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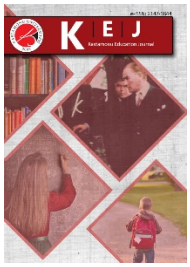

| Research Article / Araştırma Makalesi |

Mapping the Research on Educational Technology: An Overview through Text Mining

Eğitim Teknolojisi Araştırmalarının Haritalandırılması: Metin Madenciliği İle Genel Bir Bakış

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Keywords

1. Educational technology
2. Instructional technology
3. Instructional design
4. Research trends
5. Text mining

Anahtar kelimeler

1. Eğitim teknolojisi
2. Öğretim teknolojisi
3. Öğretim tasarımı
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5. Metin madenciliği

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Abstract

Purpose: In this study, it is aimed to determine the trends of studies in the field of educational technologies with the text mining method.

Design/Methodology/Approach: In study, 10,218 studies published since 2000 by the top ten journals in the "Educational Technology" sub-category in Google Scholar Metrics were analyzed by text mining.

Findings: Although it showed that the number of articles in the clusters increased daily, the rate of increase was higher in some clusters than in others. It has been seen that the most studied theories in the field of educational technologies are Cognitive Load Theory and Technology Acceptance Model. When examined in terms of variables, it is seen that the variables of Motivation, Success, Commitment and Social Presence find their place in educational technology studies.

Highlights: It has been determined that the studies in the field of Educational Technologies include articles in 20 thematic clusters in seven main categories. It is possible to collect clusters under seven headings: Assessment, Language Learning, Instructional Design, Technology in Learning Environments, Theoretical Foundations, Computational Thinking and Online Learning. While it is foreseen that some of these issues will be discussed again, especially after the pandemic, some studies are thought to be needed more. In addition, the field of educational technology is seen as an interdisciplinary field, as stated before. For this reason, it is known that more subject areas are related to the clusters created here. Different perspectives can be revealed by using different methods in similar data sets.

Öz

Çalışmanın amacı: Bu çalışmada, metin madenciliği yöntemi ile eğitim teknolojileri alanındaki çalışmaların eğilimlerini belirlemek amaçlanmıştır.

Materyal ve Yöntem: Araştıramda, Google Scholar Metrics'te "Eğitim Teknolojisi" alt kategorisinde ilk on derginin 2000 yılından bu yana yayınladığı 10.218 çalışma metin madenceliği ile incelenmiştir.

Bulgular: Kümelerdeki makale sayısının günlük olarak arttığını gösterse de, artış hızı bazı kümelerde diğerlerine göre daha yüksekti. Eğitim teknolojileri alanında en çok çalışılan teorilerin Bilişsel Yük Teorisi ve Teknoloji Kabul Modeli olduğu görülmüştür. Değişkenler açısından incelendiğinde Motivasyon, Başarı, Bağlılık ve Sosyal Varlık değişkenlerinin eğitim teknolojisi çalışmalarında kendine yer bulduğu görülmektedir.

Önemli Vurgular: Eğitim Teknolojileri alanında yapılan çalışmaların yedi ana kategoride 20 tematik kümede makaleler içerdiği tespit edilmiştir. Kümeleri yedi başlık altında toplamak mümkündür; Değerlendirme, Dil Öğrenme, Öğretim Tasarımı, Öğrenme Ortamlarında Teknoloji, Teorik Temeller, Hesaplamalı Düşünme ve Çevrimiçi Öğrenme. Bu konulardan bazılarının özellikle pandemi sonrası tekrar ele alınacağı ön görülürken bazı çalışmalara ise daha fazla ihtiyaç olduğu düşünülmektedir. Ayrıca eğitim teknolojisi alanı daha önce de belirtildiği gibi disiplinler arası bir alan olarak görülmektedir. Bu nedenle daha çok konu alanının burada oluşturulan kümelerle ilgili olduğu bilinmektedir. Benzer veri setlerinde farklı yöntemler kullanılarak farklı bakış açıları ortaya çıkarılabilir.

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INTRODUCTION

The studies so far in the field of educational technologies are shaped by important technological changes such as the internet and the subjects studied are evolving from instructional design to learning environments (Mihalca, & Miclea, 2007). Therefore, definitions made in the field of educational technology from past to present have also changed (Ely, 1963; AECT, 1972; AECT, 1977; Seels, & Richey, 1994; Spector, 2015).Considering the historical development of educational technology definitions, the definitions in the field are expressed as instructional design, educational technology, and instructional technology, with an emphasis on process and design (Reiser, 2007; Januszewski & Persichitte, 2008). In addition, under the different definitions, there are developments in technology, developments in psychology and criticisms made towards the field of instructional technologies (Reiser, 2007). While the first definitions of Educational Technology emphasized audio-visual technologies (Ely, 1963), it was later noted that Educational Technology, as a process intended to increase learning and achievement, is more complex and multi-faceted (AECT, 1977; Seels & Richey, 1994; AECT, 2008). Educational Technology does not simply involve using various forms of technology as tools, but should also be understood as the systematic organization of all resources and processes. Another definition made by Spector (2015), which is close to today, is the meaningful use and application of relevant information to strengthen the learning and teaching processes of educational technology. When these definitions are examined, it is seen that the definitions have changed over time with the developing technology and even new concepts have emerged.

Educational technology aims to increase learning and performance in different learning areas. As such, it is an interdisciplinary field (Wilson, 2012; Bodily, Leary, & West, 2019). For this reason, Educational Technology can be defined as a field that communicates and interacts with different disciplines and aims to facilitate learning (Liu, Meng & Chen, 2020; Luckin & Cukurova, 2019). Today, the rapid spread of information and the fact that individuals often want to be able to learn without being connected to a particular institution or a person have increased the importance of Educational Technology.

It is crucial for researchers who study or who are beginning to study educational technology to define the field and the place of their studies within it. However, researchers may have difficulty in defining Educational Technology (Bodily, Leary, & West, 2019). It thus becomes necessary to develop an overview of where things stand and to determine the trends occurring within the field in order to eliminate this difficulty.

The various studies conducted for this purpose have generally used the content analysis method (e.g. Gülbahar & Alper, 2009; Kucuk, Aydemir, Yildirim, Arpacik, & Goktas, 2013), conducted analyses of selected journals (e.g., Alper & Gülbahar, 2009; Bodily, Leary, & West, 2019; Hsu et al., 2012; Hsu, Hung, & Ching, 2013), or focused on one of the subject areas within Educational Technology (e.g., Hwang& Tsai, 2011; Wu, 2013). Although many studies have been carried out in the field of educational technologies, the trends revealed by the time periods of trend studies and the journals they have examined vary as well as the definitions of educational technologies. (Klein, 1997; Bozkaya, Aydin, & Kumtepe, 2012; Ross, Morrison, & Lowther, 2010; Alper, & Gülbahar 2009).

Related Reviews

In the study conducted by Martin, Diaz, Sancristobal, Gil, Castro, & Peire (2011) between 2004 and 2014 with bibliometric method, ideas about which technologies will be more efficient and effective in the field of educational technology were presented. As a different subject from other studies, the subject of augmented reality has been mentioned for future studies. According to this study, it was stated that research topics that should be focused in the future will become more useful and accurate with such trend studies.

In the study conducted by Kucuk, Aydemir, Yildirim, Arpacik, & Goktas (2013), a total of 1151 articles, including journals indexed in SSCI, SCI and ERIC, were examined between 1990-2011. According to this study, it was observed that the studies carried out in the field of educational technologies between 2002-2007 increased even more. In the study, which was conducted using educational technology classification forms and other data collection tools, the subjects were mainly observed in education technology, multimedia, distance education and educational environments. In addition, at the end of the study, it is stated that conducting such studies at certain time intervals is important in terms of following the current trends in the field and giving an idea to future studies.

In the study conducted by Baydas, Kucuk, Yilmaz, Aydemir, & Goktas (2015), it was found that learning approaches and learning environments research were mainly studied in 1255 articles published in ETR & D and BJET journals between 2002 and 2014. In addition, it has been found that there have been more frequent studies on e-learning in recent years. On the other hand, according to the information obtained, journals were categorized according to their subjects and classified under 7 titles: online learning, learning environments, learning approaches, assessment and evaluation, instructional design, educational technology and learning theories. In this study, in which the meta-analysis method was used, it was stated that policy studies on ICT are few, mixed studies should be done more frequently in order to obtain strong results for the field, and the popularity of such trend studies will continue to increase in the future.

Apart from these studies, some studies have examined the processes of different journals in the last 20 years(e.g. Martin, López-Martín, Lopez-Rey, Cubillo, Moreno-Pulido, & Castro, 2018; Natividad, Spector, & Evangelopoulos, 2018; Del Rio, Spector, & Evangelopoulos, 2016). According to these studies, it has been observed that research on the use of educational technologies

has increased, while it has been concluded that social interest on issues such as MOOC, distance education, online learning, mobile learning, and communication strategies has increased and the research trend in the field is gradually different. It was also stated that such studies are an important source of information to provide information on determining future research topics.

Today, with the expansion of online education environments, a huge amount of data is produced and researches are carried out in the field of education technology (Ferreira - Mello, André, Pinheiro, Costa, & Romero, 2019; Gürcan, & Özyurt, 2020; Baddam, Bingi, & Shuva, 2019. ; Marti Parreño, Méndez Ibáñez, & Alonso Arroyo, 2016). Therefore, text mining studies are carried out on a wide variety of topics in order to better analyze data in the field of education (e.g. Nakagawa, Asakawa, Yamada, Ushikubo, Yoshida, & Yamaguchi, 2012; Ferreira - Mello, André, Pinheiro, Costa, & Romero, 2019; Méndez Ibáñez, & Alonso Arroyo, 2016; Baddam, Bingi, & Shuva, 2019; Chen, Xu, Jin, & Wanatowski, 2019; Gürcan & Özyurt, 2020). While the most used text mining techniques in these studies were observed as classification, clustering, information retrieval and natural language operations, it was determined that electronic libraries, forums and online academic resources were used for text mining, and the main goal of the studies was generally related to the change of student performance. (Ferreira - Mello, André, Pinheiro, Costa, & Romero, 2019).

