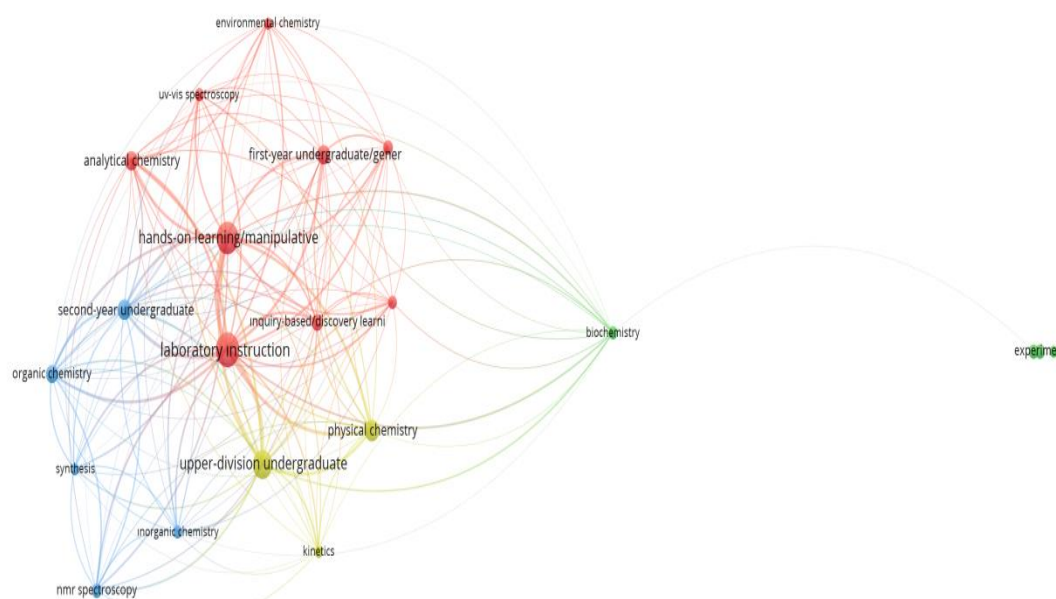


Figure 16. Concept map for the Experiment

The frequency values of the experiment ($f=50$) and the concepts used together were indicated. Accordingly, the most common concepts have been studied were laboratory instruction ($f=290$), hands-on learning / manipulatives ($f=244$), upper-division undergraduate ($f=203$), physical chemistry ($f=114$), second-year undergraduate ($f=106$).

E-Learning

Under the Pedagogy, one of the subjects that researchers focus on most was e-learning. The concept map created by the Vosviewer program was given in Figure 17.

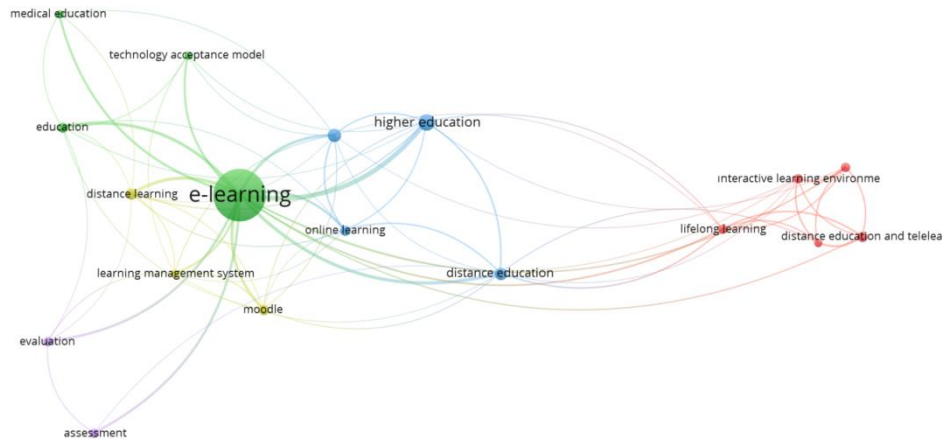


Figure 17. Concept map for the E-Learning

E-learning (f=572) and the frequency values of the concepts used together were specified. According to these findings, the most researches conducted with the concepts of higher education (f=60), blended learning (f=40), distance education (f=34), distance learning (f=31), education (f=25).

Language Learning

Under the title of pedagogy, one of the most focused topics was language learning. The concept map created by the Vosviewer program was given in Figure 18.

