PAPER DETAILS

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A Content Analysis of Studies Related to Educational Technologies in Biology Education

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Abstract

With the spread of use of education technologies in all areas, the way of using these technologies and the consequences of use of these technologies have gradually gained importance. In this respect, the present study aimed at presenting the results of content analysis on the articles related to educational technology in Biology education in Scopus database between 2013 and 2017. A total of 55 papers were examined to determine the concept list, top journal list, research methods and models, participants, data collection tools and in these articles. The study is considered to be important since it tried to reveal the studies related to educational technology in biology education. The results of the study revealed a considerable increase in the number of studies involving the use of education technologies in biology teaching especially in 2017. It is seen in these studies that the quantitative research design was favored more as the research method; that the participants were mostly undergraduate students; and that pretest-posttest and scales were among the most popular data collection tools. Lastly, academic performance was the most common dependent variable in the studies.

Keywords: Educational technology, Biology education, Content analysis

1. INTRODUCTION

With the industrial revolution of 4.0 in the 21st century, expectations from students have changed accordingly. Today, there is now a need for individuals who not only have theoretical knowledge but also can apply their theoretical knowledge. In this respect, education technologies have played quite an important role in gaining these skills. Parallel to the development of technology, the practical area of education technologies has become larger initially with multimedia software and currently with technological renovations such as simulations, augmented reality & virtual reality, 3D printers and virtual labs. As a consequence of this, it is seen that use of education Technologies has become more common in various basic areas like biology, chemistry and physics in recent years. For instance, use of digital material in biology teaching is reported to contribute to the development of learners' critical thinking and analysis skills (Kuech, Zogg, Zeeman, & Johnson, 2003). When related literature is reviewed, it is seen that education Technologies produce effective results in biology and science teaching and that use of these Technologies together with appropriate teaching methods and will allow learners to receive more effective and productive education (Daşdemir & Doymuş, 2012; Karaçöp, 2010).

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Figure 1 presents graphs related to the research articles published in the database of web of science regarding the use of education Technologies in the field of biology teaching in the last 10 years.