Chen, Xu, Jin, & Wanatowski (2019) aimed to expand existing studies by examining a total of 1810 journals published since 1982 for engineering education by using the text mining method. The profiles of the subjects covered were determined by classifying them into 4 different periods according to the subjects of the journals examined in the study. It was predicted that the integration of pedagogical methods in engineering education, examination of demographic differences and distance education that is being developed by IT will be examined more for future researches.

In the study conducted by Gürcan and Özyurt (2020), 27,735 articles were examined in order to see the general profile of the studies in the field of e-learning in the last 10 years using data mining method. According to the analysis results of this study, the e-learning area is clustered in 5 dimensions. Accordingly, it is stated that measurement and evaluation, learning environments, teaching models, teaching areas and teaching tools will provide significant benefits to the field of e-learning.

When we look at the national studies conducted in Turkey, Şimşek et al. (2008) determined the current trends in educational technology research in Turkey, and in the study of Erdoğmuş and Çağıltay (2016), the trends in master's and doctoral theses in the field of instructional technologies in Turkey. In the study of Şimşek et al., (2008), a general evaluation of the doctoral dissertations completed in the field of educational technology in the last ten years before the date of the study was made in five universities. In this study, it has been determined that there are researches on learning in computerized systems, instructional design variables and learning approaches as the subject of study. On the other hand, Erdoğmuş and Çağıltay (2016), on the other hand, have determined that many different subjects such as media forms, media comparison, educational variables, student outputs, teaching material development, teaching/learning perspective, educational methods, evaluation are discussed as the subject of study.

The Significance of the Study

Studies carried out with such approaches cannot reflect the whole area, either because it takes too much time or because it is only for a specific area. For example, in various studies conducted for this purpose, it is seen that the content analysis method is used or focused on one of the subject areas of Educational Technology (Bodily, Leary, & West, 2019; Hsu et al., 2012; Hsu, Hung & & Ching, 2013; Hwang & Tsai, 2011; Wu, 2013). Teherfore, using text mining to provide a “snapshot” of the field will provide a broader view and serve as a corrective to these issues (Li, Antonenko, & Wang, 2019). The purpose of this study was thus to first use numerical data to describe the studies in the field of Educational Technology, and then to use text mining to produce a “snapshot” of the entire field. For this purpose, answers were sought to the following research questions:

RQ1: What are the bibliometric features of studies in the field of Educational Technology?

RQ2: How are the studies in the field of Educational Technology classified?

RQ3: What trends can be seen in studies in the field of Educational Technology?

Methodology

Bibliometrics

Bibliometry is a statistical analysis method that allows a general overview to be obtained by visualizing and summarizing studies using variables such as individuals, institutions, journals, articles, books, and websites, publication year, countries, number of citations, and authors’ information(Okubo,1997; Hung, 2012; Karanatsiou, Misirlis, & Vlachopoulou, 2017; Thelwall, 2008; Martín-Martín, Orduna-Malea, & Delgado López-Cózar, 2018; Zanjirchi, Rezaeian Abrishami, &Jalilian, 2019).

Bibliometry provides an idea of the work done, enabling researchers to identify and evaluate the impact of previous research on disciplines related to the fields studied (Cooper,2015; Castellani, Pontecorvo, & Valente, 2016). The data obtained can allow a reader to gain a sense of the past and future relevance of the studies (Van Leeuwen, 2007). The graphs formed as a result of bibliometric analysis of the statistical data make it easier for the reader to analyze and interpret the work that has been carried

out. However, the bibliometric method may not be sufficient to adequately determine the themes or methodologies involved in specific studies (Zanjirchi, Rezaeian Abrishami, & Jalilian, 2019). For this reason, more detailed and comprehensive researchusing the text mining method may be required(Zanjirchi, Rezaeian Abrishami, & Jalilian, 2019; Hung, & Zhang, 2012; Wilson, 2016).

Text Mining

Text mining is a data mining technique used to reveal hidden and meaningful structures in any given data (Gupta & Lehal, 2009). Data mining can be defined as the process of discovering information present in databases. It involves the pre-processing, selection, and conversion of data, and the evaluation of the information which emerge s(Fayyad, Piatetsky-Shapiro & Smyth, 1996).Unlike other forms of data mining, text mining uses instances of text as the data set. Text mining is the process of automatically revealing a set of texts that do not appear to be relational, insignificant text blocks, or information (Hung & Zhang 2012) from databases of previously unknown information (Härkänen, Paananen, Murrells, Rafferty, & Franklin, 2019). Summarizing the information already present but previously unutilized in the databases enables the desired analyses and trending researches to be conducted (Feldman & Dagan,1995).

Data Collection Process

Studies published between 2000-2020 in the top ten journals in the Educational Technology subcategory of the Social Sciences category of Google Scholar were selected for inclusion in this research. The results were filtered by "Article" and those with "Early Access" were removed from the data set since there was a problem accessing these articles. As a result, 10.218 articles were accessed.

The studies were downloaded in text format for use in MS Excel, and the VOS viewer, and SAS Enterprise Miner programs. After the text that was relevant to this research had been isolated, the remaining text was deleted from the articles. The names of the journals, keywords, names of countries, and publication years were retained for use. In addition, tools from the Web of Science were used for descriptive data such as document type, year of publication, and country of origin.

Data Analysis & Visualization

The SAS Enterprise Miner and VOS viewer programs were used to analyze the data. SAS is a program that can analyze sets of text using various tools, reveal the relationship between words in different texts, and hierarchically group and analyze large amounts of data (Hung,2012; Hung, & Zhang, 2012). Moreover, the SAS program allows large amounts of data to be interpreted through visualization of the relationships in the data (Härkänen, Paananen, Murrells, Rafferty, & Franklin, 2019, Hung,2012; Hung, & Zhang, 2012). The data to be analyzed were thus transferred to the SAS program so the necessary operations could be performed. As shown in Figure 1,this process includes nodes for “File Import”, “Text Parsing”, “Text Filter”, “Text Cluster”, and “Graph Explore”.

First, the "File Import" node in the "sample" section was added to run the data in the program with the extension ".xslx," and the data was saved to the program thanks to this node. The “Text Parsing” node was then used to automatically process and divide the samples of text and prepare them for data mining (Hung,2012; Härkänen, Paananen, Murrells, Rafferty, & Franklin,2019; Bayrak, 2020). After checking that the data had been uploaded to the program, the "Text Parsing" node was used from the "Text Mining" section. For the “Text Parsing” node, only the keywords (DE) heading was activated from the "Edit Variables" table, and the next step was carried out by parsing.

A “Text Filter” node was employed so that only data related to each other were used, to disable data that were not intended for use and to monitor the data (Härkänen, Paananen, Murrells, Rafferty, & Franklin, 2019; Härkänen, Vehviläinen-Julkunen, Murrells, Paananen, Franklin,& Rafferty, 2020). Accordingly, the "Text Filter" node was used to filter by keywords. Only the keywords heading was activated from the "Edit Variables" table for the “Text Filter” node, and the next stage, ‘filtering’, was initiated.

The “Text Cluster” node is used to classify terms with similar structure and content in textual data (Bayrak, 2020; Härkänen Paananen, Murrells, Rafferty, & Franklin, 2019; You, 2014; Payton, Yarger, & Pinter, 2018). After the parsing and filtering process, the "Text Cluster" node was used from the "Text Mining" section so that the keywords can be classified. Therefore, the "Text Cluster" node was used.

The "Graph Explore" node in the "Explore" section was used to convert the keywords allocated to clusters into a graphic format, and the graphical results of the data were obtained for this purpose. In addition, to report the results of all transactions, the "Reporter" node in "Utility" section was used, and the report of the results was saved in pdf format. The results and the names given to the clusters were presented to the field experts, and a reporting process was started in order to name the clusters formed in this way.

Data visualization was carried out to increase the readability of the data. SAS Enterprise Miner was used for this.

Findings

Bibliometrics of the articles published in the top ten journals in Educational Technology

Findings on RQ1 are presented under three headings: Number of articles by year, issue by country, and number by journal. Findings related to this are given below.