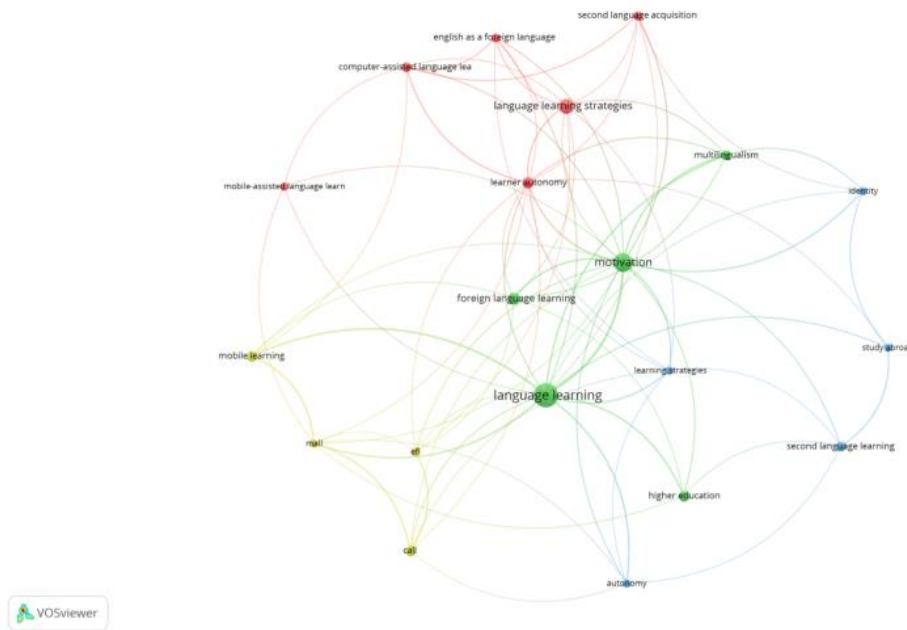


Figure 18. Concept map for the Language Learning

The frequency values of language learning (f=112) and the concepts used together were indicated. The most common studies were about motivation (f=65), language learning strategies (f=43), foreign language learning (f=28), learner autonomy (f=26) and higher education (f=23).

STEM

It was thought that the concept of STEM is one of the subjects that researchers mostly focused. The concept map created by the Vosviewer program was given in Figure 19.

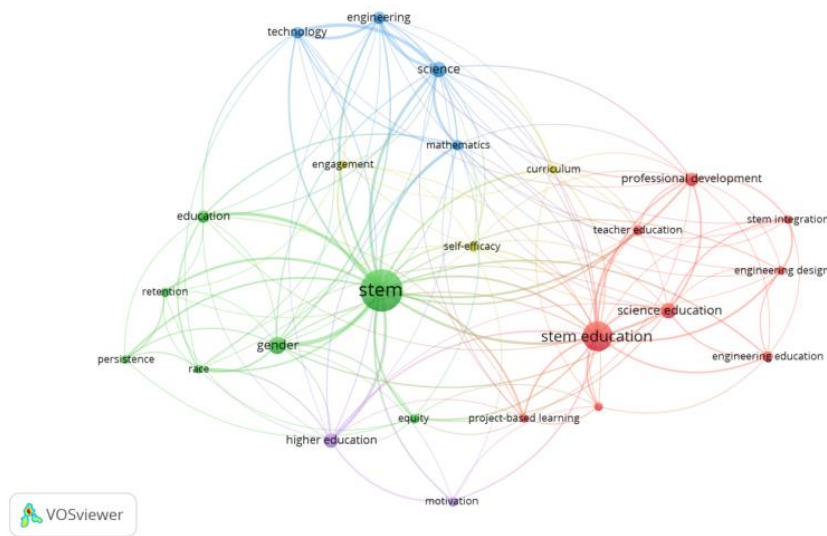


Figure 19. Concept map for the STEM

The frequency values of STEM ($f=306$) and the concepts used together were indicated. Therefore, mostly studied subjects were STEM education ($f=154$), gender ($f=51$), science ($f=42$), science education ($f=40$) and higher education ($f=38$).

Professional Learning

One of the other subjects that researchers focus on is the concept of professional learning. The concept map, created by the Vosviewer program, was given in Figure 20.

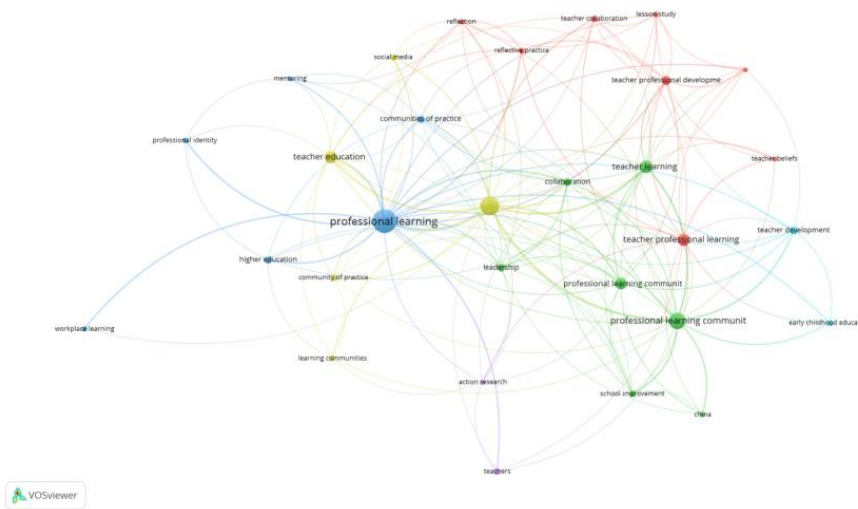


Figure 20. Concept map for the Professional Learning

The frequency values of Vocational Learning ($f=146$) and the concepts used together were determined by the Vosviewer program. Hence, studies were mostly carried out on professional development ($f=95$), professional learning communities ($f=70$), teacher learning ($f=42$), teacher education ($f=40$), teacher professional learning ($f=38$).