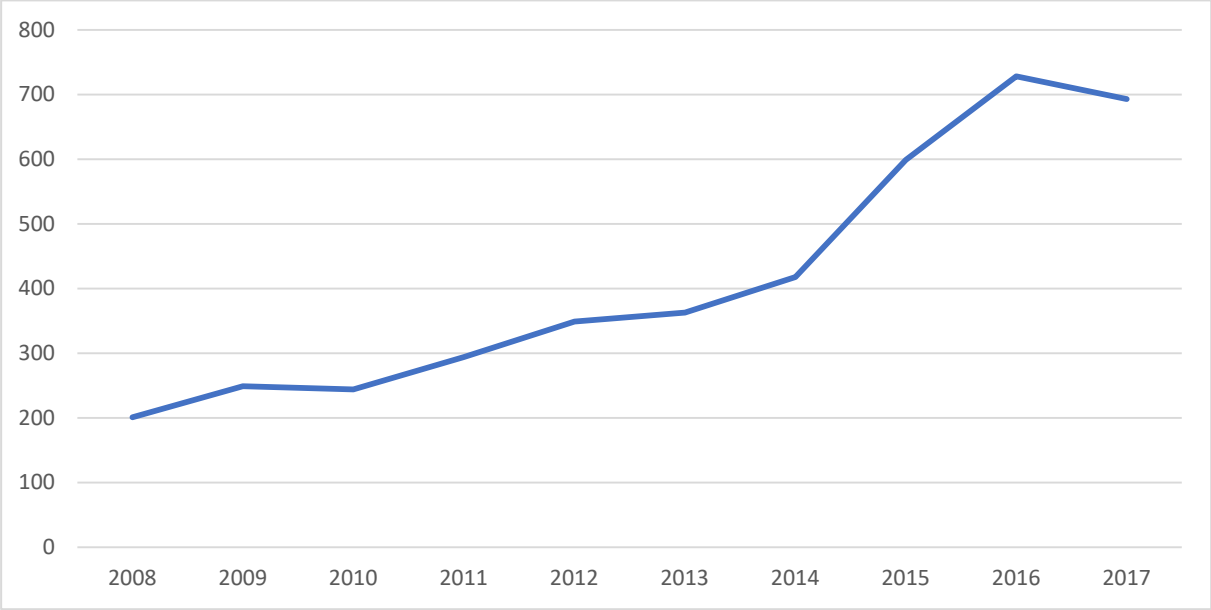

Figure 1. The number of related articles by years in Web of Science database

According to Figure 1, it could be stated that the number of studies on technology use in biology teaching has gradually increased in recent years. In other words, it is seen that researchers have increasingly conducted more studies in this field. Although there are several content analyses conducted in the field of education Technologies in related literature (Durak, Cankaya, Yunkul, & Mısırlı, 2018), there is no content analysis research examining education Technologies in the field of biology teaching. For this reason, it is important to carry out a study which will guide researchers willing to conduct related studies in this field and which will help reveal the tendencies in education Technologies in the field of biology teaching. In this respect, the purpose of the present study was to provide content analysis of scientific articles which involved education Technologies in the field of biology teaching and to reveal the related tendencies in this field.

2. THE LITERATURE REVIEW

Lee ve Tsai (2013) conducted a literature review of using educational technology in biology learning from 2001 to 2010. A total of 36 empirical articles were included for review. The results of the analyses demonstrated that mostly simulation and visualization tools were mostly used in the studies. In addition, most of the studies examined achievement, which was followed by affective skills and less frequently by higher-order skills. Also, a few studies investigated students' learning processes. Another study carried out by Umdu-Topsakal, Çalık and Çavuş (2012) examined the studies on biology education in Turkey. The results of the study revealed that the studies were mostly descriptive and that mostly undergraduate students constituted the research samples. When the studies were examined with respect to the research methodology used, it was seen that survey and experimental research design were more popular. Similar to this study, Kumandaş (2015) examined 67 articles and found that the research samples mostly included undergraduate students. The sample sizes in the studies ranged between 31 and 100. The quantitative and qualitative research methods were equal in number, and the number of studies carried out using the mixed method was quite low. As for

the data collection tools, the most popular tools were achievement tests. In one study conducted by Doğru, Gençosman, Ataalkın and Şeker (2012), the researchers conducted content analysis on the M.A. and Phd theses carried out between 1990 and 2009. In their study, the researchers reached a total of 218 studies in the field of biology using the keywords of "biology education, biology teaching and biology subjects", yet they examined only 108 of them for several reasons. In most of the theses examined, it was seen that the participants were K-12 students. It was also revealed that the theses were carried out using descriptive and experimental research designs and that achievement tests constituted the most popular data collection tools. Gül and Sozbilir (2015) conducted content analysis on 633 studies in the field of biology and found that "learning, teaching and attitudes" were among the most popular concepts. In addition, quantitative methods were the most common methods used in these studies, and the most popular data collection tools were achievement tests. In another study, Gül and Sözbilir (2016) examined a total of 1376 articles in the same field from various aspects. The results of the study revealed that most of the articles were published in the journals of JBE and IJSE. The dependent variables in these studies included teaching, learning, attitude, perception and self-efficacy. As for the sub-concepts included in the contents of these articles, they were misconception, determining achievement/knowledge levels, comparison of teaching methods and strategies and influence of teaching on achievement. Different from other studies, mostly qualitative methods were used, and among these qualitative methods, descriptive and case study models were prominent. Also, the quantitative methods mostly included experimental and survey models, while the mixed research design mostly included the method of triangulation. In relation to the use of data collection tools, they mostly included survey, interview and document analyses, which were followed by achievement tests and observation. Most of the participants were secondary and high school students, and the sample size was found to range mostly between 31-100 and between 101-300. In their study, Kula and Sadi (2016) examined a total of 363 articles published in the field of science teaching in four important journals Education and Science, Hacettepe University Journal of Education, Eurasian Journal of Educational Research, Elementary Education Online and found that only 77 of these articles were carried out in the field of biology. These studies mostly focused on teaching and learning. In addition, in the studies, mostly experimental and survey methods were used as the quantitative research model. As for the data collection tools used in these studies, it was seen that the most frequent tools included achievement tests and surveys. It was also seen that most of the participants were preservice teachers, or undergraduate students. Lastly, the sample size was found to range between 26-300.

3. METHOD

In the present study, content analysis was conducted on the articles in the database of Scopus regarding education technologies in biology teaching. In the study, the reasons for choosing the Scopus database were as follows;

- It was the biggest database including summaries and references,
- It allows easy access to full-text articles,
- It has a user-friendly interface.

The related literature was reviewed to reach the studies based on the following criteria:

- The article should be published in the last five years (2013-2017),
- The article should not have any restriction for access,
- The article should be authored in English.