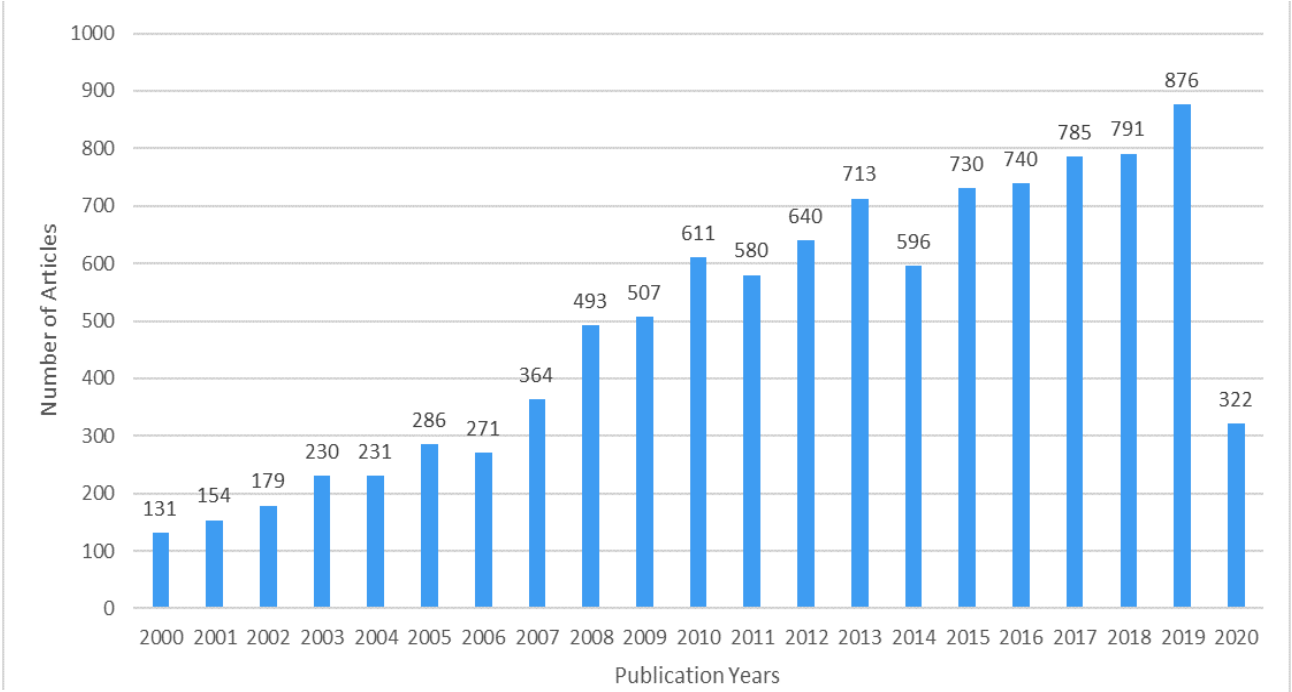

Figure 1. Number of Articles by Year

Figure 1 shows the distribution of the numbers of article by year. The greatest number of articles was published in 2019 (N = 876), and the fewest articles were published in 2000 (N = 131). Although the numbers decreased in some years compared to the previous years, the data show that for the last five years the number of articles has been increasing year-on-year. It can be assumed that the spread of the internet and changes to the online access policies of the journals have had an impact. Given the data, it can be predicted that the number of articles will continue to increase in 2020.

Figure 2 shows the number of articles by journal. Computers & Education published the most articles (n= 3142), and the International Conference on Learning Analytics and Knowledge published the fewest articles (n=125). Given that learning analytics is a new and growing field, this finding was to be expected. When the other journals were examined, it was found that the British Journal of Educational Technology published 1728 articles, the Journal of Educational Technology & Society published 1413, and the Journal of Computer Assisted Learning published 914 articles.

Figure 3 presents the distribution of articles by country. The ten countries that published the most articles between 2000 and 2020 were the USA (n = 2526), Taiwan (n = 1491), England (n = 977), China (n = 627), Australia (n = 594), Spain (n = 485), Canada (n = 483), the Netherlands (473), Turkey (n = 403) and Germany (n = 297). The regions of the world most predominantly represented were thus North America, Asia, and Europe.