Teaching and Learning

Five of the 96 keywords obtained as a result of the analyzes made in the WoS system were collected under this main title. These keywords and the number of publications and citations belonging to them between 2000 and 2019 are listed according to their citation numbers and given in Table 7.



Table 7. Keywords and their article and citation numbers

Keywords	Number of Articles	Number of Citations
Reading	7393	89775
Instruction	7244	89490
Environments	8009	82682
Communities	7961	64686
Outcomes	7091	61312

Reading

Under the title of Teaching and Learning, one of the subjects that researchers focus on was the reading. The concept map, created by the Vosviewer program, was given in Figure 21.

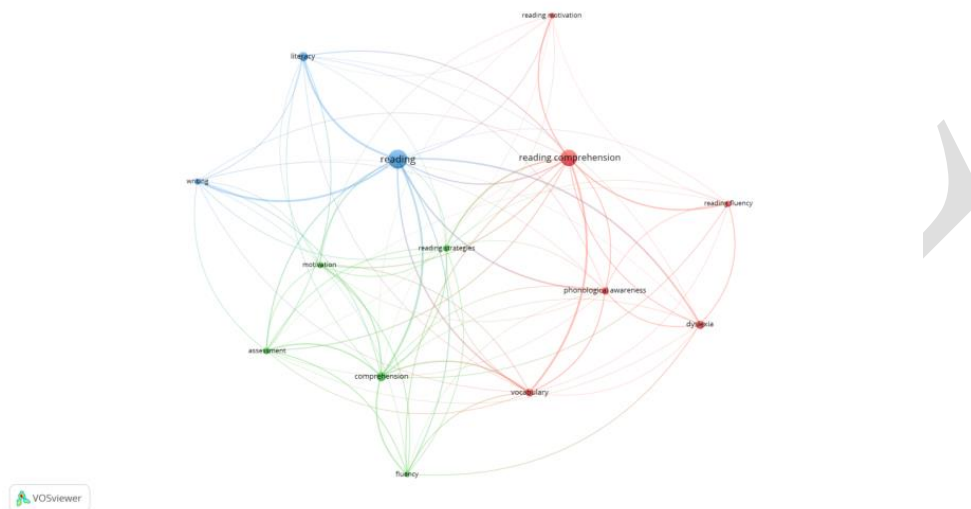


Figure 21. Concept map for the Reading

The frequency values of the reading (f=782) and the concepts those were used with the reading were determined by the Vosviewer program. Consequently, it can be said that the researchers were mostly studied on reading comprehension (f=613), literacy (f=192), comprehension (f=191), dyslexia (f=162) and vocabulary (f=149).

Instruction

Under this heading, one of the subjects that researchers mostly concentrate on is the concept of instruction. The concept map, created by the Vosviewer program, was given in Figure 22.

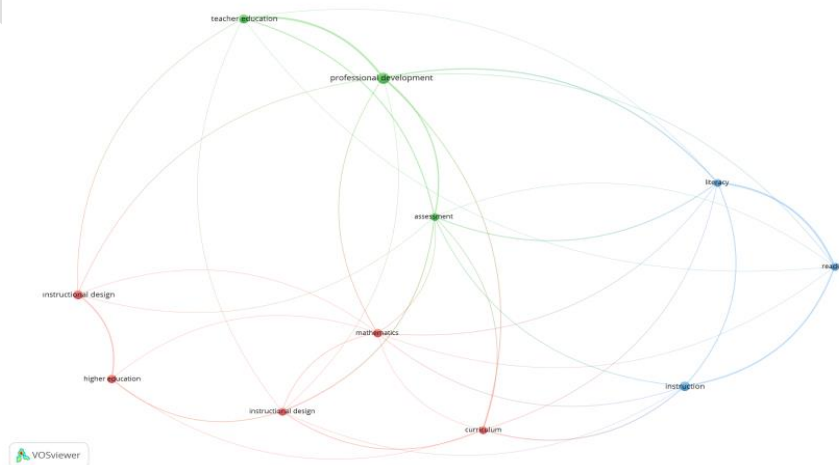


Figure 22. Concept map for the Instruction



Instruction (f=104) and the frequency values of the concepts used together by the Vosviewer program were specified. Subsequently, studies were mostly conducted on professional development (f=148), teacher education (f=101), instructional design (f=100), mathematics (89), and higher education (84).

Environments

One of the subjects that researchers focus on is the Environments. The concept map, created by the Vosviewer program, was given in Figure 23.