In order to reach the articles, Scopus database was searched in line with the above criteria. In this search, the word "biology" was typed as the article title, and various concepts regarding

education Technologies were typed in the summary part. In this way, the purpose was to reach the articles most appropriate to the research purpose. The search don on Scopus was as follows:

(TITLE (biology) AND TITLE-ABS-KEY ("education" OR "learning" OR "school" OR "training" OR "instruction" OR "teaching" OR "student" OR "teacher") AND TITLE-ABS-KEY ("elearning" OR "e-learning" OR "multimedia" OR "m-learning" OR "mlearning" OR "mobile learning" OR "educational technology" OR "web-based" OR "web based" OR "instructional technology" OR "learning environment" OR "mooc" OR "gamification" OR "virtual classroom" OR "digital storytelling" OR "adaptive learning" OR "blended learning" OR "asynchronous learning" OR "differentiated learning" OR "course management system" OR "cms" OR "learning management system" OR "lms" OR "learning network" OR "ebook" OR "e-book" OR "flipped classrom" OR "electronic classrom" OR "individualized learning" OR "learning platform" OR "lifelong learning" OR "informal learning" OR "online lab" OR "open educational" OR "personalized learning" OR "online learning" OR "one-to-one" OR "assistive technology" OR "digital classrom" OR "information and comunications technology" OR "massive open" OR "personal learning network" OR "project based learning" OR "augmented reality" OR "stem" OR "Science Technology Engineering Mathematics" OR "Science Technology Engineering Art Math" OR "steam" OR "Digital Citizenship" OR "Digital Divide" OR "Digital Literacy" OR "computer based" OR "computer-based" OR "distance learning" OR "online learning" OR "learning object" OR "Game-based" OR "Game based" OR "Makers" OR "based learning" OR "technology integration" OR "Customized learning" OR "Virtual Laboratories" OR "Online Tutoring" OR "Cloud computing" OR "coding" OR "computational" OR "educational games" OR "colloborative learning" OR "e-portfolio" OR "eportfolio" OR "simulation" OR "social media" OR "teleconferencing" OR "mentoring" OR "podcasting" OR "webquest" OR "edtech" OR "internet-based" OR "internet based")) AND (LIMIT-TO (SRCTYPE , "j ")) AND (LIMIT-TO (DOCTYPE , "ar ") OR LIMIT-TO (DOCTYPE , "re ") OR LIMIT-TO (DOCTYPE , "ip ")) AND (LIMIT-TO (SUBJAREA , "SOCI ")) AND (LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013)) AND (LIMIT-TO (LANGUAGE , "English "))

As a result of this search, a total of 157 articles were listed. Among these articles, 138 full-text articles were reached, and 19 of them were not included in the study as they were not full-text articles. In total, 138 full-text articles were examined by the authors of the present study, two of whom were experts in the field of biology education. Based on this examined, a total of 83 articles were excluded for various reasons. Some of these reasons are listed below:

- Some articles were not related to technology though they were related to biology education,
- Although the keywords provided in some of the articles included technology, it was actually the name of the course (like Science and Technology), and some of these studies did not include any technological application,
- Some of the articles were not related to biology education though they included technology applications,
- Some of the articles including the keywords were published journals with the same keywords in their names.

