TURJE
www.turje.org
2024
Volume: 13 Issue: 2
Turkish Journal of Education
https://doi.org/10.19128/turje.1345182
Research Article
Received 17.08.2023
Accepted 27.01.2024

A content analysis of blended learning studies in science education

Gizem Canbulat
Uşak University, Department of Science Education, Uşak, Türkiye, gizemcanbulattt@gmail.com
Salih Uzun
Uşak University, Department of Mathematics and Science Education, Uşak, Türkiye, salih.uzun@usak.edu.tr

ABSTRACT This research aimed to determine the trends related to blended learning studies conducted in science education through descriptive content analysis. This study was performed using the document review method. For this purpose, 120 studies on blended learning in science education were determined between 2005 and 2022 in the Web of Science (WoS) database. The studies were examined by considering themes such as keywords, country, purpose, method, sample, online system, and result. The research findings showed that more studies occurred between 2020 and 2022. The findings showed that studies mostly use quantitative research methods and experimental designs. Most of the studies were conducted with undergraduate-level sample groups. Findings revealed that the blended learning environment is designed more to teach physics subjects, and parametric tests were generally used for data analysis. The more preferred course management systems in the studies were the online systems designed by the schools. A considerable number of studies revealed that blended learning environments designed for science education have a positive effect on variables such as achievement, skill, and motivation.

Keywords: *Blended learning, Online learning, Science education*

Fen eğitiminde yapılan harmanlanmış öğrenme çalışmalarının içerik analizi

ÖZ Bu araştırmanın amacı harmanlanmış öğrenme çalışmalarına ilişkin eğilimleri betimsel içerik analizi yardımıyla belirlemektir. Bu çalışma doküman inceleme yöntemi kullanılarak gerçekleştirilmiştir. Bu çerçevede Web of Science (WoS) veri tabanında bulunan fen eğitiminde harmanlanmış öğrenmeyi konu alan çalışmalar betimsel içerik analizine tabi tutulmuştur. Bu amaç doğrultusunda 2005-2022 yılları arasında fen eğitiminde harmanlanmış öğrenmeyi konu alan 120 çalışmaya ulaşılmıştır. Ölçütlere göre belirlenen makaleler; anahtar kelimeler, ülke, yıl, amaç, yöntem, örneklem, kullanılan online sistem ve sonuç gibi temalar altında incelenmiştir. Araştırma bulguları, 2020-2022 yılları arasında daha fazla çalışmanın yapıldığını ortaya koymaktadır. Bulgular, çalışmaların çoğunlukla nicel araştırma yöntemlerini ve deneysel desenleri kullandığını göstermiştir. Çalışmaların çoğu lisans düzeyindeki örneklem gruplarıyla yürütülmüştür. Konu alanına ilişkin bulgular harmanlanmış öğrenme ortamının daha çok fizik konularını öğretmek için tasarlandığını ortaya koymuştur. Sonuçlar, çalışmalarda veri analizi için genellikle parametrik testlerin kullanıldığını göstermiştir. Yapılan çalışmalarda daha çok tercih edilen ders yönetim sistemleri okulların tasarladığı çevrimiçi sistemler olmuştur. Ayrıca birçok araştırma fen eğitiminde tasarlanan harmanlanmış öğrenme ortamlarının başarı, beceri ve motivasyon gibi değişkenler üzerinde olumlu etkilerinin olduğunu rapor etmiştir.

Anahtar Sözcükler: *Çevrimiçi öğrenme, Fen eğitimi, Harmanlanmış öğrenme*

Citation: Canbulat, G., & Uzun, S. (2024). A content analysis of blended learning studies in science education. *Turkish Journal of Education, 13*(2), 136-157. https://doi.org/10.19128/turje.1345182

INTRODUCTION

Changes and advancements in science and technology impact our everyday lives and educational practices. Notably, the technologies employed in education have expanded educational options (Osguthorpe & Graham, 2003) and led to the emergence of new learning-teaching techniques and approaches. One such approach, blended learning, has gained popularity in recent years. Halverson et al. (2014) also noted the growing popularity of the blended learning approach in practice and research.

Blended learning, also called hybrid or mixed learning, is a powerful combination of face-to-face and online learning (Manna et al., 2023, p. 19). Garrison and Kanuka (2004, p. 96), Stein and Graham (2014, p.12) also define blended learning as the careful integration of face-to-face learning experiences in the classroom and online learning experiences. According to Horn and Staker (2015, pp. 34-35), blended learning has three essential components. In blended learning, the student; (1) learns some part of the course content through online learning that allows learner control. (2) learns in some part of the course content or subject in a supervised learning environment away from home. (3) has an integrated learning experience in which the online and face-to-face components work together. Face-to-face learning environments increase communication among students but are limited in accessing innovations (Meşe, 2016). In contrast, online learning environments are flexible and provide more opportunities for accessing information, but they individualise and isolate students (Johnson et al., 2000). As Yılmaz (2018) underlines, each teaching environment has its advantages; therefore, combining various learning environments provides more effective teaching and learning. In blended learning, the technological benefits of online learning environments are combined with the participation and interaction advantages of face-to-face learning settings. It is emphasised that blended learning environments, which combine the best aspects of the two learning environments, are effective in education (Alanoğlu & Karabatak, 2021; Gürdoğan & Bağ, 2020), enable learning outside of the traditional classroom setting (Zacharis, 2015), and are essential for maintaining education in emergencies like pandemics and natural disasters (Alanoğlu & Karabatak, 2021). For instance, Covid-19 was classified on March 11, 2020, as a pandemic by the World Health Organization (WHO, 2020), and the outbreak significantly impacted people's quality of life and educational opportunities. Online learning has emerged during the outbreak as a viable alternative to face-to-face instruction under unusual circumstances. Of course, although blended learning aims to combine the strengths of face-to-face and online learning environments, it can provide opportunities for the continuity of education even when faced with the unusual situations mentioned. Especially with the emergence of the pandemic, studies and practices for creating blended learning environments have become more on the agenda. According to Ashraf et al. (2021), studies on blended education have grown during the Covid-19 pandemic.

Kahraman and Kaya (2021) underline that blended learning is one of the most appropriate methods that can be used to develop students' digital competence and self-learning skills in science education. Many researchers conducted studies focusing on blended learning in science education. Although more emphasis has been placed on blended learning studies in recent years, it has been observed that these studies have been carried out for many years. For instance, studies have investigated the effects of blended learning in science education on variables such as academic achievement (Harahap et al., 2019; Seage & Türegün, 2020), student attitudes (Kadirhan & Korkmaz, 2020; Son et al., 2016) and motivations (Akgündüz & Akınoğlu, 2017; Gürdoğan & Bağ, 2020). These studies generally reported that blended learning environments designed in science education have positive outcomes.

Considering the increasing interest in blended learning practices and studies in recent years, a content analysis study is thought to contribute to the literature. Of course, previous studies also evaluated blended learning studies through content analysis. For instance, Rasheed et al. (2020) analysed 30 empirical studies published between 2014 and 2018; Spring and Graham (2017) evaluated 76 publications published between 2000 and 2011 in seven different regions of the world; Halverson et al. (2014) examined the top-cited articles and book chapters (60 articles, 25 book chapters) published between 2000 and 2011; Pima et al. (2018) evaluated 210 papers focused on higher education published between 2000-2016 years; and Castro-Rodríguez et al. (2021) analysed 119 publications focused on

higher education published between 2010-2020. Some of these studies focused on empirical studies or a specific sample group. Naturally, it doesn't cover recent literature because some were released earlier. In addition, a significant part of these studies was not conducted with a focus on science education. Like this study, Kahraman and Kaya (2021) conducted a thematic content analysis study (publication language in Turkish) on blended learning studies in science education between 2003 and 2018, which examined a total of 63 studies (28 thesis and 35 articles). Blended learning is open to continuous change in line with the developments of educational technology. Horn and Staker (2015, p.32) state that the roots of blended learning are based on online learning. Ocak and Ünsal (2021) noted that blended learning environments regularly increase due to technological developments. The authors also emphasised that numerous blended learning studies were conducted throughout the pandemic. According to Ashraf et al. (2021), many educational institutions have attempted to implement blended learning during the outbreak in 2020, which has raised research interest in evaluating the good practices of blended learning. For this reason, it is important to analyse the literature by considering the recently added studies. Therefore, content analysis studies should be conducted routinely to reveal changes in the literature (Kahraman & Kaya, 2021).

It can be said that the importance of blended learning, which has been mentioned and researched for nearly twenty years in the international literature, has increased more in recent years. In this context, it is thought that a detailed examination of qualitative and quantitative studies focusing on the effects of blended learning environments on science education through content analysis will help future research. This study is expected to provide the opportunity to see the trends in the literature and guide future researchers and program development experts.

The main problem of this study is "What are the characteristics of blended learning studies in science education?". The following questions are addressed in the present study:
1. How is the distribution of blended learning studies in science education by year?
2. How is the distribution of blended learning studies in science education by country/location?
3. Which keywords are used in blended learning studies in science education?
4. What are the purposes of blended learning studies in science education?
5. Which research methods are used in blended learning studies in science education?
6. What are the sample levels and sizes in blended learning studies in science education?
7. What are the preferred subject areas in blended learning studies in science education?
8. What are the data collection tools and analysis methods in blended learning studies in science education?
9. What is the preferred online learning system in blended learning studies in science education?
10. What are the results of blended learning studies in science education?

METHODOLOGY

This study aims to analyse blended learning studies published between 2005 and 2022 in science education. This research adopted the document review/analysis method. Document analysis is a systematic method for reviewing and evaluating documents (Bowen, 2009).

Data Sources and Literature Search

'Scientific Research Document Classification Form' was used as a data collection tool. The authors developed this form based on the literature (e.g., Ashraf et al., 2021; Sozbilir & Kutu, 2008). The form was used to classify studies within the framework of features such as document type, publication year, purpose of studies, research design, method, subject, sample, sample size, data collection tools, analysis of data, and results of studies.