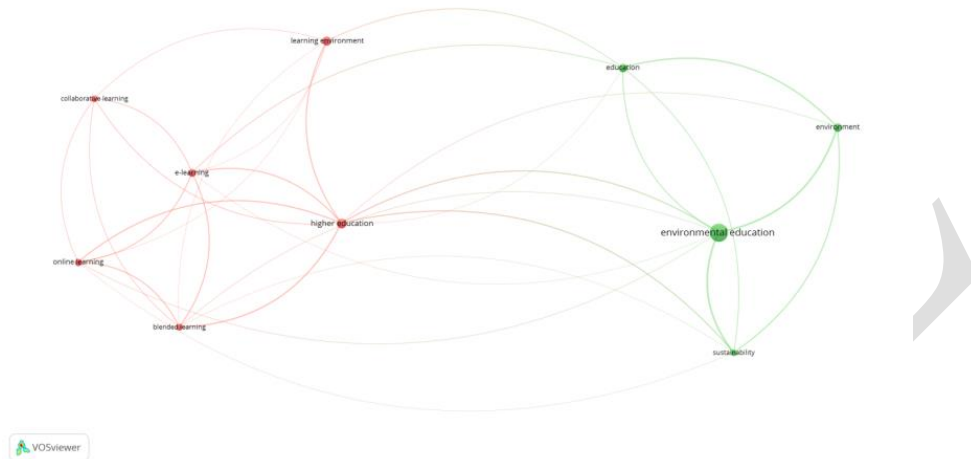


Figure 23. Concept map for the Environments

The environments (f=150) and the frequency values of the concepts used together were specified. Thus, it can be said that it is mostly handled with the concepts of environmental education (f=612), higher education (f=192), learning environment (f=153), education (f=141) and e-learning (f=114).

Communities

Under this heading, another subject that researchers mostly concentrate on is communities. The concept map, created by the Vosviewer program, was given in Figure 24.

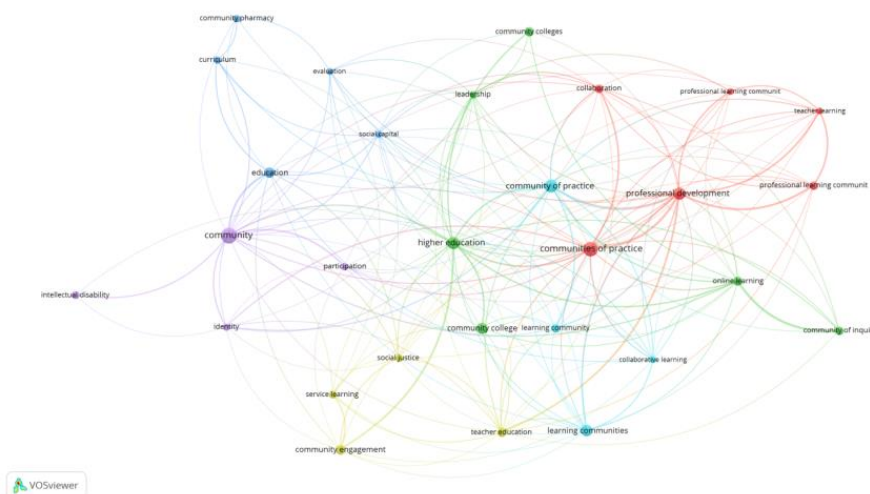


Figure 24. Concept map for the Communities

The frequency values of the communities (f=226) and the concepts used together, created by the Vosviewer program, were indicated. According to these findings, it is mostly discussed with the



concepts of community of practice (f=334), professional development (f=139), higher education (f=136), learning communities (f=116), community college (f=103).

Outcomes

Under this heading, the last topic that researchers focus most on is the outcomes. The concept map, created by the Vosviewer program, was given in Figure 25.

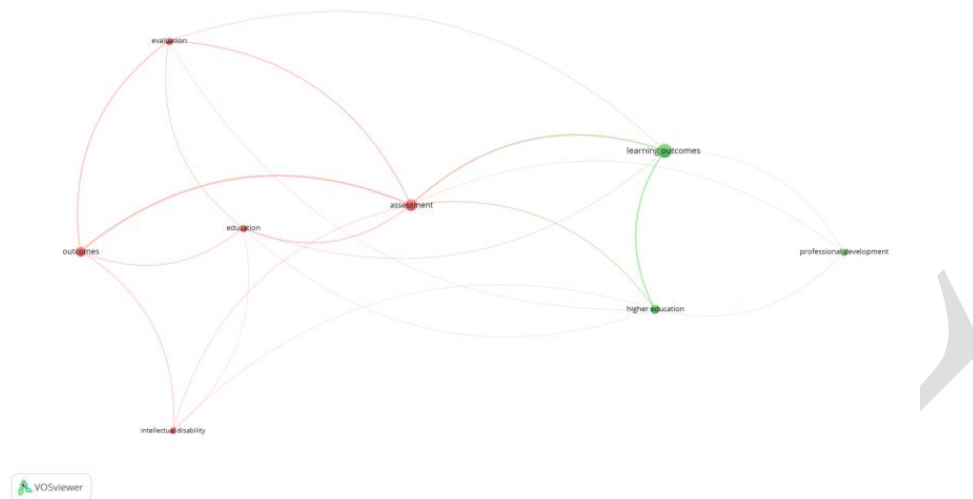


Figure 25. Concept map for the Outcomes

The outputs (f=92) and the frequency values of the concepts used with were specified. According to these findings, it is mostly discussed with the concepts of learning outcomes (f=189), assessment (f=132), higher education (f=87), professional development (f=53), education (f=52).