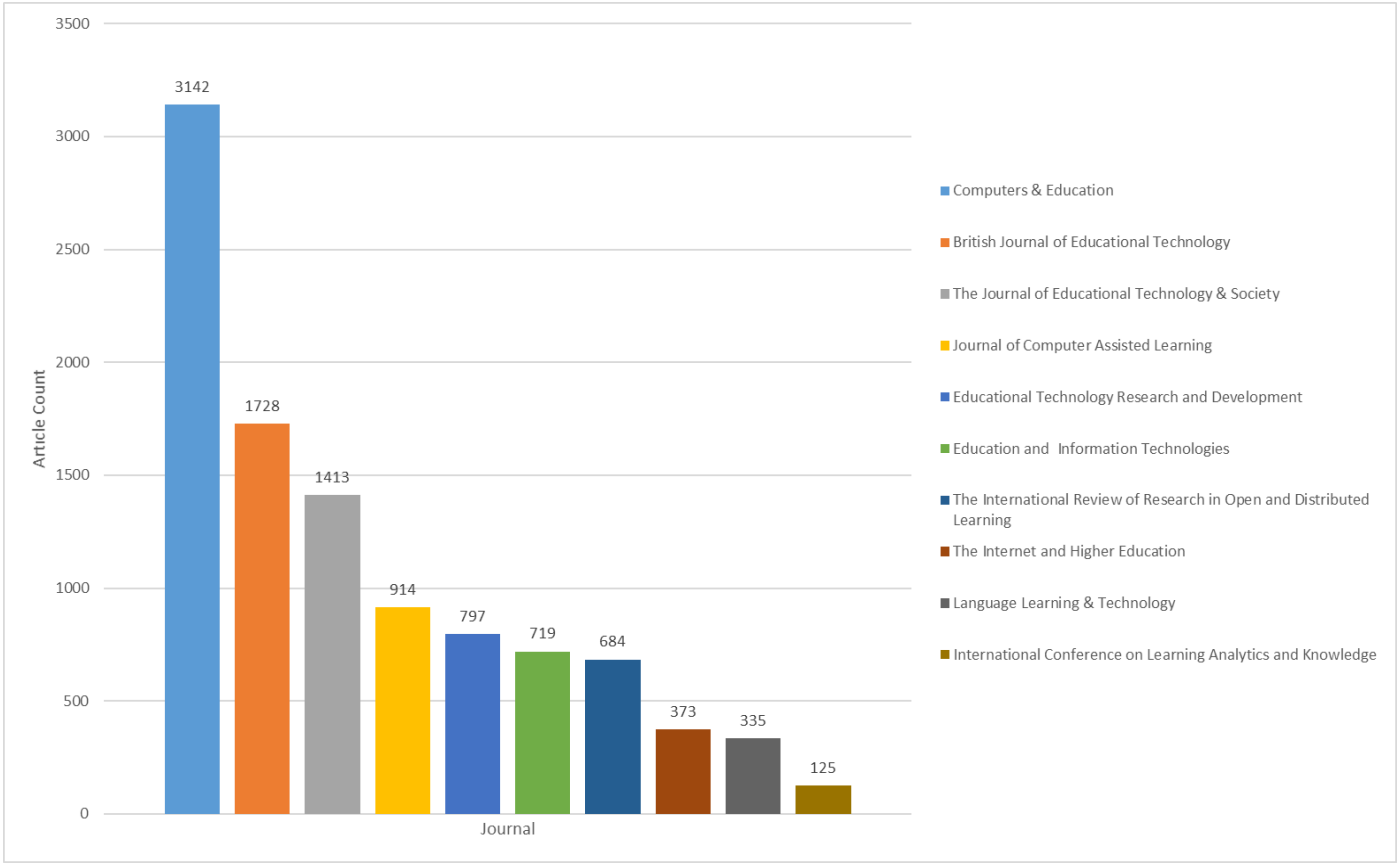

Figure 2. Numbers of Articles by Journal

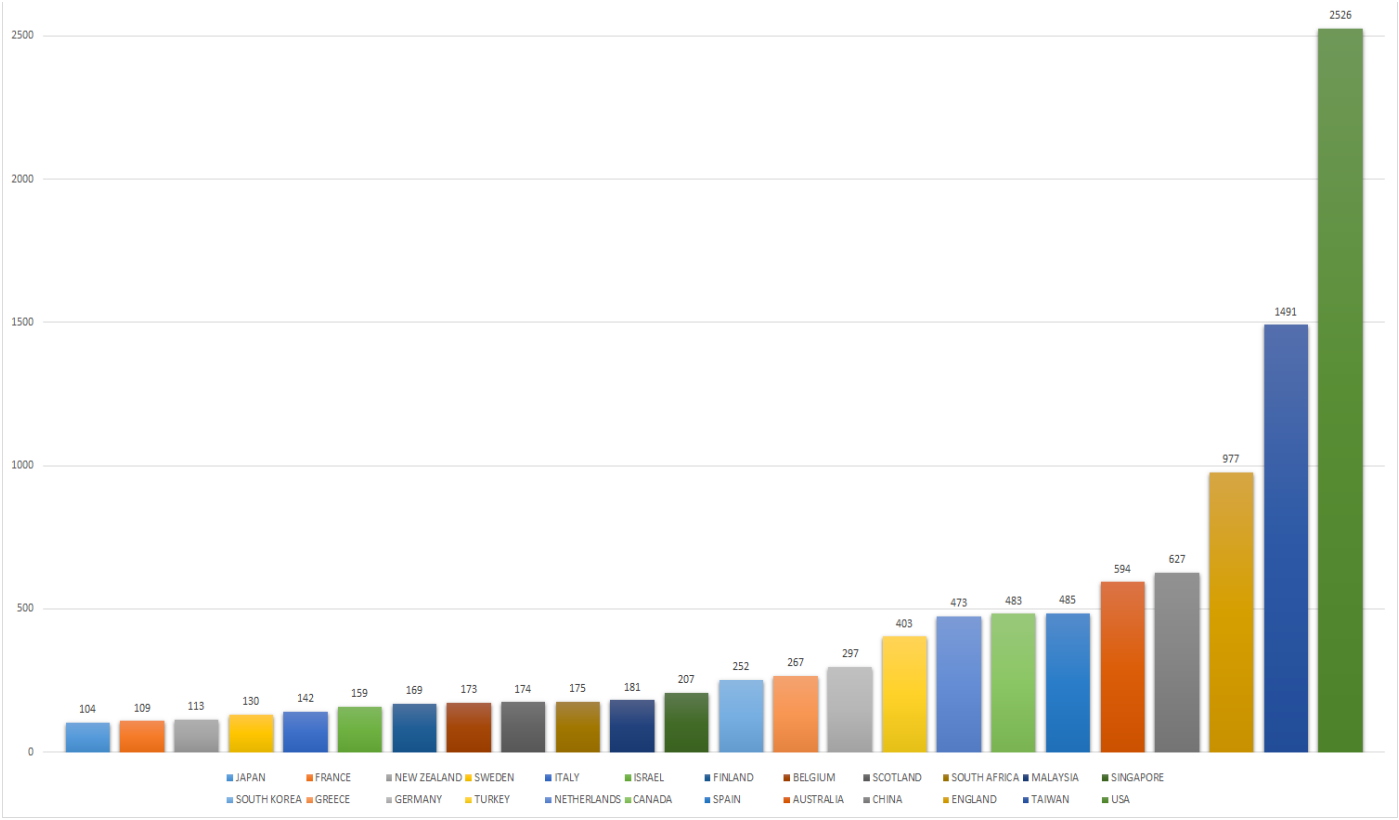

Figure 3. Numbers of Aticles by Country

Clusters of articles in Educational Technology

Figure 4 shows the numbers of clusters formed according to the similarity of the keywords within the articles. These included: MOOCS (N = 255), Pedagogical Issues in Distance Education (N = 456), Hypermedia (N = 1001), Evaluation (N = 368), Technology Acceptance Model (N = 473), Computer Supported Language Learning (N = 574), Achievement and Engagement in Online Learning (N = 555), Open Educational Sources (N = 294), Computer Integration (N = 534), Cognitive Load Theory (N = 649), e- learning in Higher Education (N = 491), Digital Assessment (N = 649), Instructional Design and Social Presence (N = 706), Computational Problem Solving (N = 278), Human-Computer Interface (N = 408), Virtual Reality Environments (N = 454), Educational Games (N = 412), Teaching Strategies (N = 639), Motivation in Language Learning (N = 449) and Online and Mobile Learning (N = 543). According to the information in the table, the most studied area between 2000-2020 was Hypermedia, and the least studied area was MOOCs.

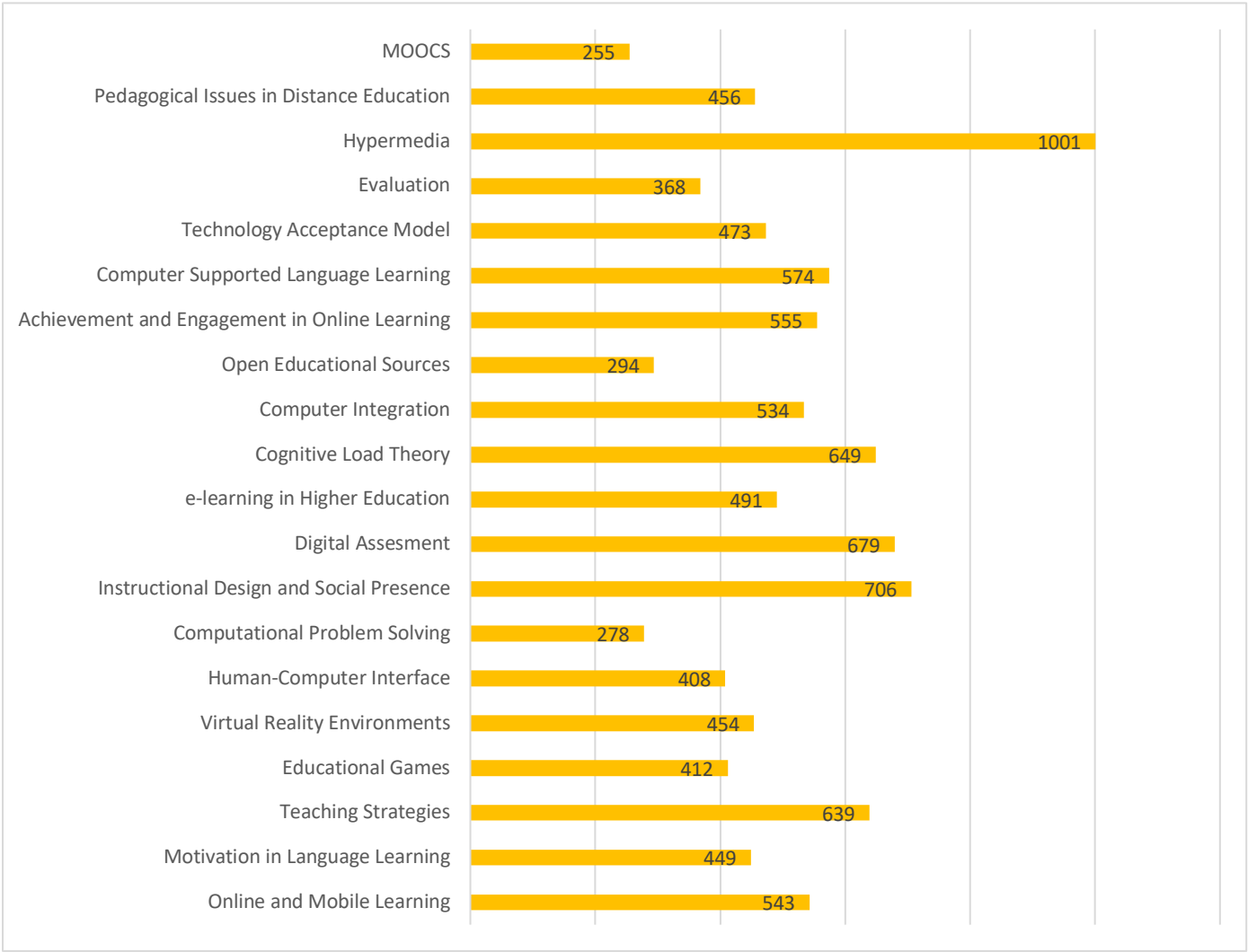

Figure 4. Article Numbers of Cllusters

It is possible to collect the clusters under seven topics; Assessment, Language Learning, Instructional Design, Technology in Learning Environments, Theoretical Foundations, Computational Thinking, and Online Learning.Evaluation and Digital Assessment Clusters can be positioned under the Assessment topic. Considering that one of the general aims of educational technology research is the answer to the question of "how do I teach?", It is inevitable that evaluation of the developed product and teaching process are also included in educational technology studies. It is inevitable that evaluation and digital assessment clusters take part in educational technology studies.

Language teaching is a discipline in which educational technologies work closely due to the need for audio and video materials. Accordingly, Motivation in Language Learning and Computer Supported Language Learning clusters have found a place in educational technology studies (Kukul & Aydın, 2020). In addition, motivation is known to be a variable studied in educational technology research (Li, Antonenko, & Wang, 2019).

Instructional Design is used instead of the term educational technologies or instructional technologies in some researches (Reiser, 2007). Instructional Design shows itself in different studies (e.g. Kukul & Aydın, 2020; Li, Antonenko, & Wang, 2019).

Instructional design generally includes "How Teaching?" Teaching strategies cluster and Instructional Design and Social Presence cluster can be grouped under the Instructional Design theme. The concept of Social Presence is a variable studied mostly in distance education (e.g. Aragon; 2003; Tu, 2002; Tu & McIsaac, 2002; Richardson, Maeda, & Caskurlu, 2017). From this point of view, it can be interpreted as instructional design is mostly used in distance education design (Kukul, & Aydın, 2020).

Six different clusters can be grouped under the Technology in Learning Environments topic. These are Educational Games, Virtual Reality Environments, Human-Computer Interface, Computer Integration, Hypermedia, e-learning in Higher Education. Among these clusters, Hypermedia stands out with its number of articles. Investigating the effect of hypermedia on learning for a period in computer-supported learning studies (Li et al., 2019) has been effective in the formation of this cluster.

We can say that there are two clusters under the Theoretical Foundations topic. These are the Cognitive Load Theory and the Technology Acceptance Model. Cognitive load theory is concerned with the processing of information by the human mind during cognitive learning and the capacity of memory types (Li et al., 2019). As a result of educational technology research being under the influence of cognitive learning theory for a long time, this theory has been frequently studied in the field of educational technologies. Technology Acceptance Model, on the other hand, is a theory that derives from the Theory of Planned Behavior and explains the behaviors of people using technology with different variables and is frequently studied in the field of educational technologies.

Computational Thinking concept is included in the research as a single set. It is a concept that was first used by Seymour Papert, but became popular in 2006 by Jeannette Wing (Kukul & Karataş, 2019). It is considered a 21st century skill that all individuals should have. Therefore, technology has started to be used in educational environments to develop computational thinking skills of individuals.

Under the Online Learning topic, there are Online and Mobile Learning, Open Educational Sources, Achievement and Engagement in Online Learning, Pedagogical Issues in Distance Education, MOOCS clusters. Distance education applications constitute a large part of educational technology studies. The global pandemic process shows that these clusters will mostly be studied in the field of educational technologies.

Trends in Clusters in Educational Technology

Considering the distribution of clusters by years, it is seen that the number of researches increases every year. It can be seen that especially until 2008, hypermedia has been studied more than other clusters. As of 2009, it is seen that especially the Teaching Strategies cluster is involved in the field of Educational Technology. After 2011, it can be said that all clusters are distributed in a balanced way.