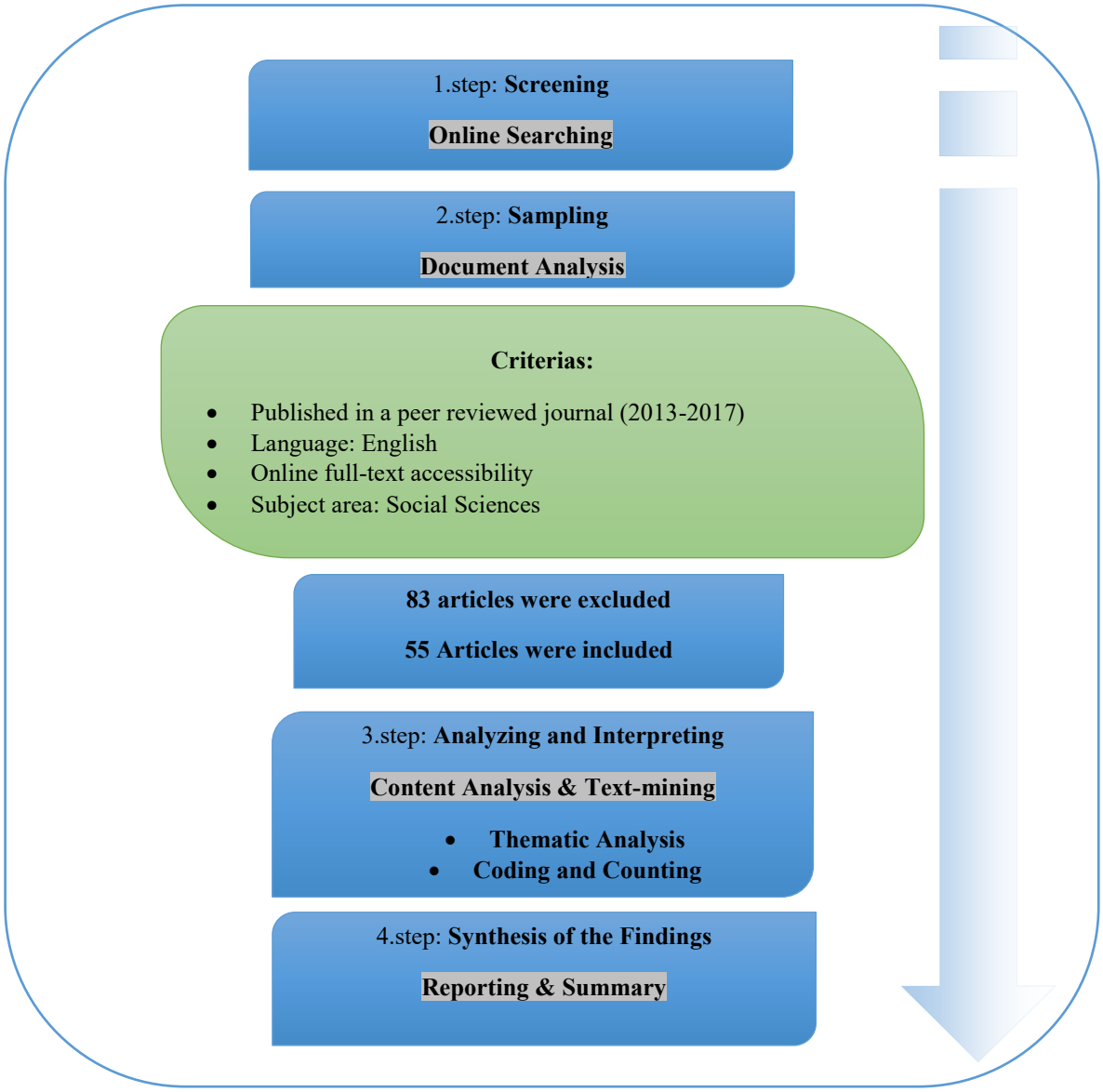

Figure 2. The overall research flow

Consequently, in the present study, content analysis was conducted on a total of 55 full-text articles. For the purpose of finding answers to the research questions, content analysis was applied, and the related articles were examined in terms of certain variables. For the examination of the descriptive statistics regarding the variables, participants and data collection tools in the articles, percentages and frequencies were used. These statistics were then interpreted in comparison with the results of other related studies in literature.

3.1. Findings and Discussion

In this part, the findings related to the articles examined are presented under the headings of concept list, top journal list, Research methods and Models, participants, data collection tools and variables.

3.2. Concept list

The concept list in Table 1 and concept map in Figure 2 depicts the major topics covered in the selected articles published between 2013 and 2017.

Table 1. Ranked concept list

Concept	Count	Concept	Count
student	240	engineering	45
science	139	school	45
biology	110	process	44
teacher	104	skill	42
study	102	practice	42
research	71	mathematics	37
course	66	university	37
learning	59	use	33
model	55	problem	30

The thematic summary includes a connectivity score to show the relative importance of the themes. The results reveal that the thematic region of *student* has the most direct mentions within the text (i.e., titles and abstracts) with 240, followed by *science*, *biology*, *teacher*, and *study*. Figure 3 provides an overview of the concepts in terms of their relative relevance in the concept map.