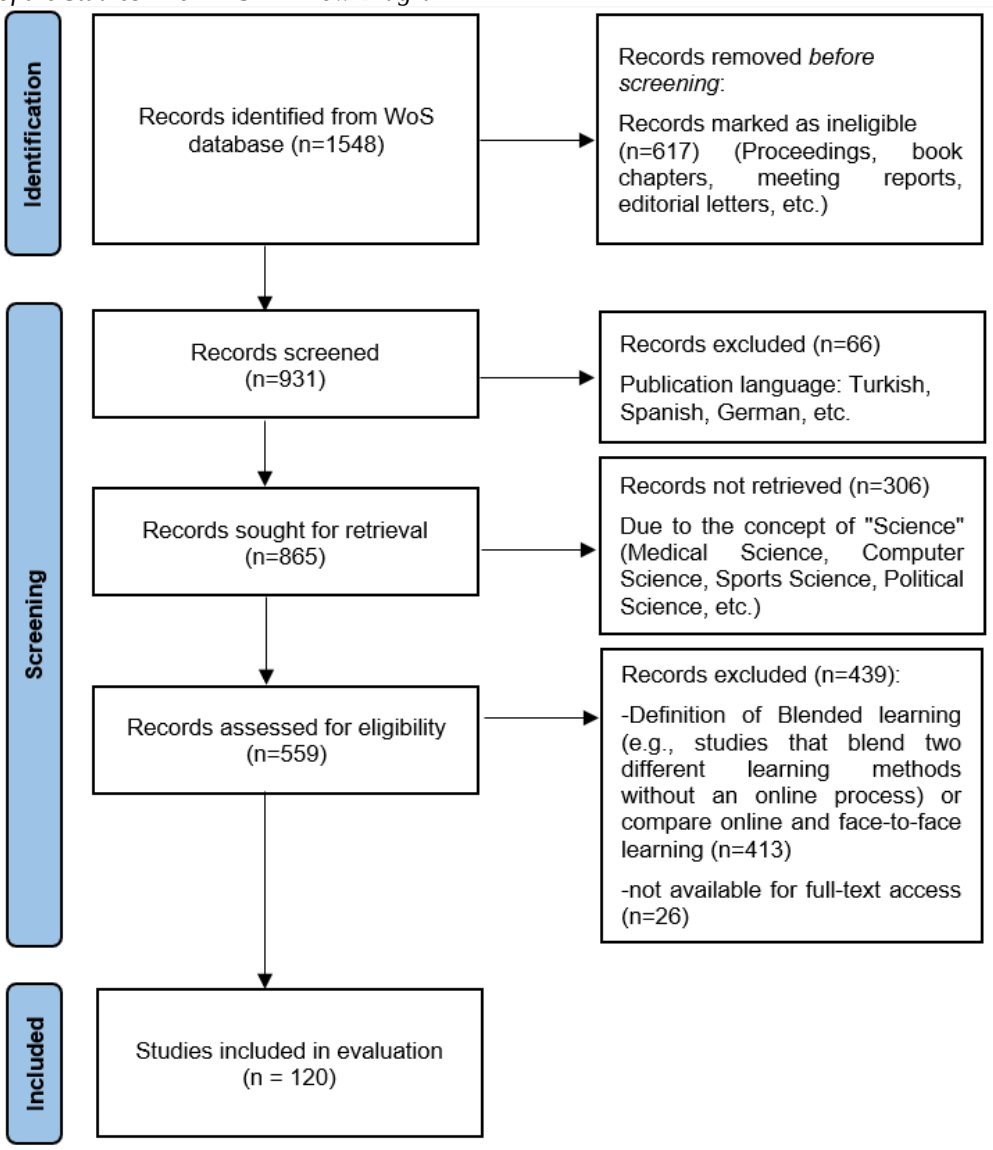
In this study, the Web of Science (WoS) database was used to access blended learning studies carried

out in science education. The Web of Science database was searched in the title, abstract and keywords sections with the following keywords: ("blended" OR "hybrid" OR "mixed") AND ("educat*" OR "teach*" OR "learn*" OR "course") AND ("science" OR "chemistry", "biology" OR "physics").

In addition, the following inclusion criteria were considered to select studies. (1) Article is written in English, (2) published in a peer-reviewed journal. Also, the following exclusion criteria were considered to select studies. (1) Article unavailable as a full text, (2) dissertations, book chapter proceeding paper, (3) research areas outside of education.

The sample of this study consists of 120 qualitative and quantitative studies focused on blended learning in the WoS database between 2005-2022. The PRISMA flow protocol was used in the selection process of the studies (Page et al., 2021) and is presented in Figure 1.

Figure 1.
Selection of the Studies-The PRISMA Flow Diagram



Data Analysis

This study was conducted using descriptive content analysis. The documents used in the study were scientific publications selected according to specific criteria, and these identified publications were

analysed using descriptive content analysis. The descriptive content analysis method was preferred to determine the general situation and trends in blended learning studies in science education (Çalık & Sözbilir, 2014; Dinçer, 2018).

The data obtained by coding the publications through the Scientific Research Document Classification Form were recorded in a data entry form in Excel. Then, the data in this database was analysed through descriptive content analysis. Also, the data are presented using tables and graphs.

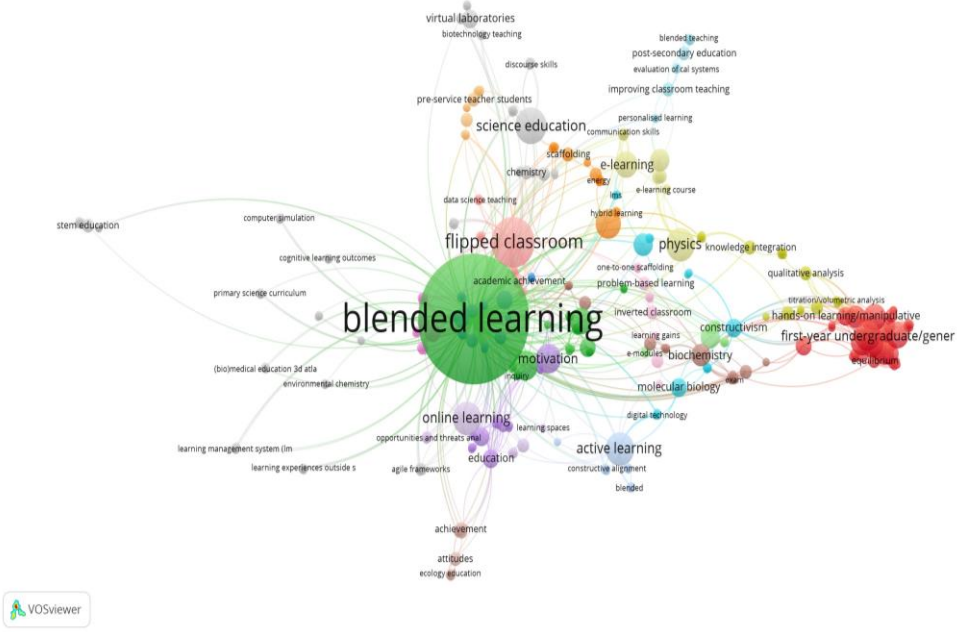
Five publications selected randomly from the studies were co-coded by two researchers before, and a consensus was reached on how to code the data. Then, the researchers coded ten randomly selected publications independently, and the inter-coder reliability was calculated as 0.91 (Miles & Huberman, 1994). A reconciliation process was carried out regarding any disagreements between these coding.

Bibliometric analysis was also used in the analysis of the data. Bibliometric analysis of the data obtained with WoS was analysed with VOSviewer software.

FINDINGS

This section presents the findings obtained from the analysis of international studies on blended learning according to the criteria determined in the WoS database between 2005-2022 within the framework of the research sub-problems/questions. Author keywords used in studies on blended learning in science education are presented in Figure 2.

Figure 2.
Author Keywords Used in Blended Learning Studies in Science Education



Bibliometric analysis of the data revealed that 388 different keywords were found in 120 studies accessed in the WoS database. The analysis revealed that the most used keyword by the authors was “blended learning”. This keyword was used in fifty-one studies. Other keywords used are “flipped classroom” in eleven studies, “science education” in seven studies, “online learning” in seven studies, “physics” in seven studies, “active learning” in seven studies, “first-year undergraduate” in six studies, “physics education” in six studies, “motivation” in six studies, “professional development” in five studies, “laboratory instruction” in five studies, “second-year undergraduate” in five studies, “student-

centred learning" in five studies and "e-learning" in five studies. The distribution of blended learning studies in science education by year is given in Figure 3.

Figure 3.
Distribution of Blended Learning Studies in Science Education by the Year

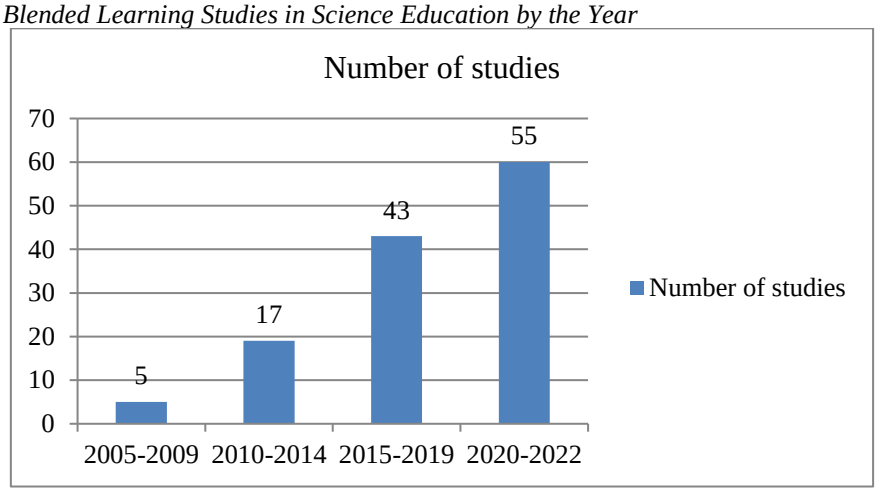
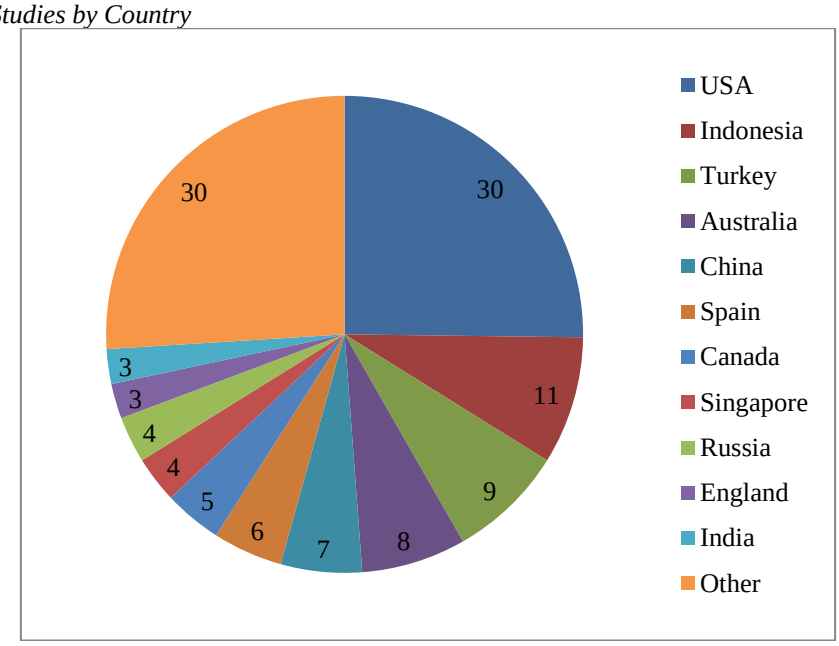


Figure 3 shows that five studies were conducted between 2005-2009, seventeen studies between 2010-2014, forty-three studies between 2015-2019 and fifty-five studies between 2020-2022. Most studies were published between 2020-2022. In the years 2020-2022 that the more studies were conducted, it was determined that seven out of fifty-five studies were in the United States of America (USA), six in Indonesia, five in China, and three in Singapore, Canada, Australia, and England. One or two studies have been conducted in some countries, such as Türkiye, Germany, the Netherlands, Ireland, India, Malaysia, Russia, Japan, Norway, and Portugal. It was determined that blended learning studies in science education were carried out in many countries in 2020-2022. The number of studies by country is presented in Figure 4.