DISCUSSION and CONCLUSION

Trends of Concepts

Out of 96 themes in the five main titles obtained in this study, only five themes with the highest number of articles from each main topic were analyzed. Discussions were made on the analysis of a total of 25 themes.

In this context, interest in the keywords under the title of Application, especially Game, Simulation, Massive Open Online Courses, Social Media (Facebook), and Augmented Reality, has increased significantly. In research on the games, game-based learning, serious games, interactive learning environments, video games, and gamification concepts were mostly discussed. These studies show that the concepts of the game, serious games, game-based learning, and gamification are inseparable elements in the field of education (Kim, 2015; Seaborn & Fels, 2015). These concepts may have caught the attention of researchers because of increasing motivation in the education process (Burguillo, 2010), problem-solving as well as other high-level thinking skills (Kim et al., 2018), increasing students' attitudes, behaviors, and learning achievements (Gros, 2007), strengthening existing conceptual knowledge (Ritterfeld et al., 2009).

Similarly, in the studies on simulation, the concepts of education, simulations, nursing education, patient simulation, and nursing students were mostly discussed. Simulation applications in nursing education may be considered to provide effective learning in many areas such as students' cognitive knowledge acquisition, critical thinking (Kaddoura, 2010), self-confidence and self-sufficiency (Bambini et al., 2009), leadership, communication, and teamwork skills (Fletcher, 1995), clinical decision-making (Lasater, 2007), clinical skills (Ballard et al., 2012) and patient care (Kaddoura, 2010). Therefore, the concept of simulation may have become a popular topic for researchers in recent years.



In the studies on Facebook, the concepts of social media, higher education, social networks, social network, and social networking sites were mostly discussed. Baran (2010) stated in his study that the easy adoption of Facebook among young students caused its use in education to become widespread. This situation may have enabled Facebook to be widely used in higher education. It was also stated that there are studies on Facebook's integration into higher education (Callaghan & Fribbance 2016). Studies have indicated that the concepts of social media and social network are used in the same sense (Adraoui et al., 2019; Chugh & Ruhi, 2017).

Along with the massive open online course subject, the concepts of MOOC, MOOCs, higher education, online learning, learning analytics, distance education, and e-learning were mostly studied. In the MOOC definition made by Jansen and Schuwer (2015), the emphasis on an e-learning application that many people can participate in for distance education can be shown as the reason why the concepts of distance education, e-learning, and online learning are used so much. In addition, it can be said that higher education has become widespread due to the efforts to integrate MOOC applications into universities (Siemens & Baker, 2012) and the interest of many students and educators at universities (Kim & Chung, 2015). It may have attracted the attention of researchers due to the use of learning analytics as a MOOC assessment tool.

Mobile learning, interactive learning environments, virtual reality, education, and elementary education are the most used concepts together with the Augmented Reality (AR) theme. M-learning, AR, and interactive learning environments are interrelated, and thanks to their innovative features, they have become popular in researches to understand educational opportunities (Cabero & Barroso, 2016; Avila & Bailey, 2016). In general, the fact that AR and virtual reality are not completely different topics (Jaros, 2018) may be the reason why these two concepts are used intensively together. It was concluded that the Inquiry-Based Learning method was used more commonly at the elementary education level using AR (Pedaste et al., 2020). Therefore, the concept of AR may have become a popular topic for researchers in recent years.

Under the main title of Design and Environments, the prominent subjects of the study were the themes of the laboratory, the internet, the virtual world, and the hypermedia. The laboratory subject is mostly discussed together with the concepts of laboratory education, hands-on learning/manipulatives, upper-division undergraduate, second-year undergraduate, and organic chemistry. Providing students with problem-solving, conceptual understanding, and practical skills by arousing interest, creative thinking, and curiosity through laboratory training (Aydođdu & Yardımcı, 2013) may have supported its popularization. The fact that laboratory courses take place at the upper-division undergraduate level in biochemistry, chemistry, and chemical engineering departments is seen as an important turning point for the education of students. These courses are important in terms of giving students access to use laboratory tools and equipment independently (Tsaparlis & Finlayson, 2014; Jolley et al., 2016). Since the concepts, models, theories, methods, and tools of chemistry are being seen in all chemistry courses, the second-year undergraduate can be seen as an important process (Tsaparlis & Finlayson, 2014). Students' difficulties in understanding organic chemistry (Anderson & Bodner, 2008) may have increased the interest in the concept of organic chemistry.