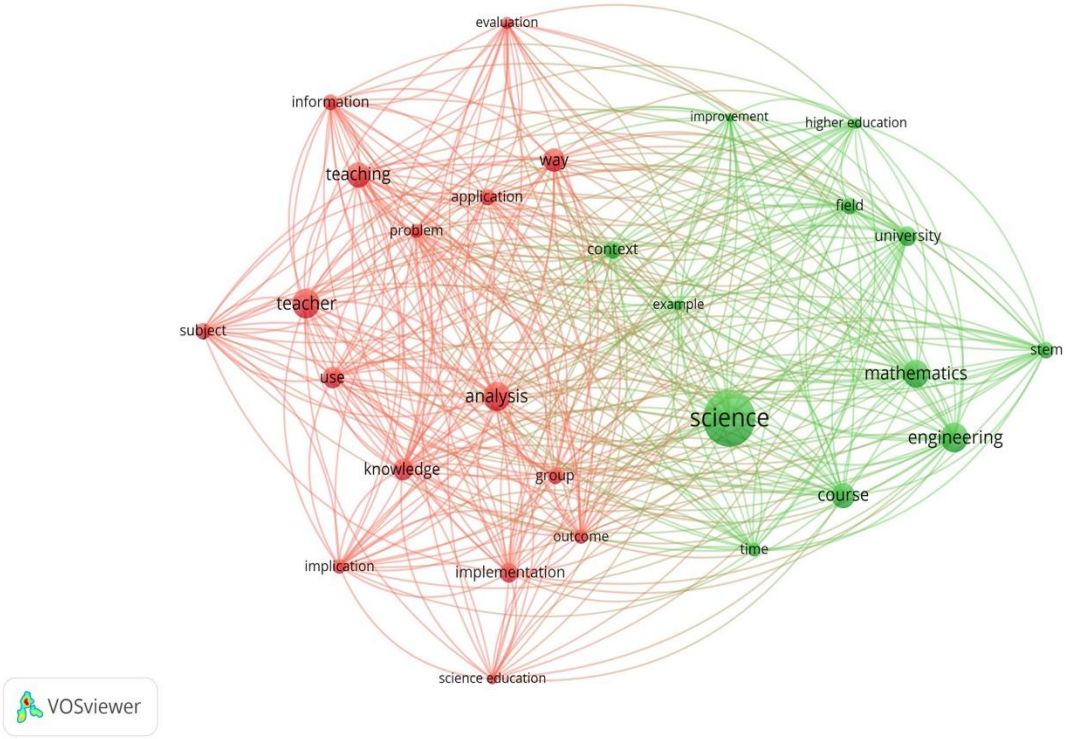

Figure 3.Concept map of research articles (N=55).

Figure 4 presents the distribution of the 55 articles by year.

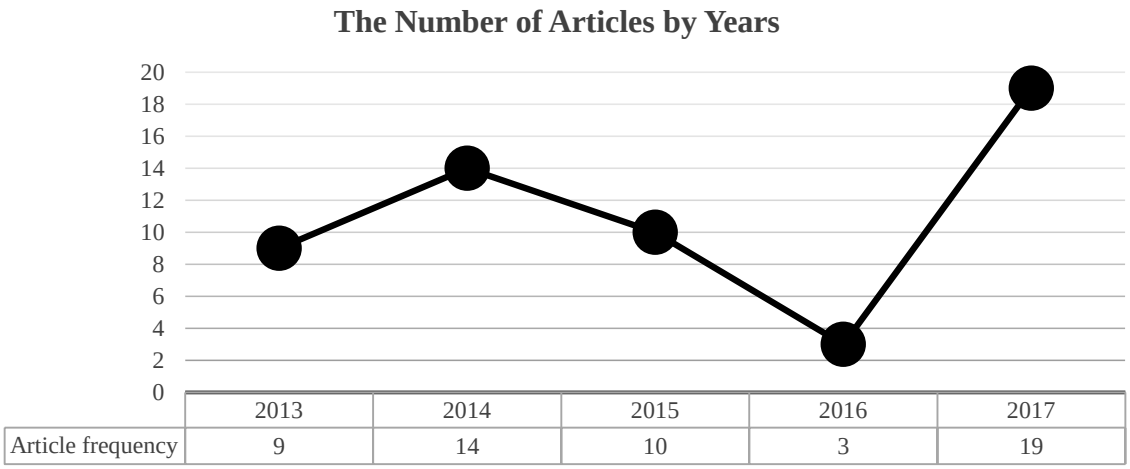

Figure 4. The Number of Articles by Years

According to the graph, the highest number of articles was in 2017, while there were only three articles in 2016. In the study, the journals where the articles were published were examined, and the related data can be seen in Figure 5.