When the distribution of clusters according to journals is examined, it is possible to say that the Hypermedia cluster is included in the British Journal of Educational Technology and the Teaching Strategies cluster in the Computer & Education. Computer Assissted Language Learning appears as a journal in which the Motivation in Language Learning and Computer Supported Language Learning clusters are seen widely. In addition, Journal of Educational Technology & Society appears as a journal in which the Computer Supported Language Learning cluster is widely seen.

Computers & Education, as the journal that publishes the most research studies in the field of Educational Technology, can be regarded as natural that many clusters appear too many in that journal. In the journal, it is seen that there are many studies on Teaching Strategies, Evaluation and Digital Assessment clusters. The clusters outside of these clusters are evenly distributed in proportion to the number of journals' publications.

When the time trends of clusters are examined, it is seen that many clusters are generally in an upward trend. In addition, many clusters have increased in parallel with the rise in the numbers of educational technology research studies, especially after 2008. At this point, some clusters differ from others. One of them is the Hypermedia cluster where the most publications are made. The Hypermedia cluster has been in a downward trend after 2008. Another cluster that tends to go down like Hypermedia is the Evaluation cluster. However, it is seen that the Digital Assessment set has increased after 2008, in contrast to Evaluation. Although not as much as Evaluation and Hypermedia, other clusters in declining trend were Teaching Strategies, Pedagogical issues in Distance Education and Human Computer Interface. It is observed that clusters other than these clusters are in an upward trend even if they do not increase regularly every year.

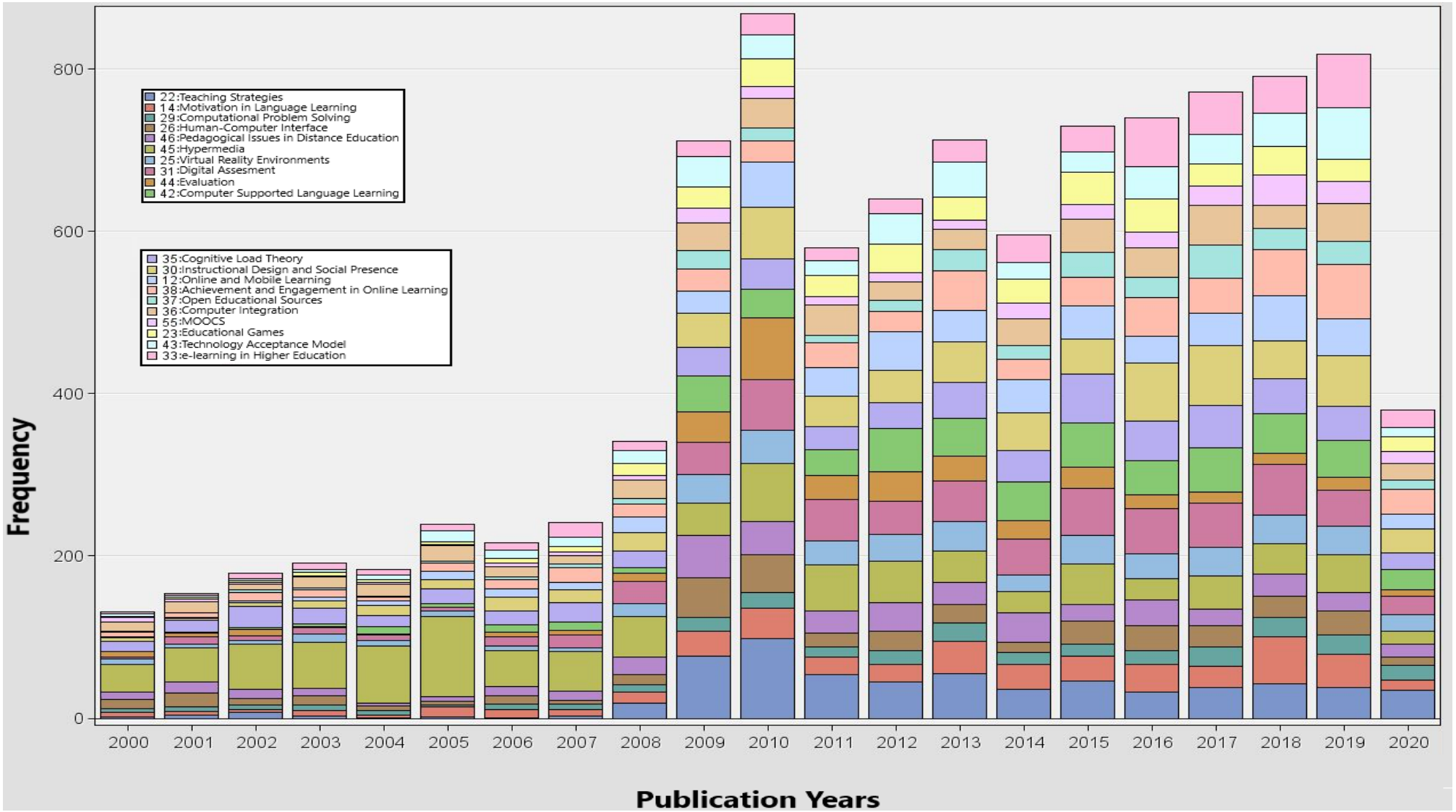

Figure 5. Trends of Clusters According to the Years

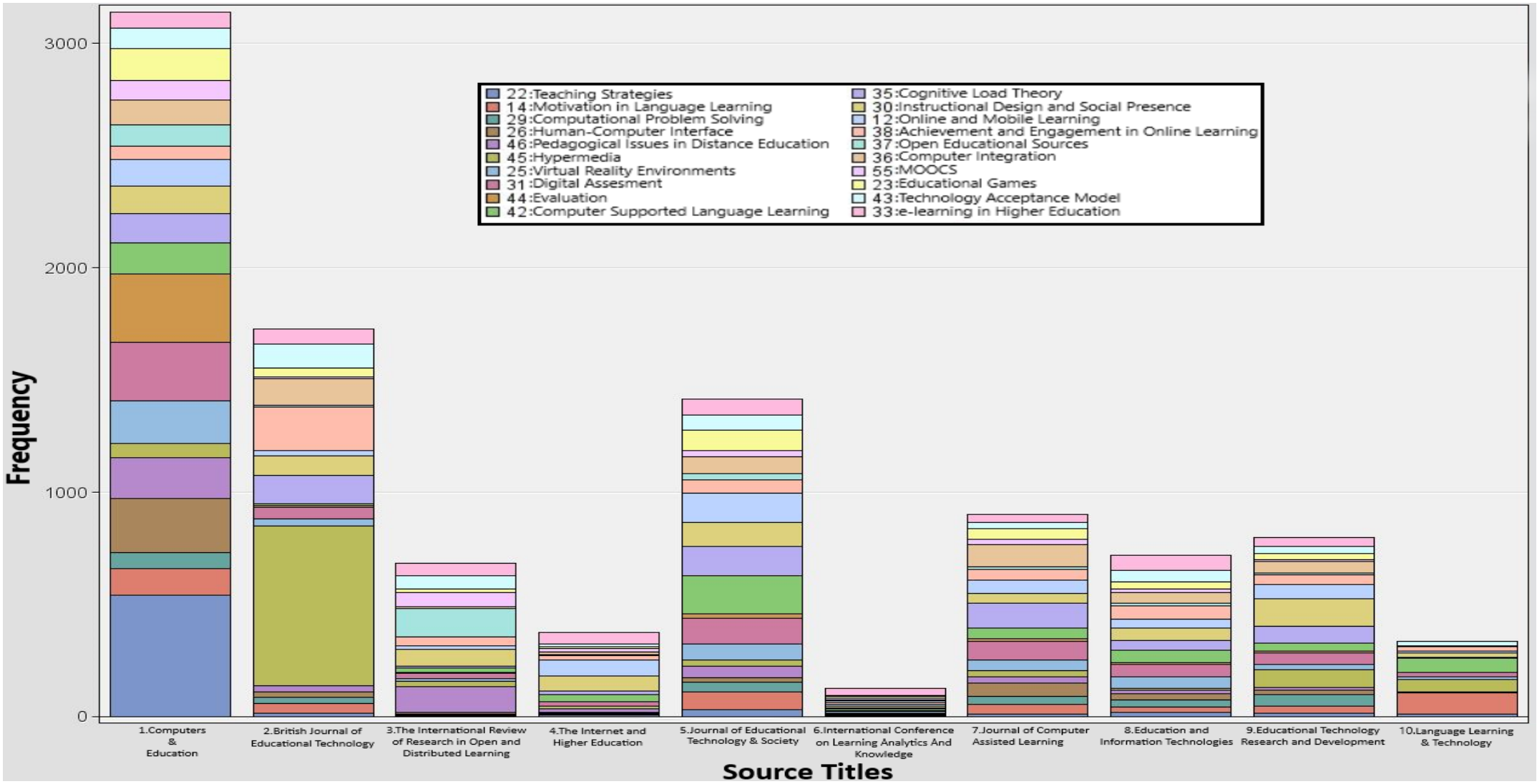

Figure 6. Trends of Clusters According to the Journals

Conclusion

This study aimed to use Google Scholar Metrics to determine trends in articles published in the top ten Educational Technology journals between 2000 and 2020. The articles were first analyzed bibliometrically, and then text-mining techniques were used to determine how they were clustered. The number of articles increased each year. That is why the trend of most of the clusters was to grow. The study found that there were 20 different thematic clusters in the field of Educational Technology.

When the clusters were examined by journal, it was seen that articles on Teaching Strategies were mostly published in Computers & Education while those on Hypermedia were most published in the British Journal of Educational Technology. Since Computers &Education is the journal where most articles are published, it could be considered natural that it would include the most clusters. However, articles on Hypermedia, and Achievement and Engagement in Online Learning were mostly published in the British Journal of Educational Technology.