Figure 4.
Distribution of Studies by Country



Note: Countries with three or more studies are indicated in the figure

As shown in Figure 4, the highest number of studies on blended learning in science education was conducted in the USA. Out of 120 studies in the WoS database, thirty studies were performed in the USA, eleven studies in Indonesia, nine studies in Türkiye, eight studies in Australia, seven studies in

China, six studies in Spain, five studies in Canada, four studies in Singapore, four studies in Russia, three studies in the UK, three studies in India. Countries with one or two studies, such as Italy, Pakistan, Japan, and Mexico were categorised as "Other". The distribution of the studies by their purpose is presented in Table 1.

Table 1.
Distribution of Blended Learning Studies in Science Education According to "Purpose" Theme

Theme	Code	Frequency
Purpose	To determine the effect of blended learning on related variables (e.g., achievement, attitude, motivation, self-efficacy, nature of science, participation, professional development, problem-solving skills, scientific process skills)	93
	To determine perceptions, views, and experiences towards blended learning	22
	To describe the process in a blended learning environment	5
Total		120

As seen in Table 1, there are three different codes/categories related to the "Purpose" theme. It was determined that most of the studies were conducted to assess the effect of blended learning on dependent variables. The variables frequently examined in studies are achievement (Alsalhi et al., 2021; Gronlien et al., 2021; Harahap et al., 2019), attitude (Alsalhi et al. 2019; Son et al., 2016), and motivation (Akgündüz & Akınoğlu, 2017; Coll & Coll, 2018; Hibbard et al., 2016; Hwang et al., 2019; Wahyuni et al., 2019). Some studies aimed to determine perceptions, views, and experiences towards blended learning (Hande, 2014; Ng et al., 2022; Olaniyi, 2020; Özdilek & Baltacı-Göktalay, 2013). Also, some studies attempted to describe the process in the blended learning environment (Liu, 2022; Louten & Daws, 2022). The distribution of the models/designs used in the studies is given in Figure 5 and Table 2 shows the distribution of the studies in terms of method/design.

Figure 5.
Research Model/Design

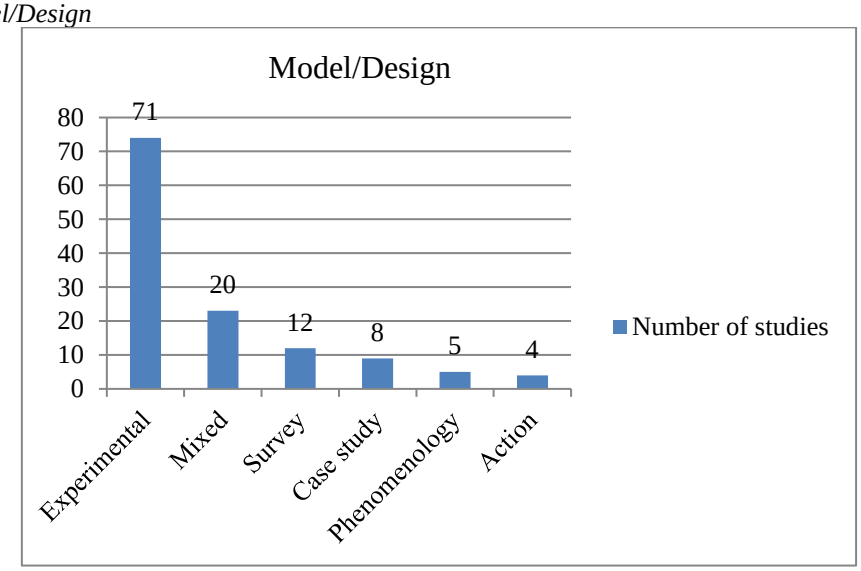


Table 2.
Research Method/Design of the Studies

Theme	Sub-theme	Code	f
Method/Design	Quantitative	Experimental	71
		Survey	12
	Qualitative	Case study	8
		Phenomenology	5
		Action research	4
	Quantitative-Qualitative	Mixed	20
Total			120

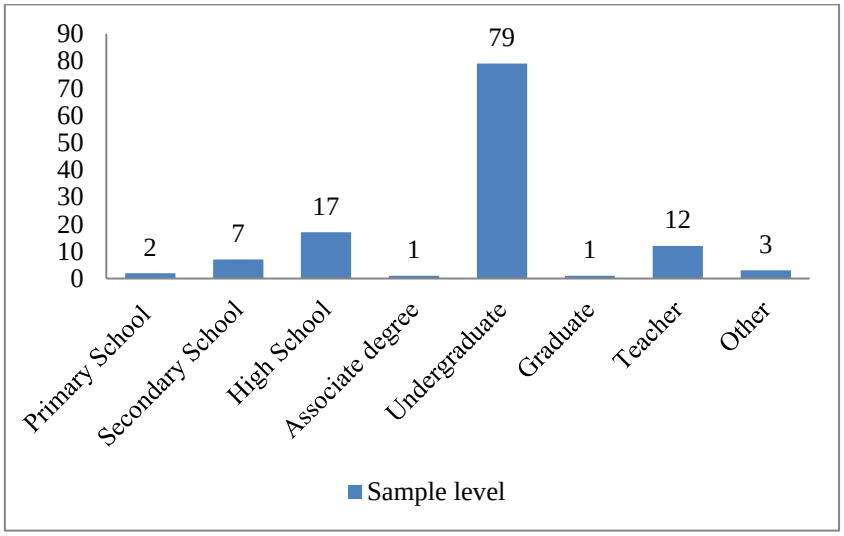
As seen in Table 2, three sub-themes related to the method/design theme were formed. Findings revealed that quantitative research methods are mainly used. Studies using experimental designs are numerous among quantitative studies (Indriyanti et al., 2020; Sulisworo et al., 2017). It is seen that the mixed design was used in some blended learning studies (Lane et al., 2021; Reyes et al., 2022; Tahir et al., 2022). The case study (Berger et al., 2008; Norberg et al., 2017), phenomenology (Dini et al., 2021; Tekane et al., 2020), and action research (Gariou-Papalexiou et al., 2017) were in the qualitative research studies in order of preference. The sample size of the studies is given in Table 3.

Table 3.
Sample Size

Theme	Code	Quantitative	Qualitative	Mixed	Total
Sample Size	0-50	19	9	2	30
	51-100	25	6	10	41
	101-150	13	1	1	15
	151-300	6	1	2	9
	301-500	13	0	3	16
	501-700	2	0	2	4
	701-1000	2	0	0	2
	1000 and above	3	0	0	3
Total		83	17	20	120

Table 3 demonstrates that sample groups of 51–100 participants were used more frequently in quantitative studies (Harahap et al., 2019; Indriyanti et al., 2020; Sulisworo et al., 2016). Mostly, the sample size for qualitative studies ranged from 0 to 50 participants (Gariou-Papalexiou et al., 2017; Tekane et al., 2020), and the sample size for mixed-design studies ranged from 51 to 100 participants (Delgado, 2021). The largest sample size was 1000 and above in quantitative studies, 501-700 in mixed design studies, and 151-300 in qualitative studies. The sample level used in the studies is presented in Figure 6.

Figure 6.
Sample Level



Note: In some studies, more than one sample level was preferred.

As shown in Figure 6, most of the studies were conducted with undergraduate-level sample groups (Brown, 2020; Jeong et al., 2018; Olaniyi, 2020; Pereira et al., 2007; Reyes et al., 2022). In addition, studies were conducted with high school students (Alsalhi et al., 2019; Yapıcı & Akbayın, 2012), secondary school students (Akgündüz & Akınoğlu, 2017; Bonitasya et al., 2021) and teachers (Gunawan et al., 2021; Krasnova & Shurygin, 2019). Studies on graduate (Barak & Dori, 2009) and associate degrees (Raffaghelli et al., 2018) were found less frequently. Sub-sample level details on the sample of the studies are presented in Table 4 and the subject/content area in the studies is presented in Table 5.

Table 4.
Sub-Sample Level Details

Sample Level	Sub-Sample Level	f
Primary School (2)	3rd Class	1
	4th Class	1
Secondary School (7)	5th Class	1
	6th Class	3
	7th Class	1
	8th Class	1
	Secondary school students (class level not specified)	1
High School (17)	9th Class	8
	10th Class	1
	12th Class	2
	High school (class level not specified)	6
Associate degree (1)	Physics associate degree students	1
Undergraduate (79)	Science, biology, physics, and chemistry teaching students	39
	University students studying medicine, nursing, dental pharmacy, anatomy, neuroscience, physiology, pharmacology, physiotherapy	16
	University (class level not specified)	11
	Students studying chemistry, biology, physics, and electronic engineering	7
	University students studying pre-school and classroom teaching	3
	Information and communication technologies students	2
	Technical school students	1
Graduate (1)	Science education	1
Teacher (12)	Biology, physics, chemistry, science, and math teachers	11
	Academics, laboratory technicians and high school teachers	1
Other (3)	Medical physicists	1
	Among all participants, students graduating from the departments of students (physics, biology, engineering, and chemistry)	1
	STEM courses	1