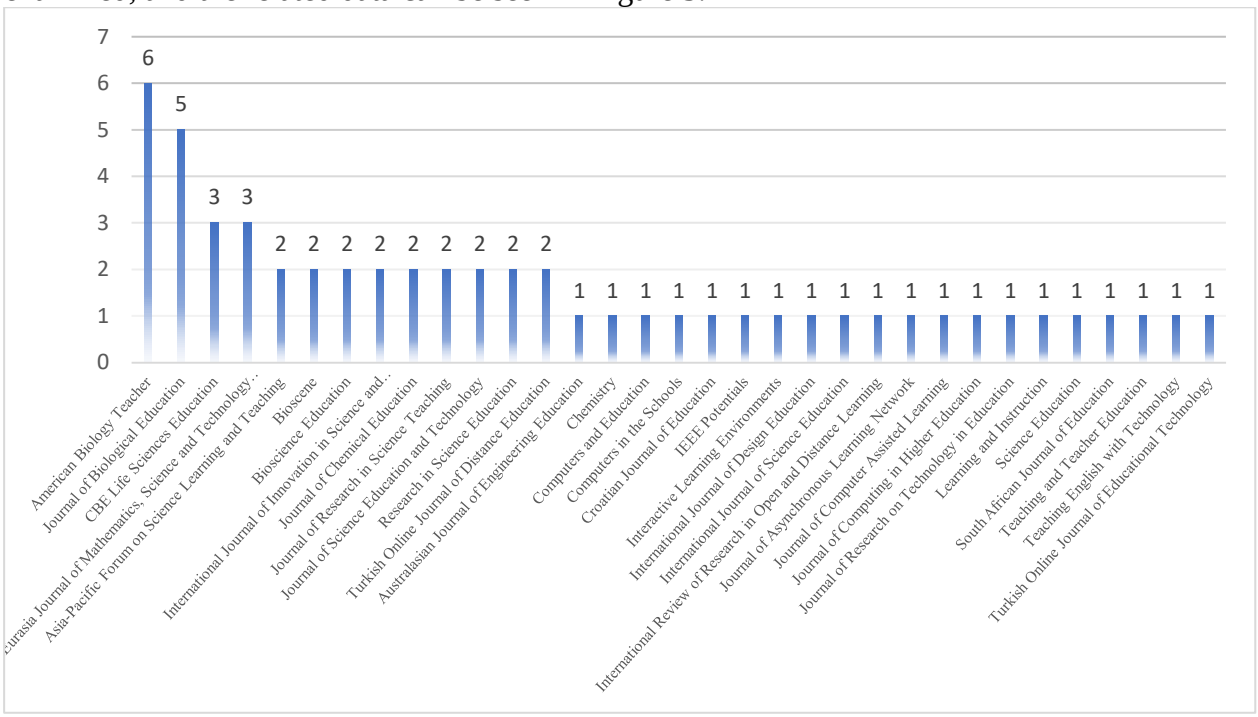

Figure 5. Top Journals

Accordingly, the first five journals where the articles were published most were American Biology Teacher, Journal of Biological Education (JBE), CBE Life Sciences Education, Eurasia Journal of Mathematics and Turkish Online Journal of Distance Education. The journal of JBE became prominent as a journal where a total of 1376 articles examined by Gül and Sözbilir (2016) were published.

3.3. Research Methods & Models

An analysis of the findings presented in Table 2 reveals that researchers mostly preferred quantitative methods (57 %), while experimental studies (n=18), surveys (n=11), causal comparative studies (n=1) were the other research models used in quantitative research. Conceptual/Descriptive methods (20%) were the second most preferred research paradigm, and among these studies, report papers (n=9) and literature reviews (n=1) were the most common in these researches. Mixed method studies scored the next highest (16%), within which explanatory sequential (n=5), embedded (n=2) and convergent parallel (n=2) designs were almost equally distributed. Qualitative methods (5%) were the fourth most preferred research paradigm, within which case studies (n=3) were the leading research model. Finally, it was revealed that practice-based research methods (2%) following action research (n=1) approaches were the least preferred method. In the sampled publications, none of the studies used data mining or analytical methods.

In the study, the result that the most frequent methods were quantitative methods was consistent with the results of other studies in literature (Umdu-Topsakal, Çalık and Çavuş, 2012; Doğru, Gençosman, Ataalkın and Şeker, 2012; Gül and Sozbilir, 2015; Kula and Sadi, 2016), yet the related result differs from the result of another study carried out by Gül and Sözbilir (2016), who examined 1376 articles and reported that the most frequent methods were qualitative methods. In addition, the result that among the quantitative methods, the most popular models were experimental and survey models was also reported by various other studies in related literature (Umdu-Topsakal, Çalık and Çavuş, 2012; Doğru, Gençosman, Ataalkın and Şeker, 2012; Gül and Sozbilir, 2015; Gül and Sozbilir, 2016; Kula and Sadi, 2016). The fact that the case study method was used in all the studies conducted with qualitative methods is supported by the study carried out by Gül and Sozbilir (2015).