The subject of the Internet has been studied mostly with the concepts of internet addiction, secondary education, computer-mediated communication (CMC), education, and media in education. In particular, internet addiction has been stated as the negative aspect of internet use (Boniel-Nissim & Sasson, 2018). It has been seen in researches that the Internet is widely used by adolescents and young people (Park, 2015). Because CMC is a method that enables people to communicate over the internet (Hrastinski, 2008), it can be considered a common research subject. It can be assumed that the internet is a medium that can be used in education and that studies have been carried out on the most beneficial integration of this media into education (Lin & Choy, 2015).

Along with the virtual world(s) theme, the subjects of Second Life (SL), virtual reality, interactive learning environments, and 3D virtual worlds were mostly studied. Many researchers have discovered



that the SL can be used for educational purposes (Hudson et al., 2019). Besides, as a result of a study, it was emphasized that the SL can be used in education as a 3D virtual world for interactive learning environments (Huang et al., 2019). Additionally, Huang et al. (2010) clearly stated in their study that virtual reality applications can be used to provide real-world experiences for students. Considering this framework, the reasons why these concepts are widely used in research can be listed.

Along with the hypermedia theme, the most of studies have been conducted on multimedia, multimedia/hypermedia systems, self-regulated learning (SRL), adaptive hypermedia, and science. The concept of Hypermedia has been defined as a system in which multimedia materials are organized as network-like information structures, information pieces are stored in interconnected nodes and can be accessed by electronic bridges (Rouet et al., 1996). Accordingly, Hypermedia systems can be controlled by students in various ways. However, Zimmerman (2008) sees SRL as processes that students use to gain academic skills such as goal setting, strategy selection, and implementation, and self-monitoring of one's effectiveness. Within the framework of this definition, it can be said that SRL is an important skill that should exist in students using hypermedia. In the light of all this information, it can be seen that these concepts have become a very active research area for academicians interested in cognition and teaching.

It can be said that studies on design-based research (DBR) and instructional design (ID) issues are mostly carried out with the theme of design principles. DBR method is generally used to examine innovative learning environments including new educational technologies (Sandoval & Bell, 2004). However, the theoretical knowledge included in the design principles is used in the DBR process (Koivisto et al. 2018). ID was defined by Dick et al. (2009) as a reflective process that translates the principles of learning and teaching into plans to produce predetermined learning outcomes efficiently and effectively. Within the framework of these definitions, so DBR and ID concepts are indispensable options for developing learning environments and applications. Therefore, it can be said that they are indispensable study subjects for researchers.

Feedback, Competencies, Reflection, Systematic Review and Questionnaire subjects were the prominent study subjects under the main title of Measurement and Evaluation. The feedback issue is mostly handled with the concepts of assessment, peer feedback, higher education, formative assessment, corrective feedback. Studies have shown that feedback is the most effective factor in higher education (Gibbs & Simpson 2005). Moreover, it has been stated that in addition to the fact that feedback affects the whole assessment process by creating an environment that is student-centered and suitable for influencing the learning process (Dawson et al., 2019), well-designed formative assessment can close the gap between the current situation and the desired state (Lizzio & Wilson 2008). Nicol et al. (2014) argue that peer feedback helps their peers first to make judgments about the quality of their work and then to develop their work. Therefore, it is an important feedback process. The literature on corrective feedback shows that they have different views. Truscott (2009) and Lee (2008) think that corrective feedback can be harmful, Chandler (2003), Ferris (2006), Hartshorn et al. (2010) reached conclusions that it would be beneficial. Therefore, intensive studies are carried out on corrective feedback.

The subject of competence(s) is mostly discussed together with higher education, evaluation, digital competence, teacher education, and communicative competence. The concept of assessment can be considered to cover studies related to the assessment of the competencies gained by the learner (Sołtysik et al., 2020; Chi et al., 2020). The importance of gaining digital competence for learning and teaching individuals to participate in the global digitalization process (Ilomäki et al., 2016) may have led to an increase in studies on this concept. Additionally, examining teacher training and teachers' competencies from different perspectives (Barber et al., 2022; Virkkula, 2022) may have popularized this concept among researchers. Communicative competence may have been a widespread subject of study, as the communication skill of the learner and instructor is the most important element in both the social and business worlds (López et al., 2020).



Along with the theme of reflection, most researches have been conducted on reflective practice, teacher education, higher education, education, and professional development. Reflective practice has been accepted as an active thinking process that aims to evaluate, understand and change applications consciously and continuously (Meierdirk, 2016). Also, reflective practice greatly helps educators to overcome the theory/practice gap (Barber, 2021). With the researches, it has been concluded that reflective practices have positive effects on teachers' professional development (Dervent, 2015; Bleach, 2014). For years, reflection and reflective practice have been discussed and promoted as an important part of teacher education programs (Minott, 2019). Therefore, the concepts mentioned can be said to be indispensable study subjects for researchers.