When the trends for each cluster were examined, it was seen that the number of articles in the Computational Problem-Solving cluster began to increase after 2006. It can be said that the growing popularity of the concept of "computational thinking", following its definition by Wing in 2006 (Kukul & Karatas, 2019; Román-González, 2015; Roman-Gonzalez, Perez-Gonzalez, & Jimenez-Fernandez, 2017; Roman-Gonzalez, Perez-Gonzalez, Moreno-Leon, & Robles, 2018), had an impact on this increase. The graphic showing the trend over time for Computational Problem-Solving shows that, although the number of articles in this cluster is no greater than in others, it is a topic that is likely to remain popular in the future.

The same situation is valid for the MOOCs cluster. The graphic shows that research on MOOCs increased after 2008. This was the date when the first MOOC opened at the University of Manitoba (Liyanagunawardena, Adams, & Williams, 2013). It is likely that, after the CoVID-19 Pandemic, MOOCs will become even more valuable, and the number of articles on them will likely increase in the coming years. The increase in the number of articles in the Open Education Sources Cluster supports this conclusion. The prevalence of articles in this cluster is increasing in parallel with those about MOOCs.

The number of articles in the Teaching Strategies, Pedagogical Issues in Distance Education, and Evaluation clusters decreased after 2009 and 2010. This suggests that research is increasingly focusing on learners. The rapid development of technology is changing the roles and competencies of instructors, and this may be one of the results. It can be said that there needs to be more studies about instructors.

It has been seen that the most studied theories in the field of educational technologies are Cognitive Load Theory and Technology Acceptance Model. Li et al. (2019) similarly revealed that Cognitive Load Theory is frequently studied in multimedia studies. When examined in terms of variables, it is seen that Motivation, Achievement, Engagement and Social Presence variables find their place in educational technology studies.

Although the field of Educational Technology is often seen as an umbrella term for other disciplines, only Language Learning, as a separate field of study, finds a place as one of the clusters. This finding can be interpreted as showing that Language Learning is the discipline that most interacts with Educational Technology.

Although the number of articles examined in this study is large, there are some limitations. First, the Social Science Citation Index, one of the important indexes, is scanned in such studies. However, it is known that there are valuable research studies that contribute to many areas outside of this index. In addition, the field of educational technology is seen as an interdisciplinary field as stated before. Therefore, it is known that more subject areas are concerned with the clusters formed here. Different perspectives can be revealed by using different methods in similar data sets.

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Statements of publication ethics

I/We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

References

Aragon, S. R. (2003). Creating social presence in online environments. New directions for adult and continuing education, 2003(100), 57-68. https://doi.org/10.1002/ace.119

Association for Educational Communications and Technology. (1972). The field of educational technology: a statement of definition. Audio-visual Instruction, 17(8), 36-43.

AECT (1977). The definition of educational technology. Washington: AECT.

AECT (2008). Definition. In A. Januszewski and M. Molenda (Eds.), Educational Technology: A definition with commentary. New York: Lawrence Erlbaum Associates.

Alper, A., & Gulbahar, Y. (2009). Trends and issues in educational technologies: A review of recent research in TOJET. *Online Submission, 8*(2).

Baddam, S., Bingi, P., & Shuva, S. (2019). Student Evaluation of Teaching in Business Education: Discovering Student Sentiments Using Text Mining Techniques. *The e-Journal of Business Education & Scholarship of Teaching, 13*(3), 1-13.

Baydas, O., Kucuk, S., Yilmaz, R. M., Aydemir, M., & Goktas, Y. (2015). Educational technology research trends from 2002 to 2014. *Scientometrics, 105*(1), 709-725. https://doi.org/10.1007/s11192-015-1693-4

Bayrak, T. (2020). A content analysis of top-ranked universities' mission statements from five global regions. *International Journal of Educational Development, 72*, 102130. https://doi.org/10.1016/j.ijedudev.2019.102130

Bodily, R., Leary, H., & West, R. E. (2019). Research trends in instructional design and technology journals. *British Journal of Educational Technology, 50*(1), 64-79. https://doi.org/10.1111/bjet.12712

Bozkaya, M., Aydin, I. E., & Kumtepe, E. G. (2012). Research Trends and Issues in Educational Technology: A Content Analysis of TOJET (2008-2011). *Turkish Online Journal of Educational Technology-TOJET, 11*(2), 264-277.

Castellani, T., Pontecorvo, E., & Valente, A. (2016). Epistemic Consequences of Bibliometrics-based Evaluation: Insights from the Scientific Community. *Social Epistemology, 30*(4), 398–419. https://doi.org/10.1080/02691728.2015.1065929

Chen, W., Xu, Y., Jin, R., & Wanatowski, D. (2019). Text mining–based review of articles published in the journal of professional issues in engineering education and practice. *Journal of Professional Issues in Engineering Education and Practice, 145*(4), 06019002.

Cooper, I. D. (2015). Bibliometrics basics. Journal of the Medical Library Association : *JMLA, 103*(4), 217–218. https://doi.org/10.3163/1536-5050.103.4.013

Del Rio, G. N. B., Spector, J. M., & Evangelopoulos, N. (2016,). *An Analysis of Educational Technology Publications from January 1995 to December 2014.* In 2016 IEEE 16th International Conference on Advanced Learning Technologies (ICALT) (pp. 227-229). IEEE.

Ely, D. P. (1963). *The changing role of the audiovisual process in education: A definition and glossary of related terms.* Washington, D.C.: National Education Association.

Ely, D. P. (1992). Trends in educational technology.

Fayyad, U., Piatetsky-Shapiro, G., & Smyth, P. (1996). From data mining to knowledge discovery in databases. *AI journal, 17*(3), 37-54. https://doi.org/10.1609/aimag.v17i3.1230

Feenberg, A. (2001). Whither educational technology?. *International Journal of Technology and Design Education, 11*(1), 83-91.

Feldman, R., & Dagan, I. (1995). Knowledge discovery in textual databases (KDT). *Proceedings of the first international conference on knowledge discovery and data mining (KDD-95)*.

Ferreira-Mello, R., André, M., Pinheiro, A., Costa, E., & Romero, C. (2019). Text mining in education. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 9*(6), e1332. https://doi.org/10.1002/widm.1332

Gupta, V., & Lehal, G. S. (2009). A survey of text mining techniques and applications. *Journal of emerging technologies in web intelligence, 1*(1), 60-76.

Gürcan, F , Özyurt, Ö . (2020). E-Öğrenme Araştırmalarındaki Temel Eğilimler ve Bilgi Alanları: 2008-2018 Yılları Arasında Yayımlanan Makalelerle Konu Modelleme Analizi . *Journal of Computer and Education Research , 8* (16) , 738-756 . DOI: 10.18009/jcer.769349

Hsu, Y. C., Ho, H. N. J., Tsai, C. C., Hwang, G. J., Chu, H. C., Wang, C. Y., & Chen, N. S. (2012). Research trends in technology-based learning from 2000 to 2009: A content analysis of publications in selected journals. *Journal of Educational Technology & Society, 15*(2), 354-370.

Hsu, Y. C., Hung, J. L., & Ching, Y. H. (2013). Trends of educational technology research: More than a decade of international research in six SSCI-indexed refereed journals. *Educational Technology Research and Development, 61*(4), 685-705. DOI 10.1007/s11423-013-9290-9

Hung, J. L. (2012). Trends of e-learning research from 2000 to 2008: Use of text mining and bibliometrics. *British Journal of Educational Technology, 43*(1), 5-16. https://doi.org/10.1111/j.1467-8535.2010.01144.x

Hung, J. L., & Zhang, K. (2012). Examining mobile learning trends 2003–2008: A categorical meta-trend analysis using text mining techniques. *Journal of Computing in Higher education, 24*(1), 1-17. https://doi.org/10.1007/s12528-011-9044-9

Hwang, G. J., & Tsai, C. C. (2011). Research trends in mobile and ubiquitous learning: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology, 42*(4), E65-E70. https://doi.org/10.1111/j.1467-8535.2011.01183.x

Härkänen, M., Paananen, J., Murrells, T., Rafferty, A. M., & Franklin, B. D. (2019). Identifying risks areas related to medication administrations-text mining analysis using free-text descriptions of incident reports. *BMC health services research, 19*(1), 791. https://doi.org/10.1186/s12913-019-4597-9

Härkänen, M., Vehviläinen-Julkunen, K., Murrells, T., Paananen, J., & Rafferty, A. M. (2019). Text mining method for studying medication administration incidents and nurse-staffing contributing factors: A pilot study. *CIN: Computers, Informatics, Nursing, 37*(7), 357-365. doi: 10.1097/CIN.0000000000000518

Härkänen, M., Vehviläinen-Julkunen, K., Murrells, T., Paananen, J., Franklin, B. D., & Rafferty, A. M. (2020). The Contribution of Staffing to Medication Administration Errors: A Text Mining Analysis of Incident Report Data. *Journal of Nursing Scholarship, 52*(1), 113-123. https://doi.org/10.1111/jnu.12531

Januszewski, A., & Persichitte, K. A. (2008). *A history of the AECT's definitions of educational technology.* In A. Januszewski& M. Molenda (Eds.), Educational technology (pp. 259-282). New York: Lawrence Erlbaum Associates.

Karanatsiou, D., Misirlis, N., & Vlachopoulou, M. (2017). Bibliometrics and altmetrics literature review. *Performance Measurement and Metrics, 18*(1), 16–27. https://doi.org/10.1108/pmm-08-2016-0036

Klein, J. D. (1997). ETR&D-Development: An analysis of content and survey of future direction. *Educational Technology Research and Development, 45*(3), 57-62.