Table 5.
Subject/Content Area in the Studies

Theme	Code	f
Physics	Physics; Physics education(8), Force and Motion(6), Modern Physics and Thermodynamics(5), Electricity(5), Waves(3), Mechanics(3), Work and Energy(3), Impulse-Moment(3), Electromagnetism (2), Energy and Magnetism(2), Vectors(1), Optics(1), Modern Physics(1), Radiation Physics(1), Atomic Physics(1), Air Pressure(1), Energy Science(1), Theoretical Physics Skills(1), Physics Concepts(1).	49
Chemistry	Chemistry; Main Branches of Chemistry(2): Organic Chemistry(8), Physical Chemistry(4), Analytical Chemistry(3), Inorganic Chemistry(1)), Chemistry Education(7), Atomic-Chemical Bonding and Molecular Structure(6), Biochemistry(5), Acid-Base(4), Chemistry Concepts(2), Spectroscopy and Quantum Chemistry(1), Environmental Chemistry(1).	44
Biology	Biology; Biology education(7), Cellular and Molecular Biology(6), Genetics(4), Anatomy(4), Cell Biology(3), Microbiology(3), Systems(2), Cell Tissue Biology(1), Plant Biology(1), Plant Tissue Culture(1), Embryology(1), Microbes(1), Classification of Living Things and Biological Diversity(1), Photosynthesis(1), Environmental Biology(1).	37
Multi-disciplines	Science topics are integrated with other disciplines (Mathematics, Social Sciences, Computer Science, Human Geography)	5
Others	Earth Science(4), Life Science(2), Astronomy(2), Space Science(1), Ecology(1), Evolution(1), Geology(1), Water quality(1), Natural Phenomena-Erosion(1).	14
Not specified	Science Education	4
Total		153

As shown in Table 5, the blended learning environment is designed more in the fields and subjects of physics (Erlina et al., 2022; Olaniyi, 2020; Orekhova et al., 2021). The physics domain is followed by chemistry (Ang & Ng, 2022; Kuroki & Mori, 2021; Tekane et al., 2020) and biology (Andrini et al., 2020; Clark & Post, 2021; Tahir et al., 2022), respectively. Content areas of some studies include earth science, life science, astronomy, and space subjects (Coll & Coll, 2018; Lee et al., 2012). Some studies integrated science topics with other disciplines (Lane et al., 2021). The data collection tools used in the studies are shown in Table 6.

Table 6.
Data Collection Tools

Theme	Code	f
Data collection tools	Tests (e.g., achievement, knowledge, evaluation, skills)	66
	Questionnaire (e.g., satisfaction, metacognition, feedback, process evaluation)	42
	Likert Scales (e.g., attitude, motivation, individual participation).	41
	Interview	29
	Discussion	10
	Video document (virtual diary)	6
	Written text	5
	Report (written, lab.)	4
	Observation	3
	Other (portfolio, story writing)	1
Total		207

Note: In some studies, more than one data collection tool was used.

Table 6 shows ten codes related to the data collection tools. In the studies, tests (Alsalhi et al., 2019; Siddiqui et al., 2020), questionnaires (Kuroki & Mori, 2021; Ren et al., 2022) and Likert scales (Erlina et al., 2022; Fonseca et al., 2021) were primarily used in data collection. In addition, interviews (Dini et al., 2021), discussions (Cui et al., 2022; Gunawan et al., 2021), video documents (Belland et al., 2015), written text (Eppler et al., 2021), report (Enneking et al., 2019), observations (Bonitasya et al., 2021), story writing and portfolio (Bortnik et al., 2017) were also used. The data analysis methods used in the studies are presented in Table 7.

Table 7.
Data Analysis Methods

Theme	Sub-Theme	Code	f
Quantitative	Parametric Tests	t-tests	40
		ANOVA/MANOVA	33
		ANCOVA/MANCOVA	10
		Regression analysis	7
		Pearson Correlation Analysis	7
		Factor Analysis	6
	Non-Parametric Tests	Mann-Whitney U Test	10
		Chi-Square Test	8
		Kruskal Wallis Test	4
		Wilcoxon Signed-Rank Test	3
		Spearman Correlation analysis	3
Qualitative		Content analysis	20
		Descriptive analysis	17

As seen in Table 7, two themes are formed under the “Data Analysis Method” theme. These themes are divided into “Quantitative” and “Qualitative” sub-themes. The quantitative sub-theme consists of two codes “parametric tests” and “non-parametric tests”. Among the parametric tests, the more preferred data analysis methods are “t-tests” (Jiang & Ning 2021; Ren et al., 2022; Yılmaz & Malone, 2020), “ANOVA/MANOVA” (Bernard et al., 2017; Hu et al., 2022; Siddiqui et al., 2020), and “ANCOVA/MANCOVA” (Çetin & Özdemir, 2018; Hwang et al., 2019; Sulisworo et al., 2016). Among the non-parametric tests, the “Mann-Whitney U Test” (Le et al., 2022; Suana et al., 2019) was the

preferred analysis method. The analysis of qualitative data used "Content Analysis" (Din et al., 2020; Norberg et al., 2017) and "Descriptive Analysis" (Ng et al., 2022; Özdilek & Baltacı-Göktalay, 2013). The online system (learning management system) and additional software/platforms used in the studies are presented in Table 8.

Table 8.
Online System and Additional Software/Platforms

Theme	Code	f
Online system used in blended learning environment	School Online System	26
	Moodle	19
	Blackboard	9
	MOOC Platform	4
	Connect Platform	4
	Educanon and Playposit	4
	Google Classroom	3
	WEBCT	3
	Youtube	2
	Edmodo Portal	2
	LON-CAPA Learning Platform	2
	Google Meet	2
	QQ and WeChat Technology Acceptance Module	2
	Sakai	2
	Pre Class Learnsmart Platform	2
	Smartboard	2
	WISE (Web Based Enquiry Platform)	1
	Sapling Learning System	1
	LAMS Platform	1
	QUIPPER School Application	1
	LMS Schoology	1
	Molearn App	1
	Talent LMS	1
	Campus Global	1
	Angel	1
	Remind (Virtual Classroom)	1
	Open Education Consortium	1
	MIRAGE LEARN+ Application	1
	Experimento Prog. Code.org application (online learning system)	1
	Adobe Captivate 6 (e-learning application)	1
	Github Classroom	1
	Chaoxing Platform	1
	OMIM and PUBMED Platform	1
	Tandberg Video Conference System	1
	Dailymotion	1
	Getsmart	1
	Biotechnology Information Centre Platform	1
	Online System Unspecified	14
Additional Software/Platforms	Powerpoint (12), Youtube-whatsapp-facebook-twitter(10), HTML5 (2), EdX Platform(1), SPOC Platform(1), Microsoft Office 365(1), Telepresence(1), Dylabs 20(1), Adobe Premiere Pro(1), Vevox(1), TEEL platform(1), Google Form(1), Qualtrics.com(1), Storyline 360 (1), Microsoft Producer (1)	36
Total		159

As shown in Table 8, the schools' (educational institution) online systems are used more in the studies (Alsalhi et al., 2021; Andrini et al., 2020; Harahap et al., 2019). The other most used learning management systems were "Moodle" (Indriyanti et al., 2020; Lane et al., 2021; Reyes et al., 2022) and "Blackboard" (Chamberlain et al., 2021; Eppler et al., 2021; Sadaghiani, 2011). The results of blended learning studies in science education are presented in Table 9.

Table 9.
Distribution of Blended Learning Studies in Science Education According to the "Result" Theme

Theme	Sub-Theme	Code	f
Result	Effect	Positive outcomes	116
		No positive outcomes	9
	Opinion	Opinions on the blended learning environment	42
	Model	Explaining the designed blended learning model	5
Total			172

As seen in Table 9, three sub-themes related to the "Result" theme were formed as "Effect", "Opinion", and "Model". Many studies reported that blended learning environments have a significant effect on dependent variables (Alsalhi et al., 2021; Harahap et al., 2019; Hariadi et al., 2022; Indriyanti et al., 2020), and a limited number of studies have reported no significant effect on some dependent variables (Christiansen, 2014; Suana et al., 2019). Some studies also try to reveal opinions about blended learning environments (Dini et al., 2021; Ng et al., 2022). Fewer studies reported the results of the blended learning model (Liu, 2022; Louten & Daws, 2022).

DISCUSSION AND CONCLUSION

The research sought to identify the trends in international blended learning studies published between 2005 to 2022 in the Web of Science (WoS) database through descriptive content analysis. The analysis for this study included 120 studies that met the criteria. A total of 388 keywords were found in 120 studies. The findings revealed that the most used keyword by the authors was "blended learning" in fifty-one studies. Similarly, Hebebci and Usta (2015), in a literature review of theses on blended learning, and Omar et al. (2021), in a bibliometric study, reported that "blended learning" is the most used keyword. This finding may be interpreted as "blended learning" is more commonly used in science education literature than alternative terms/concepts (e.g., hybrid and mixed learning).

The distribution of blended learning studies in science education by year shows that more studies were published in the period 2020-2022. Moreover, it can be mentioned that there is a growing trend in blended learning studies in science education based on the distribution of studies by year. As Kahraman and Kaya (2021) emphasised, this trend is compatible with the development of information and communication technologies. Since one dimension of blended learning is related to technology, it is possible that rapidly developing technologies used in the field of education will affect this learning approach. On the other hand, the publication of many studies between 2020 and 2022 is probably connected to the emerging Covid-19 pandemic beyond the development of information and communication technologies. If the pandemic period is examined in detail, more studies were conducted in the USA, which is consistent with the general trend. However, although more studies were in the USA, blended learning studies were conducted in many countries over a broad spectrum in 2020–2022. Similarly, Ashraf et al. (2021), Ocak and Ünsal (2021) emphasised that blended learning studies have increased during the Covid-19 pandemic. Ashraf et al. (2021) underlined that the increase in blended learning studies in 2020 might result from the COVID-19 pandemic, which compelled most educational institutions to adopt blended learning to meet the requirements of students during this period.

The highest number of studies on blended learning in science education was conducted in the USA, with thirty studies (see Fig. 4). Similarly, some studies reported, when comparing countries, the USA produced the most research on blended learning (Chung et al., 2019; Yang et al., 2017). Some potential causes for this situation are (1) the number of active researchers (Arifin et al., 2021), (2) the high internal and external motivation of institutions and researchers in the country (Julia et al., 2020), and (3) the development of educational technologies (Kushairi & Ahmi, 2021).

The studies mainly aimed to determine the effect of blended learning on dependent variables such as

achievement and motivation. Similar results are obtained in content analysis studies conducted in different fields related to blended learning (Halverson et al., 2014; Hebebci & Usta, 2015; Kahraman & Kaya, 2021; Karaotcu & Baran, 2019).

The findings showed that studies mostly use quantitative research methods and experimental designs. This finding is consistent with the literature (Chung et al., 2019; Halverson et al., 2014; Meral et al., 2020). Studies that adopt qualitative and mixed methods are fewer numbers than quantitative studies. Based on the findings, it can conclude that blended learning studies have employed experimental designs commonly used in education research. This preference in the studies might be explained by the fact that the quantitative method and experimental designs allow data collection more quickly, control of some variables, and generalisation (Kahraman & Kaya, 2021).