Along with the questionnaire theme, most studies were conducted on validity, reliability, assessment, validation, factor analysis. Studies conducted to determine and verify the validity and reliability of the questionnaires prepared are quite common (e.g. Balgiu, 2020; Yurtseven, 2020). Since these concepts are the most used in survey development studies, they may have yielded results as the most common concepts.

Along with the comparative study theme, studies have mostly been carried out on higher education, teacher education, comparative education, education, and China. The subject of higher education may have gained popularity due to the prevalence of studies on the comparative study in higher education (e.g. Herodotou et al., 2020; Hong, 2020). Studies conducted with the concept of teacher education constitute studies on the analysis and comparison of teacher training curricula of countries (Madsen et al., 2018). In addition, studies conducted with the concept of comparative education have become widespread in research due to the comparison of the education systems or educational periods of countries, states, or cities, and as a result, suggestions for the development of education systems (Jayakumar, 2016).

The prominent study topics under the main heading of pedagogy were Experiment, E-Learning, STEM, Language Learning, and Professional Learning.

In the studies on the experiment, the concepts of laboratory instruction, hands-on learning/manipulatives, upper-division undergraduate, physical chemistry, second-year undergraduate were mostly discussed. Looking at the experiment theme, it is seen that the same concepts as the laboratory theme are widely used. This situation emphasized that the concepts of experiment and laboratory in education cannot be separated from each other.

The subject of e-learning has been handled together with the concepts of higher education, blended learning, distance education, distance learning, education in the researches. Since e-learning is one of the two most important learning methods of blended learning (Lin & Wang, 2012), these two concepts may have become popular research topics. At the same time, E-learning platforms are seen as the major element of distance education and distance learning methods (Hamidi & Chavoshi, 2018). Mostly, the use of the e-learning method in higher education may be the reason why the concept of higher education is widespread (Bøe, Sandvik, & Gulbrandsen, 2021; Torun, 2020).

Along with the theme of language learning, most studies have been conducted on motivation, language learning strategies, foreign language learning, learner autonomy and higher education. Causes affecting motivation in language learning (Iwaniec, 2020) and the effects of motivation on learning (Bailey et al., 2021) can be seen as the reason why the topic of motivation is a common topic of research. Decades of extensive research have shown that language learning strategies play a key role in foreign language learning (Griffiths, 2015). Since the concept of Learner autonomy is a basic dimension required by language learning (Iamudom & Tangkiengsirisin, 2020), it can be cited as the reason why it is popular in language learning studies. The most widespread study of the subject of language learning in higher education may be the reason why the concept of higher education is widespread (e.g. Hoi, 2020; Nami, 2020).



Along with the STEM theme, STEM education, gender, science, science education, and higher education were studied. The aim of combining STEM education studies with the discipline of Science, Technology, Engineering, and Mathematics to solve problems that students may encounter in the real world and to cooperate and learn these four disciplines together (Mutambara & Bayaga, 2021) may be the reason why this subject was widely used. Since the concept of science is the first of the four disciplines of STEM theme, it has been inevitable that the concepts of science and science education are widely used in research. The widespread study of STEM subject in higher education may be the reason why the concept of higher education is widespread (Maldonado et al., 2020; Shukla et al., 2020).

Along with the Professional Learning theme, most studies have been carried out on professional development, professional learning communities, teacher learning, teacher education, teacher professional learning. Teachers' professional learning paths have changed throughout history from learning only for the course to improving teacher skills and abilities (Bergmark, 2020). This situation may have caused the concepts of teacher education, teacher learning and teacher professional development to be widely studied. The reason why the concept of professional learning communities is popular can be considered as the professional learning communities offering environments that support teachers' professional development (Feldman & Fataar, 2014).

The prominent topics of study under the title of Teaching and Learning were Reading, Teaching / Learning, Environments, Communities and Outcomes. Along with the theme of reading, the topics of reading comprehension, literacy, comprehension, dyslexia and vocabulary were mostly studied. Reading comprehension may have been studied extensively, both because of the academic success of individuals (Levine et al., 2000) and because it is an important skill in daily life (Farhady, 2005, p. 1). Also, vocabulary, which is the most important element of reading comprehension in academia and daily life, has been seen as a significant concept (French et al., 1995). However, since dyslexia is also a brain-based reading disorder (Arrington et al., 2019), it may be normal to work intensively with the reading theme.

Along with the Instruction theme, most researches have been conducted on professional development, teacher education, instructional design, mathematics, and higher education. Teacher education may have increased the research on these concepts due to the positive effects of student performance (King, 2014) and the continuation of teachers' participation in professional learning, and the increase in student success (Desimone, 2009). On the other hand, to examine the content-oriented aspects of mathematics teaching, to better understand the relationship between teacher knowledge and teaching practice, and the relationship between teaching characteristics and student outcomes (Charalambous & Litke, 2018), prospective mathematics teachers need to observe more than one experienced teacher in one semester (Ulusoy, 2020). This situation may indicate that intensive studies have been carried out on the concept.