Kucuk, S., Aydemir, M., Yildirim, G., Arpacik, O., & Goktas, Y. (2013). Educational technology research trends in Turkey from 1990 to 2011. *Computers & Education, 68*, 42-50. https://doi.org/10.1016/j.compedu.2013.04.016

Kukul, V., & Aydın, K. A. (2020). Classification of the Theses and Dissertations in the Field of Computer Education and Instructional Technology in Turkey: An Investigation through Text Mining. *Participatory Educational Research, 8*(1), 279-291. https://doi.org/10.17275/per.21.16.8.1

Kukul, V., & Karatas, S. (2019). Computational Thinking Self-Efficacy Scale: Development, Validity and Reliability. *Informatics in Education, 18*(1), 151-164.

Li, J., Antonenko, P. D., & Wang, J. (2019). Trends and issues in multimedia learning research in 1996–2016: A bibliometric analysis. *Educational Research Review*, *28*, 100282. https://doi.org/10.1016/j.edurev.2019.100282

Liu, J., Meng, X., & Chen, C. (2020). Knowledge Structure Analysis on Educational Technology Based on Citation Analysis. *International Journal of Emerging Technologies in Learning (iJET), 15*(05), 171-183.

Liyanagunawardena, T. R., Adams, A. A., & Williams, S. A. (2013). MOOCs: A systematic study of the published literature 2008-2012. *The International Review of Research in Open and Distributed Learning, 14*(3), 202-227. https://doi.org/10.19173/irrodl.v14i3.1455CopiedAn error has occurred

Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology, 50*(6), 2824-2838. https://doi.org/10.1111/bjet.12861

Martí Parreño, J., Méndez Ibáñez, E., & Alonso Arroyo, A. (2016). The use of gamification in education: a bibliometric and text mining analysis. *Journal of computer assisted learning, 32*(6), 663-676.https://doi.org/10.1111/jcal.12161

Martín-Martín, A., Orduna-Malea, E., Delgado López-Cózar, E., (2018). A novel method for depicting academic disciplines through Google Scholar Citations: The case of Bibliometrics. *Scientometrics*. https://doi.org/10.1007/s11192-017-2587-4

Martin, F., & Ertzberger, J. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers & Education, 68*, 76-85. https://doi.org/10.1016/j.compedu.2013.04.021

Martin, S., López-Martín, E., Lopez-Rey, A., Cubillo, J., Moreno-Pulido, A., & Castro, M. (2018). Analysis of new technology trends in education: 2010–2015. *IEEE Access, 6*, 36840-36848. 10.1109/ACCESS.2018.2851748

Martin, S., Diaz, G., Sancristobal, E., Gil, R., Castro, M., & Peire, J. (2011). New technology trends in education: Seven years of forecasts and convergence. *Computers & Education, 57*(3), 1893-1906. https://doi.org/10.1016/j.compedu.2011.04.003

Mihalca, L., & Miclea, M. (2007). Current trends in educational technology research. *Cognitie, Creier, Comportament/Cognition, Brain, Behavior, 11*(1).

Nakagawa, K., Asakawa, Y., Yamada, K., Ushikubo, M., Yoshida, T., & Yamaguchi, H. (2012). Benefits of off-campus education for students in the health sciences: a text-mining analysis. *BMC medical education, 12*(1), 84. https://doi.org/10.1186/1472-6920-12-84

Natividad, G., Spector, J. M., & Evangelopoulos, N. (2018*). Research Topics and Trends in Educational Technology*. In An Analysis of Two Decades of Educational Technology Publications (pp. 85-94). Springer, Singapore.

Okubo, Y. (1997). *Bibliometric indicators and analysis of research systems: Methods and examples*, STI Working Papers 1997/1, OECD Science, Paris.

Payton, F. C., Yarger, L. K., & Pinter, A. T. (2018). Text Mining Mental Health Reports for Issues Impacting Today's College Students: Qualitative Study. *JMIR mental health, 5*(4), e10032.

Reiser, R. A. (2007). What field did you say you were in? Defining and naming our field. In Trends and issues in instructional design and technology (2nd ed.) (pp. 2-9). Upper Saddle River, NJ: Pearson Education, Inc.

Richardson, J. C., Maeda, Y., Lv, J., & Caskurlu, S. (2017). Social presence in relation to students' satisfaction and learning in the online environment: A meta-analysis. *Computers in Human Behavior, 71*, 402-417. https://doi.org/10.1016/j.chb.2017.02.001

Román-González, M. (2015). Computational Thinking Test: Design Guidelines and Content Validation. Proceedings of the 7th Annual International Conference on Education and New Learning Technologies (EDULEARN 2015). Valencia, Spain: IATED Academy, 2436–2444.

Roman-Gonzalez, M., Perez-Gonzalez, J.-C., & Jimenez-Fernandez, C. (2017). Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test. *Computers in Human Behavior, 72*, 678-691. https://doi.org/10.1016/j.chb.2016.08.047

Roman-Gonzalez, M., Perez-Gonzalez, J.-C., Moreno-Leon, J., & Robles, G. (2018). Extending the nomological network of computational thinking with non-cognitive factors. *Computers in Human Behavior, 80*, 441-459. https://doi.org/10.1016/j.chb.2017.09.030

Ross, S. M., Morrison, G. R. Lowther, D. L. (2010). Educational technology research past and present: Balancing rigor and relevance to impact school learning. *Contemporary Educational Technology, 1*(1),17–15. https://doi.org/10.30935/cedtech/5959

Seel, B.B., & Richey, R.C. (1994). Instructional Technology: The Definition and Domain of The Field. Washington: AECT.

Spector, J. M. (2015). Foundations of educational technology: Integrative approaches and interdisciplinary perspectives. Routledge.

Thelwall, M. (2008). Bibliometrics to webometrics. *Journal of Information Science, 34*(4), 605–621. https://doi.org/10.1177/0165551507087238

Tsai, C. C., & Hwang, G. J. (2013). Issues and challenges of educational technology research in Asia. *The Asia-Pacific Education Researcher, 22*(2), 215. DOI 10.1007/s40299-012-0038-9

Tu, C. H. (2002). The measurement of social presence in an online learning environment. *International Journal on E-learning, 1*(2), 34-45.

Tu, C. H., & McIsaac, M. (2002). The relationship of social presence and interaction in online classes. *The American journal of distance education, 16*(3), 131-150. https://doi.org/10.1207/S15389286AJDE1603_2

Van Leeuwen, T. N. (2007). Modelling of bibliometric approaches and importance of output verification in research performance assessment. *Research Evaluation, 16*(2), 93–105. https://doi.org/10.3152/095820207x227529

We Are Social (2020). Digital in 2020. Accessed: https://wearesocial.com/digital-2020 13.06.2020.

Wilson, B. G. (2012). Constructivism in practical and historical context. *Trends and issues in instructional design and technology, 3*, 45-52.

Wilson, V., 2016. Research Methods: Bibliometrics. Evidence Based Library and Information Practice. https://doi.org/10.18438/b80917

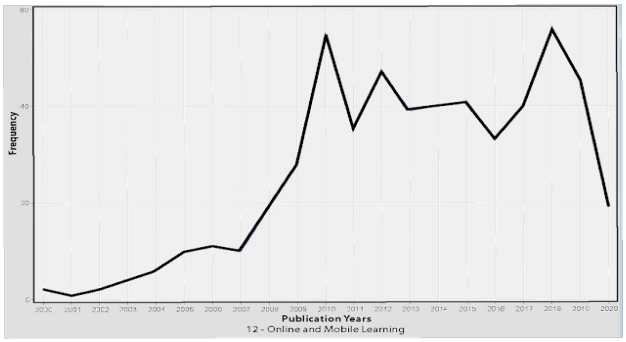
Winn, W. (2002). Research into practice: Current trends in educational technology research: The study of learning environments. *Educational psychology review, 14*(3), 331-351. https://doi.org/10.1023/A:1016068530070

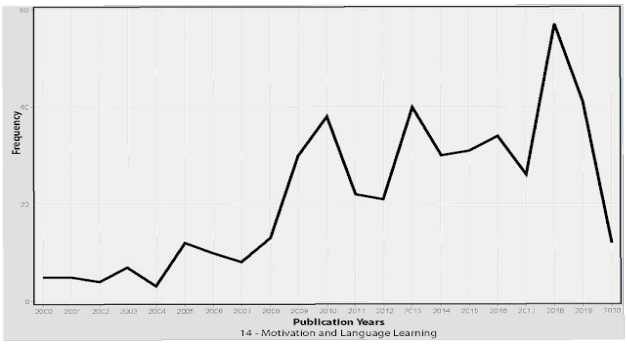
Wu, Y. T. (2013). Research trends in technological pedagogical content knowledge (TPACK) research: A review of empirical studies published in selected journals from 2002 to 2011. *British Journal of Educational Technology, 44*(3). https://doi.org/10.1111/j.1467-8535.2012.01349.x

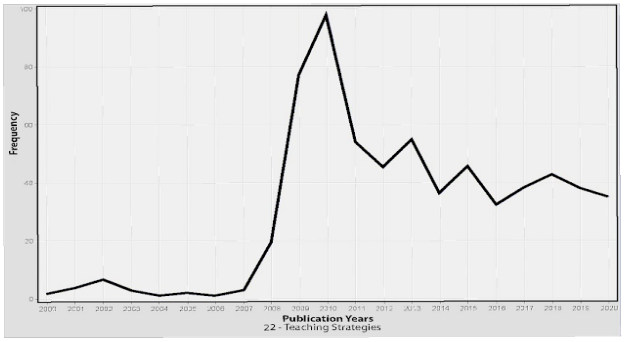
You, X. (2014). Comparative Analysis of Three Typical Text Mining Software. In 2nd International Conference on Soft Computing in Information Communication Technology. Atlantis Press.