The sample groups of 51–100 participants were used more frequently in quantitative studies. Different studies obtained similar results (Hebebci & Usta, 2015; Kahraman & Kaya, 2021). In qualitative studies, it is seen that the sample size is mainly in the range of 0-50 participants. The necessity of providing in-depth and detailed information in qualitative research (Alkış Küçükaydın, 2020) may naturally be the reason why these studies are conducted with fewer participants than quantitative studies.

Most of the studies were conducted with undergraduate-level sample groups. Similar results have been reported in studies in the literature (Hebebci & Usta, 2015; Kahraman & Kaya, 2021; Karaotcu & Baran, 2019; Meral et al., 2020). It is determined that the number of studies conducted with participants at primary school, associate degree, and graduate is limited. This finding might be because students at a young age in primary school may have challenges using educational technologies independently in a designed blended learning environment. In their study, Yadigar and Yadigar (2021) reported that primary school teachers stated that some aspects of distance education are unsuitable for the development of children at the primary school level. The limited number of studies conducted with samples at associate and graduate levels may be due to the shorter teaching period at this level of education (Kahraman & Kaya, 2021).

Findings of the subject area revealed that the blended learning environment is designed more to teach physics subjects. It is also seen that blended learning studies are frequently carried out to teach biology and chemistry subjects. Kahraman and Kaya (2021), in their study of the analysis of blended learning studies, reported that blended learning studies were conducted more in biology. Köse and Yüzüak (2020) stated that blended learning studies in science education were conducted more in chemistry. Naturally, different findings are possible due to databases and criteria (e.g., years and language of selected studies). On the other hand, this finding might be interpreted as an increasing trend towards using blended learning studies in physics teaching.

Data collection tools such as tests (e.g., achievement, skill, knowledge.), questionnaires (e.g., satisfaction/metacognition/process/feedback) and Likert scales (e.g., attitude, motivation) were frequently used in the studies. Since more quantitative research methods are preferred in studies, it is not unexpected that these data collection tools are commonly used. The most used data collection tool in qualitative studies is the interview. These findings are compatible with the literature (Hebebci & Usta, 2015; Kahraman & Kaya, 2021; Karaotcu & Baran, 2019). In addition, results showed that parametric tests were generally used for data analysis. The fact that achievement/skill tests, questionnaires, and Likert scales are mainly used as data collection tools in the studies can explain why statistical analyses such as “t-tests” and “ANOVA/MANOVA” are frequently used in data analysis methods. Content and descriptive analyses were used in the analysis of qualitative data. Similarly, it was reported that descriptive/content analysis methods are frequently used in qualitative data analysis in studies evaluating the blended learning literature (Hebebci & Usta, 2015; Kahraman & Kaya, 2021; Karaotcu & Baran, 2019; Meral et al., 2020).

The more preferred course management systems in the studies were the online systems designed by the schools. Of course, the rapid development of technology and instructional technologies may be

considered one of the possible reasons for this situation. However, this finding is consistent with the fact that the studies carried out during the Covid-19 period are primarily at the undergraduate level and that most universities developed online systems during the pandemic. Kahraman and Kaya (2021) reported that Moodle was the most used course management system in the study in which they evaluated blended studies in science education between 2003 and 2018. The findings of Kahraman and Kaya (2021), evaluating the studies performed before the pandemic, also support the idea that universities focus more on designing their learning management systems during the pandemic. "Moodle" was the second-most widely used course management system in the selected studies. Moodle is an open-source and free e-learning system (Brandl, 2005). Moodle, a lesson management system that allows students to access lessons and assignments anywhere and anytime easily, was frequently used during the pandemic (Quansah & Essiam, 2021). Additionally, the Moodle course management system was found to improve student communication, contribute to student success, and be effective in creating a blended learning environment, according to Kışla et al.'s (2014) study on the opinions of faculty members and graduate students on the use of the Moodle. For such reasons, it may be said that the Moodle course management system is widely preferred in blended learning studies.

The analysed studies indicate that blended learning environments designed for science education generally have a positive effect on variables such as achievement (Harahap et al., 2019), motivation (Akgündüz & Akınoğlu, 2017), attitude (Son et al., 2016), and skill (Hariadi et al., 2022). For instance, Akgündüz and Akınoğlu (2017) reported that the blended learning approach significantly increased achievement and motivation compared to face-to-face learning in science education. Harahap et al. (2019) reported in their experimental studies that the blended learning approach significantly improved students' achievement in biology education. Similar findings were reported in content analysis studies conducted in various fields related to blended learning (Hebebci & Usta, 2015; Kahraman & Kaya, 2021).

This study evaluates the studies on the blended learning environment in science education in the international literature. As previously indicated, the Covid-19 pandemic during 2020–2022 raised the value of blended learning in science education. Thus, it can be said that the outbreak has increased the number of studies on blended learning in science education. The studies that focus on blended learning environments, which enable teaching and learning to continue both in the classroom and out-of-school settings, are anticipated to rise. The outcomes of this study may guide future studies on blended learning.

The study offers the following suggestions: Quantitative/qualitative studies can be increased in countries with fewer blended learning studies in science education, and why fewer studies are conducted in these countries can be investigated. More research on blended learning may be carried out at the primary, secondary, high school, associate, and graduate levels. More qualitative research may be conducted to identify views on blended learning environments. Studies can be carried out to determine course management systems that can contribute to science education. Studies might be conducted to determine whether the course management systems designed by educational institutions are appropriate for all educational levels. Every five to ten years, content analysis studies to assess blended learning environments could be carried out due to the rapid growth of educational technology.

Acknowledgement

This study is produced from the ongoing master's thesis of the first author, who enrolled at the Institute of Graduate Education, Uşak University, under the supervision of the second author.

REFERENCES

Akgündüz, D., & Akınoğlu, O. (2017). The impact of blended learning and social media-supported learning on the academic success and motivation of the students in science education. *Education and Science, 42*(191), 69-90. http://dx.doi.org/10.15390/EB.2017.6444

Alanoğlu, M., & Karabatak, S. (2021). Harmanlanmış öğrenme [Blended learning]. In T. Talan (Ed.), *Eğitimde dijitalleşme ve yeni yaklaşımlar [Digitalisation and new approaches in education]* (pp.193-210). Efe Academy.

Alkış Küçükaydın, M. (2020). Fen eğitiminde kavram öğretimi konulu araştırmaların sistematik derleme yöntemiyle incelenmesi [Examination of studies on concept teaching in science education: A systematic review of literature]. *Ege Journal of Education, 21*(2), 36-56. http://dx.doi.org/10.12984/egeefd.746326

Alsalhi, N. R., Eltahir, M. E., & Al-Qatawneh, S. S. (2019). The effect of blended learning on the achievement of ninth grade students in science and their attitudes towards its use. *Heliyon, 5*(9), 1-11. https://doi.org/10.1016/j.heliyon.2019.e02424

Alsalhi, N. R., Eltahir, M., Dawi, E., Abdelkader, A., & Zyoud, S. (2021). The effect of blended learning on the achievement in a physics course of students of a dentistry college: A case study at Ajman University. *Electronic Journal of E-Learning, 19*(1), 1-17. https://doi.org/10.34190/ejel.19.1.1992

Andrini, V. S., Matsun, M., & Wahyuni, T. (2020). Implementation of webinars in blended learning models to improve motivation and learning outcomes of the study of human skeletal system. *Periodico Tche Quimica, 17*(36), 402-414.

Ang, J. W. J., & Ng, Y. N. (2022). Effect of research-based blended learning with scrum methodology on learners' perception and motivation in a laboratory course. *Journal of Chemical Education, 99*(12), 4102-4108. https://doi.org/10.1021/acs.jchemed.2c00002

Arifin, M. Z., Jalal, F., & Makmuri (2021). Bibliometric analysis and visualisation of blended learning research trends with PoP and VOS viewer. *Turkish Journal of Computer and Mathematics Education, 12*(11), 2010-2014.

Ashraf, M. A., Yang, M., Zhang, Y., Denden, M., Tlili, A., Liu, J., Huang, R., & Burgos, D. (2021). A systematic review of systematic reviews on blended learning: Trends, gaps and future directions. *Psychology Research and Behavior Management*, 14, 1525–1541. https://doi.org/10.2147/PRBM.S331741

Barak, M., & Dori, Y. J. (2009). Enhancing higher order thinking skills among inservice science teachers via embedded assessment. *Journal of Science Teacher Education, 20*(5), 459-474. https://doi.org/10.1007/s10972-009-9141-z

Belland, B. R., Burdo, R., & Gu, J. (2015). A blended professional development program to help a teacher learn to provide one-to-one scaffolding. *Journal of Science Teacher Education, 26*(3), 263-289. https://doi.org/10.1007/s10972-015-9419-2

Berger, H., Eylon, B. S., & Bagno, E. (2008). Professional development of physics teachers in an evidence-based blended learning program. *Journal of Science Education and Technology, 17*(4), 399-409. https://doi.org/10.1007/s10956-008-9109-3

Bernard, P., Bros, P., & Migdat-Mikuli, A. (2017). Influence of blended learning on outcomes of students attending a general chemistry course: Summary of a five-year-long study. *Chemistry Education Research and Practice, 18*(4), 682-690. https://doi.org/10.1039/c7rp00040e

Brandl, K. (2005). Review of are you ready to "Moodle"?. *Language Learning & Technology, 9*(2), 16-23. http://dx.doi.org/10125/44016

Bonitasya, D. A., Widiyatmoko, A., & Sovansophal, K. (2021). The effect of blended learning with a collaborative problem solving approach on students' cognitive learning outcomes and collaboration skills in science learning. *Jurnal Penelitian Dan Pembelajaran Ipa, 7*(2), 152-167. https://doi.org/10.30870/jppi.v7i2.12670

Bortnik, B., Stozhko, N., Pervukhina, I., Tehernysheva, A., & Belysheva, G. (2017). Effect of virtual analytical chemistry laboratory on enhancing student research skills and practices. *Research in Learning Technology, 25*. http://dx.doi.org/10.25304/rlt.v25.1968

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27-40. http://dx.doi.org/10.3316/QRJ0902027

Brown, J. A. L. (2020). Producing scientific posters, using online scientific resources, improves applied scientific skills in undergraduates. *Journal of Biological Education, 54*(1), 77-87. https://doi.org/10.1080/00219266.2018.1546758

Castro-Rodríguez, M. M., Marín-Suelves, D., López-Gómez, S., & Rodríguez-Rodríguez, J. (2021). Mapping of scientific production on blended learning in higher education. *Education Sciences*, 11, 494. https://doi.org/10.3390/educsci11090494