The issue of environments is mostly discussed together with the concepts of environmental education, higher education, learning environment, education and e-learning. Environmental education is seen as an important element that helps students gain environmental awareness (Borges, 2013). Students' learning processes may be an indication that the concept of learning environment is being studied widely, as it is deeply connected with the safety and comfort of the learning environments they are in (Prashanti & Ramnarayan, 2020). The concept of e-learning as an educational environment (Aquino & Shell, 2020) can be assumed as a popular study topic. The concept of higher education may have been widely used, since studies on environments are generally carried out at higher education (e.g. Schaeper, 2020; Caliskan et al., 2020).

The issue of communities has been mostly addressed with the concepts of the community of practice (CoP), professional development (PD), higher education, learning communities, community college. The reason why CoP is widely researched is that learning takes place in the background of community activities (Wenger, 1998). The concept of PD may have been widely used due to the more successful professional development training provided as a community (Admiraal et al., 2021; Bond & Lockee, 2018). It can be said that learning communities are one of the most researched concepts because they



expand the collective knowledge of the group (Barber, 2020) and additionally "learn how to learn" (Collins, 1998). The reason why the community college is widespread can be seen as the fact that students living in the USA who have financial difficulties or who live in rural areas can easily go to these places and get an education after secondary education (Bahr et al., 2017; Ezarik, 2017).

The subject of outputs is mostly handled with the concepts of learning outcomes, assessment, higher education, professional development and education. Investigating the effects of different teaching methods on learning outcomes (e.g. Lim & Richardson, 2021; van Alten et al., 2020) may be the reason for the high interest in the concept of learning outcomes. The issue of assessment (Chen et al., 2021) may have gained popularity due to the studies on the evaluation of the outputs obtained as a result of the trainings provided. Studies on examining the outputs obtained as a result of professional development trainings (Kowalski et al., 2020) may also have enabled the widespread use of the concept of professional development.

In the light of the data obtained in this study, it should not be overlooked that all these concepts and keywords will be more significant in the future and will guide researches that will further enrich the literature.

Researchers who will conduct similar studies to this study can scan other databases such as Scopus, Google Scholar or ERIC together with the WoS database and make international comparisons. It is recommended that researchers who will work in the future work on concepts and keywords that have a high number of leading journals, citations and articles.

It has been observed that researchers working in Turkey usually send their publications to journals with foreign addresses. It can be said that this is the reason why Turkey lags behind in terms of citation exchange. It is estimated that Turkey ranks higher in terms of the number of studies and citations in the field of educational technologies. This situation is also recommended as a study subject.

Ethics and Conflict of Interest

In the completion process of our above study, scientific ethical rules have been complied with. No changes were made during the data collection, compilation and editing phases. The study does not have a data set that requires "Ethics Committee Approval". We undertake that the International Online Journal of Primary Education (IOJPE) has no responsibility for all violations that may be encountered in this regard, all responsibility belongs to the relevant authors and this study has not been sent for publication on any academic platform other than the International Online Journal of Primary Education (IOJPE). We also declare that there is no conflict of interest between the authors in the study.

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**APPENDIX A****Keyword List**

Application	Design and Environments	Evaluation and Measurement	Pedagogy	Teaching and Learning
Artificial intelligence	Design principles	Benchmarking	Blended learning	Activity theory
Augmented Reality	Hypermedia	Comparative study	Collaborative learning	Communication
Courseware	Internet	Competences	Constructivism	Communities
E-mail	Laboratory	Discourse analysis	Cooperative learning	Communities of practice
Facebook	Virtual world	Experimentation	Distance learning	Creativity
Game	World-wide web	Feedback	E-learning	Dialogue
Learning management systems		Formative assessment	Experiential learning	Discourse
Learning resources		Learning Analytics	Experiment	Environments
Massively Open Online Course		Peer assessment	Flipped Learning	Groupwork
Open Educational Resources		Qualitative Analysis	Informal learning	Instruction
Simulation		Quantitative Analysis	Language learning	Interactivity
Social Media		Questionnaire	Mobile Learning	Interview
Tutorial		Reflection	Online learning	Learner centredness
Twitter		Summative assessment	Personalized learning	Learning Technology
Virtual laboratory		Systematic Review	Problem-based learning	Lecture
Virtual learning environment			Professional learning	Mentoring
Virtual reality			Project-based learning	Metacognition
			Security	Objectives
			Self-Regulated Learning	Observation
			Standardization	Outcomes
			STEM	Participatory Action
			Student-Centredness	Problem Solving
			Technology Acceptance Model	Reading
			Technological Pedagogical Content Knowledge	Reading motivation
			Web-based learning	Role play
				Scaffolding
				Special needs
				Strategies
				Student retention
				Teacher development
				Teacher perceptions
				Teacher Support
				Teacher Training