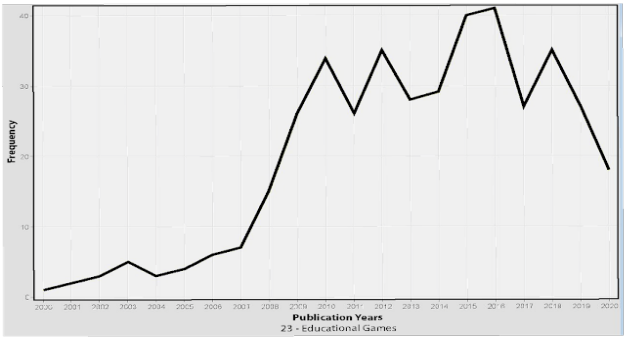
Zanjirchi, S. M., Abrishami, M. R., & Jalilian, N. (2019). Four decades of fuzzy sets theory in operations management: application of life-cycle, bibliometrics and content analysis. *Scientometrics, 119*(3), 1289-1309. https://doi.org/10.1007/s11192-019-03077-0

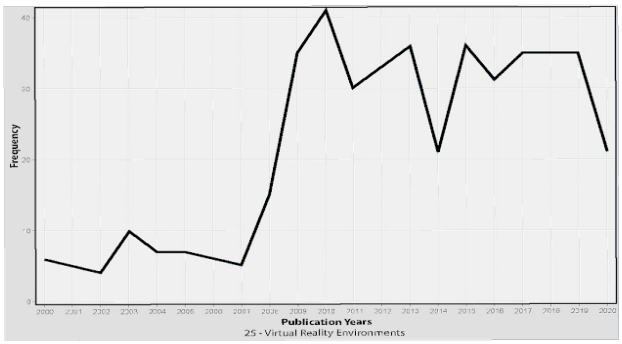
Annex-1

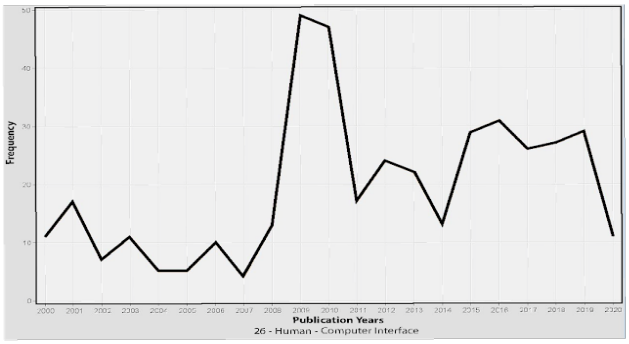


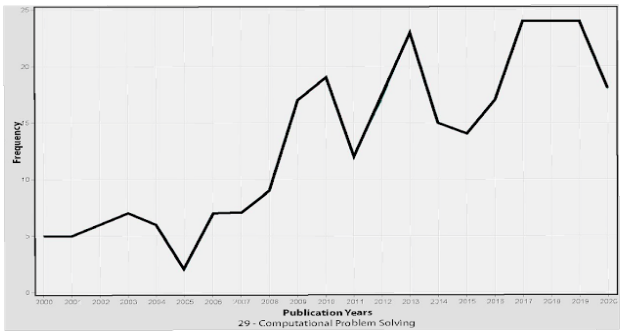


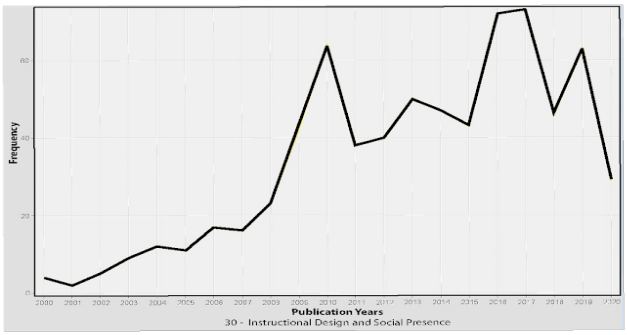


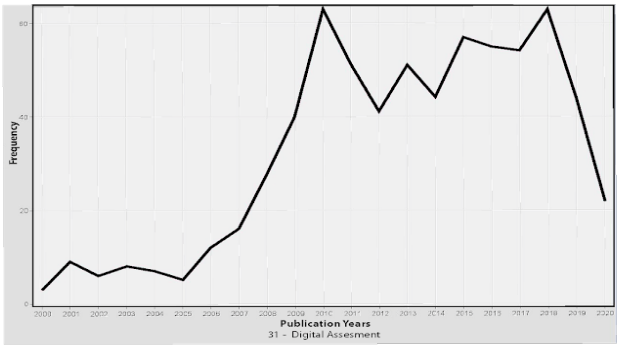












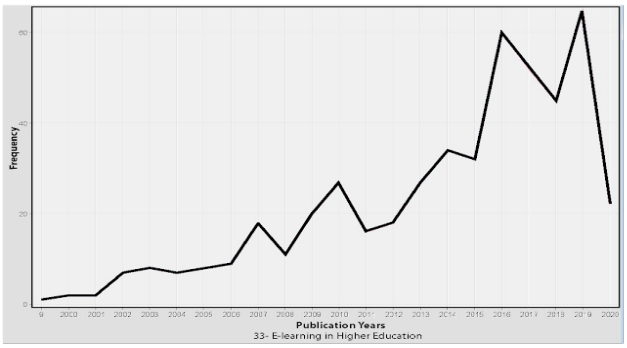


Figure 7.Time Trends of Clusters - 1

Annex-2

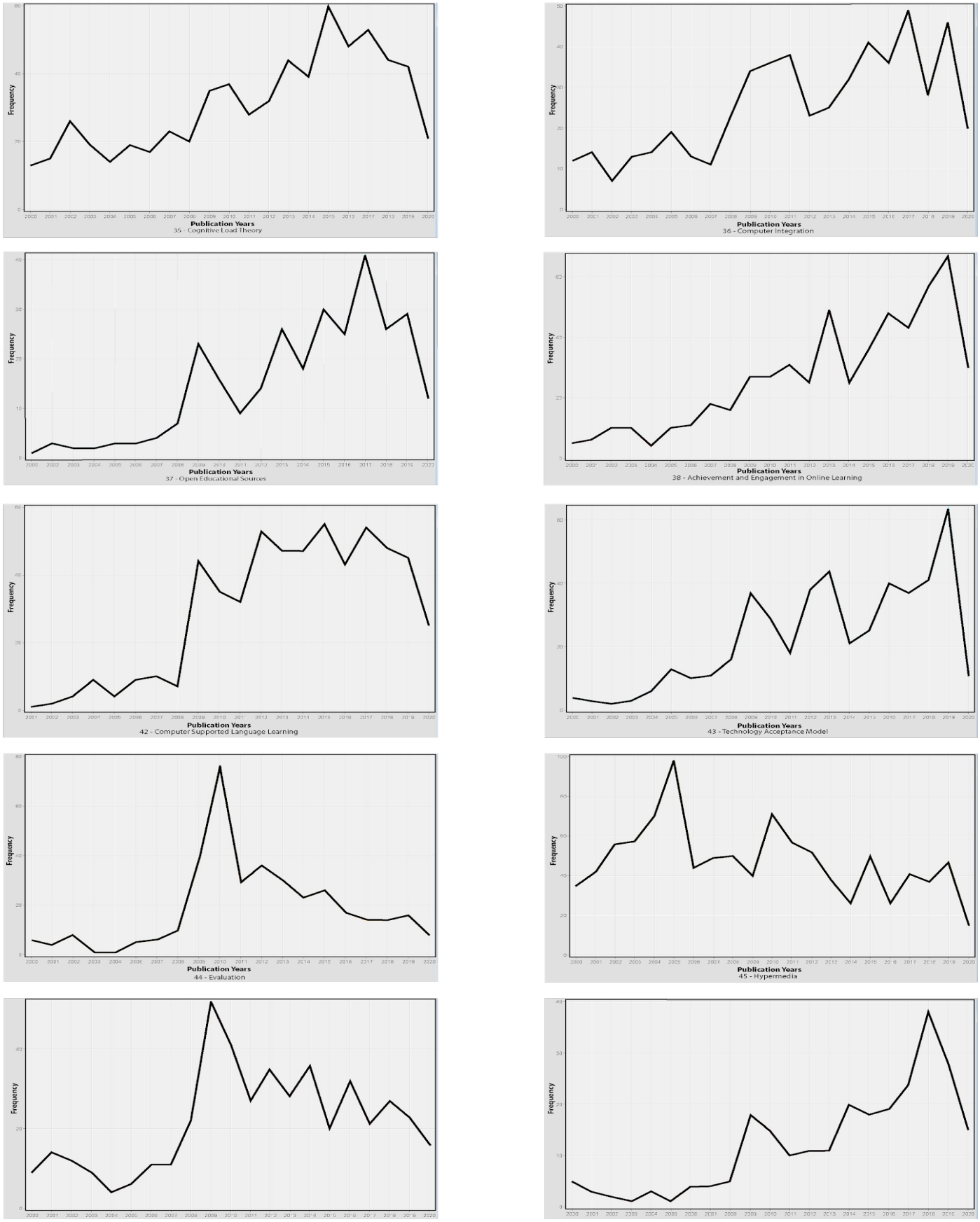


Figure 8.Time Trends of Clusters - 2