Chamberlain, S., Elford, D., Lancaster, S. J., & Silve, F. (2021). Tailored blended learning for foundation year chemistry students. *Chimia, 75*(1-2), 18-26. https://doi.org/10.2533/chimia.2021.18

Christiansen, M. A. (2014). Inverted teaching: Applying a new pedagogy to a university organic chemistry class. *Journal of Chemical Education, 91*(11), 1845-1850. https://dx.doi.org/10.1021/ed400530z

Chung, C. J., Lai, C. L., & Hwang, G. J. (2019). Roles and research trends of flipped classrooms in nursing education: A review of academic publications from 2010 to 2017. *Interactive Learning Environments, 29*(6), 883-904. https://doi.org/10.1080/10494820.2019.1619589

Clark, C. E. J., & Post, G. (2021). Preparation and synchronous participation improve student performance in a blended learning experience. *Australasian Journal of Educational Technology, 37*(3), 187-199. https://doi.org/10.14742/ajet.6811

Coll, S. D., & Coll, R. K. (2018). Using blended learning and out-of-school visits: Pedagogies for effective science teaching in the twenty-first century. *Research in Science & Technological Education, 36*(2), 185-204. https://doi.org/10.1080/02635143.2017.1393658

Cui, Y., Zhao, G., & Zhang D. (2022). Improving students' inquiry learning in web-based environments by providing structure: Does the teacher matter or platform matter?. *British Journal of Educational Technology, 53*(4), 1049-1068. https://doi.org/10.1111/bjet.13184

Çalık, M., & Sözbilir, M. (2014). Parameters of content analysis. *Education and Science, 39*(174), 33-38. http://dx.doi.org/10.15390/EB.2014.3412

Çetin, A., & Özdemir, O. F. (2018). Mode-method interaction: The role of teaching methods on the effect of instructional modes on achievements, science process skills, and attitudes towards physics. *Eurasia Journal of Mathematics Science and Technology Education, 14*(5), 1815-1826. https://doi.org/10.29333/ejmste/85217

Delgado, F. (2021). Teaching physics for computer science students in higher education during the Covid-19 pandemic: A fully internet-supported course. *Future Internet, 13*(2), 24. http://doi.org/10.3390/fi13020035

Din, W. A., Saıkım, F. H., Swanto, S., Latıp, N. A. A., Ismaıl, I. H., & Rasıt, M. R. A. (2020). Students' perspectives on the effectiveness of problem-based learning with inverted classroom assistance in improving. *Akademika, 90*(2), 63-76. https://doi.org/10.17576/akad-2020-90IK2-06

Dinçer, S. (2018). Content analysis in for educational science research: Meta-analysis, meta-synthesis, and descriptive content analysis. *Bartın University Journal of Faculty of Education, 7*(1), 176-190. https://doi.org/10.14686/buefad.363159

Dini, V., Jaber, L., & Danahy, E. (2021). Dynamics of scientific engagement in a blended online learning environment. *Research in Science Education, 51*(2), 439-467. https://doi.org/10.1007/s11165-018-9802-z

Enneking, K. M., Breitenstein, G. R., Coleman, A. F., Reeves, J. H., Wang, Y., & Grove, N. P. (2019). The evaluation of a hybrid, general chemistry laboratory curriculum: Impact on students' cognitive, affective, and psychomotor learning. *Journal of Chemical Education, 96*(6), 1058-1067. https://doi.org/10.1021/acs.jchemed.8b00637

Eppler, E., Meyer, J., Serowy, S., Link, K., Pauk, B., & Filgueira, L. (2021). Enhancing scientific communication skills: A real-world simulation in a tertiary-level life science class using e-learning technology in biomedical literature perception, reflective review writing on a clinical issue, and self and peer assessments. *Research in Science Education, 51*(2), 277-299. https://doi.org/10.1007/s11165-018-9795-7

Erlina, N., Prayekti, & Wicaksono, I. (2022). Atomic physics teaching materials in blended learning to improve self-directed learning skills in distance education. *Turkish Online Journal of Distance Education, 23*(4), 20-38. https://doi.org/10.17718/tojde.1182747

Fonseca, C. S. C., Zacarias, M., & Figueiredo, M. (2021). Milage learn plus: A mobile learning app to aid the students in the study of organic chemistry. *Journal of Chemical Education, 98*(3), 1017-1023. https://dx.doi.org/10.1021/acs.jchemed.0c01313

Gariou-Papalexiou, A., Papadakis, S., Manousou, E., & Georgiadu, I. (2017). Implementing a flipped classroom: A case study of biology teaching in a Greek high school. *Turkish Online Journal of Distance Education, 18*(3), 47-65. https://dx.doi.org/10.17718/tojde.328932

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7, 95-105. https://doi.org/10.1016/j.iheduc.2004.02.001

Gronlien, H. K., Christoffersen, T. E., Ringstad, O., Andreassen, M., & Luga, R. G. (2021). A blended learning teaching strategy strengthens the nursing students' performance and self-reported learning outcome achievement in an anatomy, physiology and biochemistry course - A quasi-experimental study. *Nurse Education in Practice*, 52, 1471-5953. https://doi.org/10.1016/j.nepr.2021.103046

Gunawan, K. D. H., Liliasari, L., Kaniawati, I., & Setiawan, W. (2021). Implementation of competency enhancement program for science teachers assisted by artificial intelligence in designing hots-based integrated science learning. *Jurnal Penelitian Dan Pembelajaran Ipa, 7*(1), 55-65. https://doi.org/10.30870/jppi.v7i1.8655

Gürdoğan, M., & Bağ, H. (2020). Harmanlanmış öğrenme ortamlarının akademik başarı ve fen öğrenmeye yönelik motivasyona etkisi [The effect of blended learning environments on academic achievement and motivation

for science learning]. *Mehmet Akif Ersoy University Journal of Education Faculty*, 56, 139-158. https://doi.org/10.21764/maeuefd.489893

Halverson, L. R., Graham, C. R., Spring, K. J., Drysdale, J. S., & Henrie, C. R. (2014). A thematic analysis of the most highly cited scholarship in the first decade of blended learning research. *Internet and Higher Education, 20*, 20-34. https://doi.org/10.1016/j.iheduc.2013.09.004

Hande, S. (2014). Strengths weaknesses opportunities and threats of blended learning: Students perceptions. *Annals of Medical and Health Sciences Research, 4*(3), 336-339. https://doi.org/10.4103/2141-9248.133455

Harahap, F., Nasution, N. E. A., & Manurung, B. (2019). The effect of blended learning on student's learning achievement and science process skills in plant tissue culture course. *International Journal of Instruction, 12*(1), 521-538. https://doi.org/10.29333/iji.2019.12134a

Hariadi, B., Jatmiko, B., Sunarto, M. J. D., Prahani, B. K., Sagirani, T., Amelia, T., & Lemantara, J. (2022). Higher order thinking skills based learning outcomes improvement with blended web mobile learning model. *International Journal of Instruction*, *15*(2), 565-578. https://doi.org/10.29333/iji.2022.15231a

Hebebci, M., & Usta, E. (2015). Türkiye'de harmanlanmış öğrenme eğilimleri: Bir literatür çalışması [Blended learning trends in Turkey: A literature review study]. *Adiyaman University Journal of Social Sciences*, (19), 195-219. http://dx.doi.org/10.14520/adyusbd.23061

Hibbard, L., Sung, S., & Wells, B. (2016). Examining the effectiveness of a semi -self-paced flipped learning format in a college general chemistry sequence. *Journal of Chemical Education, 93*(1), 24-30. https://doi.org/10.1021/acs.jchemed.5b00592

Horn, M. B., & Staker, H. (2015). *Blended: Using Disruptive Innovation to Improve Schools*. Jossey-Bass.

Hu, Y., Huang, J. Y., & Kong, F. Z. (2022). College students' learning perceptions and outcomes in different classroom environments: A community of inquiry perspective. *Frontiers in Psychology*, 13. https://doi.org/10.3389/fpsyg.2022.1047027

Hwang, R. H., Lin, H. T., Sun, J. C.Y., & Wu, J. J. (2019). Improving learning achievement in science education for elementary school students via blended learning. *International Journal of Online Pedagogy and Course Design, 9*(2), 44-62. https://doi.org/10.4018/IJOPCD.2019040104

Indriyanti, N. Y., Yamtinah, S., & Muawiyah, D. (2020). An inquiry into students' metacognition and learning achievement in a blended learning design. *International Journal of Emerging Technologies in Learning, 15*(21), 77-88. https://doi.org/10.3991/ijet.v15i21.12907

Jeong, J. S., Canada, F. C., & Gomez, D. G. (2018). The study of flipped-classroom for pre-service science teachers. *Education Sciences, 8*(4), 11. https://doi.org/10.3390/educsci8040163

Jiang, X. Y., & Ning, Q. (2021). The impact and evaluation of COVID-19 pandemic on the teaching model of medical molecular biology course for undergraduates major in pharmacy. *Biochemistry and Molecular Biology Education, 49*(3), 346-352. https://doi.org/10.1002/bmb.21471

Johnson, S. D., Aragon, S. R., & Shaik, N. (2000). Comparative analysis of learner satisfaction and learning outcomes in online and face-to-face learning environments. *Journal of Interactive Learning Research, 11*(1), 29-49.

Julia, J., Afrianti, N., Soomro, K. A., Supriyadi, T., Dolifah, D., Isrokatun, I., Erhamwilda, E., & Ningrum, D. (2020). Flipped classroom educational model (2010-2019): A bibliometric study. *European Journal of Educational Research, 9*(4), 1377-1392. https://doi.org/10.12973/eu-jer.9.4.1377

Kadirhan, M., & Korkmaz, Ö. (2020). EBA içerikleriyle harmanlanmış öğretim uygulamasının öğrencilerin fen bilimleri dersindeki akademik başarılarına ve tutumlarına etkisi [The effects of learning blended with eba content on students' academic achievement and attitudes toward science course]. *Trakya Journal of Education, 10*(1), 64-75. https://doi.org/10.24315/tred.529721

Kahraman, B., & Kaya, O. N. (2021). Fen eğitimi alanında yapılmış harmanlanmış öğrenme çalışmalarına yönelik tematik içerik analizi [Thematic content analysis of blended learning studies in science education]. *Hacettepe University Journal of Education*, *36*(3), 509-526. https://doi/10.16986/HUJE.2020058309

Karaotcu, İ., & Baran, B. (2019, May). *Türkiye'de Harmanlanmış Öğrenme Çerçevesinde Yapılmış Çalışmalar [Studies on Blended Learning in Turkey]* (pp.68-73). Paper presented at 1st International Science Education Art and Technology Symposium (UBEST), Buca Faculty of Education, İzmir, Türkiye.