Table 1. Methods and Models/Designs

Method	f	%	Model/Design	f	%CUM	%TOTAL
Quantative	31	57	Survey	11	35	20
			Experimental	18	59	33
			Causal Comparative	1	3	2
			Correlational	1	3	2
			Meta-analysis	0	0	0
Qualitative	3	5	Case Study	3	100	5
			Content Analysis	0	0	0
			Etnography	0	0	0
			Descriptive	0	0	0
			Delphi	0	0	0
			Grounded Theory	0	0	0
			Meta-synthesis	0	0	0
			Historical	0	0	0
			Heuristic	0	0	0
Mixed	9	16	Explanatory sequential	4	45	7
			Embedded	2	22	4
			Convergent Parallel	2	22	4
			Exploratory Sequential	1	11	2
			Multiphase	0	0	0
			Transformative	0	0	0
Conceptual/Descriptive /Other	11	20	Opinion Paper	1	9	2
			Literature Review	1	9	2
			Report	9	82	15
			Reflection Paper	0	0	0
			Comparative	0	0	0
			Technical Paper	0	0	0
			Position Paper	0	0	0
			Field Notes	0	0	0
			Systematic Review	0	0	0
Practice Based	1	2	Design Based Research	0	0	0
			Action Research	1	100	2
Data Mining and Analysis	0	0	Learning Analytics	0	0	0
			Social Network Analysis	0	0	0
			Text Mining	0	0	0
			Log Analysis	0	0	0
			Internet and Traffic Ranks	0	0	0
			Sentiment Analysis	0	0	0

3.4. Participants

Table 2 presents the frequencies and percentages regarding the participants in the articles examined within the scope of the present study.

Table 2. Participants

Participants	**Frequency**	**Percentage**	**Sample Size**
Undergraduate Students	19	42,3	23-1975
K12-Students	18	40	17-2748
K12-Teachers	6	13,3	32-988
System/Program	1	2,2	97
Graduate student	1	2,2	36

*One study may employ more than one target group

When the data presented in Table x are examined, it is seen that undergraduate students (N=19), K-12 students (N=18) and K-12 teachers (N=6) were in the first three places and that these groups constituted approximately 96% of all the participants. When examined in terms of sample sizes, it was seen that there were at least 23 and at most 1975 students and that there were at least 17 and at most 2748 K-12 students. The fact that undergraduate students were mostly preferred as participants is parallel to the results of other studies in related literature (Umdu-Topsakal, Çalık and Çavuş, 2012; Kumandaş, 2015; Gül and Sözbilir, 2016; Kula and Sadi, 2016).

3.5. Data Collection Tools

Table 3 presents frequencies and percentages regarding the data collection tools used in the articles examined within the scope of the study.

Table 3. Data Collection Tools

Data Collection Tools	Frequency	Percentage
Pretest-posttest	21	32,81
Scale	16	25
Questionnaire	9	14,06
Academic Achievement Test	8	12,5
Interview	4	6,25
Observation	3	4,69
Log	1	1,56
App analysis	1	1,56
Audio record	1	1,56

*One study may employ more than one data collection tools

According to Table x, the most popular data collection tool was pre-test- post-test (32,81%), while scale (25%) and questionnaire (14,1%) were the most frequent ones used in quantitative studies. The fact that pre-test and post-test were among the most common data collection tools was also the case in many other studies in related literature (Doğru, Gençosman, Ataalkın and Şeker, 2012; Lee and Tsai, 2013; Kumandaş, 2015; Gül and Sozbilir, 2015; Kula and Sadi, 2016).

3.6. Variables/Research Interests

The articles were categorized with respect to the dependent variables. Table 4 presents the related frequencies and percentages.