Kışla, T., Karaoğlan, B., Bozok Algin, G., & Candemir, C. (2014). Harmanlanmış öğrenme ortamında moodle platformunun kullanılması ile ilgili paydaş görüşlerinin incelenmesi [The investigation of stakeholders' views on use of moodle in blended learning environment]. *Journal of Research in Education and Teaching, 3*(2), 2146-9199.

Köse, S., & Yüzüak, A. V. (2020). Fen ve matematik eğitiminde ters yüz edilmiş sınıf modeliyle ilgili yapılan çalışmalar: Tematik bir inceleme [Studies on flipped classroom in science and mathematics education: A thematic review]. *Bartın University Journal of Educational Research, 4*(1), 15-33.

Krasnova, L., & Shurygin, V. (2019). Blended learning of physics in the context of the professional development of teachers. *International Journal of Emerging Technologies in Learning, 14*(23), 17-32. https://doi.org/10.3991/ijet.v14i23.11084

Kuroki, N., & H. Mori (2021). Comprehensive physical chemistry learning based on blended learning: A new laboratory course. *Journal of Chemical Education, 98*(12), 3864-3870. https://doi.org/10.1021/acs.jchemed.1c00666

Kushairi, N., & Ahmi, A. (2021). Flipped classroom in the second decade of the Millenia: A bibliometrics analysis with Lotka's law. *Education and Information Technologies*, 26, 4401-4431. https://doi.org/10.1007/s10639-021-10457-8

Lane, S., Hoang, J. G., Leighton, J. P., & Rissanen, A. (2021). Engagement and satisfaction: Mixed-method analysis of blended learning in the sciences. *Canadian Journal of Science Mathematics and Technology Education, 21*(1), 100-122. https://doi.org/10.1007/s42330-021-00139-5

Le, B., Lawrie, G. A., & Wang, J. T. H. (2022). Student self-perception on digital literacy in STEM blended learning environments. *Journal of Science Education and Technology, 31*(3), 303-321. https://doi.org/10.1007/s10956-022-09956-1

Lee, Y., Kinzie, M. B., & Whittaker, J. V. (2012). Impact of online support for teachers' open-ended questioning in pre-k science activities. *Teaching and Teacher Education, 28*(4), 568-577. https://doi.org/10.1016/j.tate.2012.01.002

Liu, X. (2022). Primary science curriculum student acceptance of blended learning: Structural equation modeling and visual analytics. *Journal of Computers in Education, 9*(3), 351-377. https://doi.org/10.1007/s40692-021-00206-8

Louten, J., & Daws, L. B. (2022). Interdisciplinary differences in hybrid courses: A study in biology & communication. *Internet and Higher Education,* 53. https://doi.org/10.1016/j.iheduc.2022.100847

Manna, M. S., Balusamy, B., Sharma, M., & Samuel, P. (2023). *Blended Learning and MOOCs: A New Generation Education System (1st ed.)*. Routledge.

Meral, E., Teke, D., Güler, M., & Başcı-Namlı, Z. (2020). General trends of studies on flipped classroom model: Bibliometric mapping and content analysis. *International Online Journal of Education and Teaching (IOJET), 8*(2). 564-587.

Meşe, C. (2016). *Harmanlanmış öğrenme ortamlarında oyunlaştırma bileşenlerinin etkililiği* [*Effectiveness of gamification elements in blended learning environments]*. (Publication no. 438244). [Doctoral dissertation. Anadolu University]. YÖK Thesis.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd edition). Sage Publications.

Ng, B. J. M., Han, J. Y., Kim, Y., Togo, K. A., Chew, J. Y., Lam, Y., & Fung, F. M. (2022). Supporting social and learning presence in the revised community of inquiry framework for hybrid learning. *Journal of Chemical Education, 99*(2), 708-714. https://doi.org/10.1021/acs.jchemed.1c00842

Norberg, A., Stöckel, B., & Antti, M. L. (2017). Time shifting and agile time boxes in course design. *International Review of Research in Open and Distributed Learning, 18*(6), 88-103. https://doi.org/10.19173/irrodl.v18i6.3182

Ocak, M. A., & Ünsal, N. Ö. (2021). A content analysis of blended learning studies conducted during Covid-19 pandemic period. *Academic Perspective, 1*(2), 175-210.

Olaniyi, N. E. E. (2020). Threshold concepts: Designing a format for the flipped classroom as an active learning technique for crossing the threshold. *Research and Practice in Technology Enhanced Learning, 15*(1), 15. https://doi.org/10.1186/s41039-020-0122-3

Omar, R., Kaliappen, N., Khamis, K., A., & Sulisworo, D. (2021). Blended learning approach in graduate studies: A bibliometric analysis from 1997-2021. *International Journal of Information and Education Technology,* 11, 546-552. https://doi/10.18178/ijiet.2021.11.11.1563

Orekhova, Y. Y., Sysoev, S. M., & Alekseev, M. M. (2021). Use of enhanced feedback in an electronic learning course fundamentals of molecular physics and thermodynamics. *Periodico Tche Quimica, 18*(39), 71-87. https://doi/10.52571/PTQ.v18.n39.2021.06_OREKHOVA_pgs_71_87.pdf.

Osguthorpe, R. T., & Graham, C. R. (2003). Blended learning environments: Definitions and directions. *Quarterly Review of Distance Education, 4*(3), 227-233.

Özdilek, Z., & Baltacı-Göktalay, S. (2013). Pre-service science teachers' perceptions about effective design of blended university chemistry courses. *Turkish Online Journal of Distance Education, 14*(3), 165-180.

Page, M. J., McKenzie J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Larissa, S., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, (*372)71. https://doi.org/10.1136/bmj.n71

Pereira, J. A., Pleguezuelos, E., Meri, A., Molina-Ros, A., Molina-Tomas, M. C., & Masdeu, C. (2007). Effectiveness of using blended learning strategies for teaching and learning human anatomy. *Medical Education, 41*(2), 189-195. https://doi/10.1111/j.1365-2929.2006.02672.x

Pima, J. M., Odetayo, M., Iqbal, R., & Sedoyeka, E. (2018). A thematic review of blended learning in higher education. *International Journal of Mobile & Blended Learning, 10*(1). https://doi.org/10.4018/IJMBL.2018010101

Quansah, R. E., & Essiam, C. (2021). The use of learning management system (LMS) Moodle in the midst of Covid-19 pandemic: Students' perspective. *Journal of Educational Technology & Online Learning, 4*(3), 418-431. http://doi.org/10.31681/jetol.934730

Raffaghelli, J., Ghislandi, P., Sancassani, S., Canal, L., Micciolo, R., Balossi, B., Bozzi, M., Di Sieno, L., Genco, I., Gondoni, P., Pini, A., & Zani, M. (2018). Integrating MOOCs in physics preliminary undergraduate education: Beyond large size lectures. *Educational Media International, 55*(4), 301-316. https://doi.org/10.1080/09523987.2018.1547544

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computers & Education*, 144. https://doi.org/10.1016/j.compedu.2019.103701

Ren, G., Zhuang, P., Guan, X., Tian, K., & Zeng, J. (2022). How do blended biochemistry classes influence students' academic performance and perceptions of self-cognition?. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.843392

Reyes, C. T., Kyne, S. H., Lawrie, G. A., & Thompson, C. D. (2022). Implementing blended first year chemistry in a developing country using online resources. *Online Learning, 26*(1), 174-202. https://doi.org/10.24059/olj.v26i1.2508

Sadaghiani, H. R. (2011). Using multimedia learning modules in a hybrid-online course in electricity and magnetism. *Physical Review Special Topics-Physics Education Research, 7*(1), 7. https://doi.org/10.1103/PhysRevSTPER.7.010102

Seage, S. J., & Türegün, M. (2020). The effects of blended learning on STEM achievement of elementary school students, *International Journal of Research in Education and Science, 6*(1), 133-140.

Siddiqui, S., Thomas, M., & Soomro, N. N. (2020). Technology integration in education: Source of intrinsic motivation, self-efficacy and performance. *Journal of E-Learning and Knowledge Society, 16*(1), 11-22. https://doi.org/10.20368/1971-8829/1135188

Son, J., Narguizian, P., Beltz, D., & Desharnais, R. A. (2016). Comparing physical, virtual, and hybrid flipped labs for general education biology. *Online Learning, 20*(3), 228-243. https://doi.org/10.24059/olj.v20i3.687

Sozbilir, M., & Kutu, H. (2008). Development and current status of science education research in Turkey. *Essays in Education, 24*(1), Article 3.

Spring, K. J., & Graham, C. R. (2017). Thematic patterns in international blended learning literature, research, practices, and terminology. *Online Learning Journal, 21*(4), 337-361. https://doi.org/10.24059/olj.v21i4.998

Stein, J., & Graham, C. R. (2014*). Essentials for blended learning: A Standards-Based Guide.* Routledge.

Suana, W., Distrik, I. W., Herlina, K., Maharta, N., & Putri, N. M. A. A. (2019). Supporting blended learning using mobile instant messaging application: Its effectiveness and limitations. *International Journal of Instruction, 12*(1), 1011-1024. https://doi.org/10.29333/iji.2019.12165a

Sulisworo, D., Agustin, S. P., & Sudarmiyati, E. (2016). Cooperative-blended learning using Moodle as an open source learning platform. *International Journal of Technology Enhanced Learning, 8*(2), 187-198. https://doi.org/10.1504/IJTEL.2016.078089

Sulisworo, D., Sulistiyo, E. N., & Akhsan, R. N. (2017). The motivation impact of open educational resources utilisation on physics learning using quipper school app. *Turkish Online Journal of Distance Education, 18*(4), 120-128. https://doi.org/10.17718/TOJDE.340399

Tahir, I., Mierlo, V. V., Radauskas, V., Yeung, W., Tracey, A., & da Silva, R. (2022). Blended learning in a biology classroom: Pre-pandemic insights for post-pandemic instructional strategies. *Febs Open Bio, 12*(7), 1286-1305. https://doi.org/10.1002/2211-5463.13421

Tekane, R., Pilcher, L. A., & Potgieter, M. (2020). Blended learning in a second year organic chemistry class: Students' perceptions and preferences of the learning support. *Chemistry Education Research and Practice, 21*(1), 24-36. https://doi.org/10.1039/c9rp00099b

Wahyuni, S., Sanjaya., I., M., Erman, E., & Jatmiko, B. (2019). Edmodo-based blended learning model as an alternative of science learning to motivate and improve junior high school students' scientific critical thinking skills. *International Journal of Emerging Technologies in Learning, 14*(7), 98-110. https://doi.org/10.3991/ijet.v14i07.9980

WHO [World Health Organization] (2020). Coronavirus disease 2019 (COVID-19) Situation Report No:51 https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/

Yadigar, H., & Yadigar, G. C. (2021). İlkokullarda uzaktan eğitime yönelik paydaş görüşleri [Stakeholder views on distance education in primary schools]. *Çankırı Karatekin University Journal of Institute of Social Sciences, 12*(2), 526-566. https://doi.org/10.54558/jiss.943013

Yang, L., Sun, T., & Liu, Y. (2017). A Bibliometric investigation of flipped classroom research during 2000-2015. *International Journal of Emerging Technologies in Learning (IJET), 12*(6), 178-186. https://doi.org/10.3991/ijet.v12i06.7095

Yapıcı, I. U., & Akbayın, H. (2012). High school students' views on blended learning. *Turkish Online Journal of Distance Education, 13*(4), 125-139.