Table 4. Variables / Research Interests

Dependent Variables	f	%	Dependent Variables	f	%
Academic-performance	26	37,68	Effectiveness	3	4,35
Opinion	7	10,14	Satisfaction	3	4,35
Attitude	6	8,7	Learners' Preferences	2	2,9
Engagement	4	5,8	Quality	2	2,9
Motivation	4	5,8	Experience	1	1,45
Perception	4	5,8	Interaction	1	1,45
Self-efficacy	4	5,8	Participation	1	1,45

According to Table 10, the most frequent dependent variable was "academic-performance" (37,7%) used in 26 studies. This variable was followed by "opinion" (10,1%) in 7 studies, "attitude" (8,7%) and "engagement" (5,8%). It was seen that the most frequent dependent variables used in the articles were academic performance and opinion, which constituted almost 50% of all the variables. This result is consistent with the findings of studies carried out by Lee and Tsai, (2013) and by Gül and Sözbilir (2016).

4. CONCLUSION

In the present study, content analysis was conducted on Scopus database not only to analyze the contents of the scientific articles in which education technologies were used in the field of biology education but also to reveal the related tendencies in this field. As a result of including all the possible concepts related to education technologies into the search criteria, a total of 157 articles published in the last five years were reached. However, among these articles, 19 of them were not reached as full texts, and 83 of them were excluded for various other reasons. Consequently, the remaining 55 articles were examined. The analyses conducted on the keywords used in the articles revealed that concepts like student, science, biology and teacher were prominent. As the present study focused on education technologies in the field of biology education, the fact that these concepts became prominent was quite natural. When these 55 articles were examined with respect to their research designs, it was seen that quantitative methods were quite common. The reasons for the popularity of quantitative methods could be the desire to see the practical consequences of use of educational technologies. Parallel to this, experimental design was the most popular methodology, and academic performance was the most common variable. When the studies were examined with respect to the participants, it was seen that undergraduate students were prominent. This result could be explained with the fact that undergraduate students constitute the most convenient and easy-to-reach sample group to see the applied consequences of use of education technologies. Similarly, the fact that pretest and posttest were the most common as data collection tools and that academic performance was the most popular dependent variable could be explained with the experimental research design favored in these studies.

As review of the related literature demonstrated that there is no study conducted to educational Technologies in biology education, the present study is expected to be a pioneering one. In the light of the findings obtained in the study, the following suggestions could be put forward:

- Researchers who plan to conduct Educational Technologies in biology education may benefit from the findings of the present study and make use of the dimensions examined in the present study.
- Conducting this study in an international scale and using multiple databases like “Web of Science” may yield further significant results by providing research sample diversity.
- With content analyses conducted on extensive sampling, various variables (country, language, article, thesis, etc.) can be compared.
- The results of the present study demonstrate that qualitative and mixed methods were least popular ones. Therefore, more qualitative research designs could be used to collect more in-depth data in the related field, and the mixed method, which takes advantages of the two methods (qualitative and quantitative methods) could be applied more.

Eğitim Teknolojileri ile İlgili Yapılan Çalışmaların İçerik Analizi: Biyoloji Eğitimi Örneği

Özet

Eğitim teknolojilerin kullanımının her alanında yaygınlaşmasıyla bu teknolojilerden ne şekilde yararlanıldığı ve ne gibi sonuçlar alındığı konusu da giderek önem kazanmaktadır. Bu bağlamda bu çalışmada 2013-2017 yılları arasında Scopus veritabanında yer alan biyoloji eğitiminde teknolojileri konusu ile ilgili yapılan çalışmaların içerik analizini yapmak amaçlanmıştır. Araştırmada toplam 55 makale araştırma yöntemi ve modelleri, katılımcılar, veri toplama araçları açısından analiz edilmiştir. Biyoloji eğitiminde eğitim teknolojisi ile ilgili yapılan çalışmaları ortaya çıkarmayı amaçlayan bu araştırma önem arz etmektedir. Çalışma sonuçlarına göre, biyoloji eğitiminde eğitim teknolojilerinin kullanıldığı çalışmalarda özellikle 2017 yılında ciddi bir artışın olduğu gözlenmiştir. Çalışmalarda araştırma yöntemi olarak nicel araştırmaların daha çok tercih edildiği, katılımcılar açısından undergraduate student lerin önde olduğu, veri toplama araçlarında ise en çok ön-test, son-test ve ölçeklerin başı çektiği görülmüştür. Son olarak incelenen çalışmalarda bağımlı değişken olarak en fazla akademik performansın yer aldığı ortaya çıkmıştır.

Anahtar Kelimeler: Eğitim teknolojisi, Biyoloji eğitimi, İçerik analizi

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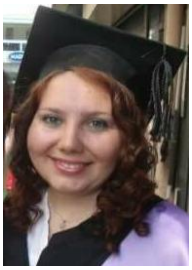

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