Yılmaz, O., & Malone, K. L. (2020). Preservice teachers perceptions about the use of blended learning in a science education methods course. *Smart Learning Environments, 7*(1), 21. https://doi.org/10.1186/s40561-020-00126-7

Yılmaz, Ö. (2018). Blended learning in science instruction: Advantages and students usage habits. *Hitit University Journal of Institute of Social Sciences, 11*(3), 2111-2121. https://10.17218/hititsosbil.439414

Zacharis, N. Z. (2015). A multivariate approach to predicting student outcomes in web-enabled blended learning courses. *The Internet and Higher Education, 27*, 44-53. https://dx.doi.org/10.1016/j.iheduc.2015.05.002

TÜRKÇE GENİŞLETİLMİŞ ÖZET

Bilim ve teknolojideki değişimler ve ilerlemeler günlük yaşamımızı ve eğitim uygulamalarımızı etkilemektedir. Özellikle eğitimde kullanılan teknolojiler, eğitim seçeneklerini genişletmiş (Osguthorpe & Graham, 2003) ve yeni öğrenme-öğretme teknikleri ve yaklaşımlarının ortaya çıkmasına neden olmuştur. Bu yaklaşımlardan biri de harmanlanmış öğrenme yaklaşımıdır. Hibrit veya karma öğrenme olarak da adlandırılan harmanlanmış öğrenme, yüz yüze ve çevrimiçi öğrenmenin güçlü bir birleşimidir (Manna vd., 2023, s. 19). Garrison ve Kanuka (2004, s. 96), Stein ve Graham (2014, s.12) de harmanlanmış öğrenmeyi sınıfta yüz yüze öğrenme deneyimlerinin ve çevrimiçi öğrenme deneyimlerinin dikkatli bir şekilde bütünleştirilmesi olarak tanımlar.

Birçok araştırmacı fen eğitiminde harmanlanmış öğrenmeye odaklanan çalışmalar yapmıştır. Harmanlanmış öğrenme çalışmalarına son yıllarda daha fazla ağırlık verilse de bu çalışmaların uzun yıllardır yürütüldüğü görülmektedir. Harmanlanmış öğrenme uygulamalarına ve çalışmalarına son yıllarda artan ilgi göz önüne alındığında bir içerik analizi çalışmasının alan yazına katkı sağlayacağı düşünülmektedir. Elbette önceki çalışmalarda da harmanlanmış öğrenme çalışmaları içerik analizi yoluyla değerlendirilmiştir. Bu çalışmalardan bazıları deneysel çalışmalara veya belirli bir örneklem grubuna odaklanmıştır. Doğal olarak, bazıları daha önce yayınlandığı için yakın tarihli literatürü kapsamamaktadır. Ayrıca bu çalışmaların önemli bir kısmı fen eğitimi odaklı yapılmamıştır. Harmanlanmış öğrenme, eğitim teknolojisindeki gelişmeler doğrultusunda sürekli değişime açıktır. Benzer şekilde Ocak ve Ünsal (2021) harmanlanmış öğrenme ortamlarının teknolojik gelişmelere bağlı olarak düzenli olarak arttığını belirtmektedir. Yazarlar ayrıca pandemi boyunca çok sayıda harmanlanmış öğrenme çalışması yapıldığının altını çizmektedirler. Benzer şekilde, Ashraf ve arkadaşlarına göre. (2021), birçok eğitim kurumu, 2020'deki salgın sırasında harmanlanmış öğrenmeyi uygulamaya çalıştı ve bu durum harmanlanmış öğrenmenin iyi uygulamalarını değerlendirmeye yönelik araştırma ilgisini artırdı. Bu çerçevede son zamanlarda eklenen çalışmalar dikkate alınarak literatürün incelenmesi önemlidir.

Özetle, uluslararası literatürde yaklaşık yirmi yıldır adından söz ettiren ve araştırılan harmanlanmış öğrenmenin öneminin son yıllarda daha da arttığı söylenebilir. Bu bağlamda harmanlanmış öğrenme ortamlarının fen eğitimine etkilerine odaklanan nitel ve nicel çalışmaların içerik analizi yoluyla detaylı bir şekilde incelenmesinin bundan sonraki araştırmalara yardımcı olacağı düşünülmektedir. Bu çalışmanın literatürdeki eğilimleri görme fırsatı sağlaması ve geleceğin araştırmacılarına ve program geliştirme uzmanlarına yol göstermesi beklenmektedir. Bu çerçevede çalışmanın temel problemi "Fen eğitiminde harmanlanmış öğrenme çalışmalarının özellikleri nelerdir?" sorusudur.

Bu çalışma, 2005-2022 yılları arasında fen eğitiminde yayınlanan harmanlanmış öğrenme çalışmalarına ilişkin eğilimleri belirlemeyi amaçlamaktadır. Bu araştırma doküman inceleme/analiz yöntemini benimsemiştir. İncelenen çalışmalara Web of Science (WoS) veritabanı taranarak ulaşılmıştır. İnceleme alınacak çalışmaların belirlenmesinde; (1) Yayın dilinin İngilizce, (2) hakemli bir dergide yayınlanmış olması kriterleri dikkate alınmıştır. Ayrıca çalışmaların belirlenmesinde, (1) tam metin olarak bulunmayan makaleler, (2) tezler, kitap bölümü bildiri metni vb., (3) eğitim dışı araştırma alanları dışlama kriterleri dikkate alınmıştır. Bu çerçevede çalışmada, 2005-2022 yılları arasında fen eğitiminde harmanlanmış öğrenmeye odaklanan 120 araştırma belirlenmiştir. Veri toplama aracı olarak 'Bilimsel Araştırma Doküman Sınıflandırma Formu' kullanılmıştır. Bu form yazarlar tarafından literatüre dayalı olarak geliştirilmiştir (örn. Ashraf vd., 2021; Sozbilir & Kutu, 2008). Form, çalışmaları belge türü, yayın yılı, araştırmaların amacı, araştırma deseni, yöntemi, konusu, örneklemi, örneklem büyüklüğü, veri toplama araçları, verilerin analizi, araştırmaların sonuçları gibi özellikler çerçevesinde sınıflandırmak için kullanılmıştır. Bu çalışmadaki verilerin çözümlenmesinde betimsel içerik analizi kullanılmıştır. Fen eğitiminde harmanlanmış öğrenme çalışmalarında genel durumu ve eğilimleri belirlemek için betimsel içerik analizi yöntemi tercih edilmiştir (Çalık & Sözbilir, 2014; Dinçer, 2018). Ayrıca verilerin analizinde bibliyometrik analizden de yararlanılmıştır.

Fen eğitiminde harmanlanmış öğrenmeye yönelik WoS veri tabanında 2005-2022 yılları arasında yayınlanmış ve belirli kriterlere dayalı seçilmiş 120 çalışmada 388 farklı anahtar kelimenin kullanıldığı görülmüştür. Bulgular, yazarlar tarafından en çok kullanılan anahtar kelimenin "blended learning" olduğunu göstermektedir. Fen eğitiminde harmanlanmış öğrenme ile ilgili en fazla sayıda çalışma, otuz çalışma ile ABD'de yapılmıştır. Ayrıca bulgular, fen eğitiminde harmanlanmış öğrenme çalışmalarının 2020 ile 2022 yılları arasında daha fazla yapıldığını göstermektedir. Benzer şekilde 2020-2022 yılları arasında birçok ülkede geniş bir yelpazede harmanlanmış öğrenme çalışmaları yapıldığı görülmektedir. Covid-19 salgınının fen eğitiminde harmanlanmış öğrenmeye yönelik çalışmaların sayısını artırdığı söylenebilir. Bu sonuçlar, literatürde Covid-19 pandemisi döneminde harmanlanmış öğrenme çalışmalarının sayısının arttığı sonuçlarıyla tutarlıdır. Çalışmalar ağırlıklı olarak harmanlanmış öğrenmenin başarı, tutum vb. bağımlı değişkenler üzerindeki etkisini belirlemeye yöneliktir. Bulgular, çalışmaların çoğunlukla nicel araştırma yöntemlerini ve deneysel desenleri kullandığını göstermiştir. Nitel ve karma yöntemleri benimseyen araştırmalar, nicel araştırmalara göre daha az sayıdadır. Bulgulara dayalı olarak, eğitim araştırmalarında sıklıkla olarak kullanılan deneysel desenlerin harmanlanmış öğrenme çalışmalarında da yaygın bir şekilde kullanıldığı ifade edilebilir. Nicel araştırmalarda 51-100 katılımcıdan oluşan örneklem grupları daha sık kullanılmıştır. Nitel araştırmalarda örneklem büyüklüğünün ağırlıklı olarak 0-50 katılımcı aralığında olduğu görülmektedir. Çalışmaların çoğu lisans düzeyindeki örneklem gruplarıyla yürütülmüştür. İlkokul, önlisans ve lisansüstü düzeyindeki katılımcılarla yapılan araştırma sayısının sınırlı olduğu belirlenmiştir. Konu alanına ilişkin bulgular harmanlanmış öğrenme ortamının daha çok fizik konularını öğretmek için tasarlandığını ortaya koymuştur. Ayrıca biyoloji ve kimya konularının öğretiminde harmanlanmış öğrenme çalışmalarının sıklıkla yapıldığı görülmektedir. Araştırmalarda testler (örneğin başarı, beceri, bilgi), anketler (örneğin memnuniyet/üst biliş/süreç/geri bildirim) ve Likert ölçekleri (örneğin tutum, motivasyon) gibi veri toplama araçları sıklıkla kullanılmıştır. Nitel araştırmalarda en çok kullanılan veri toplama aracı görüşmedir. Parametrik testler arasında daha çok tercih edilen veri analiz yöntemleri “t-testi” ve “ANOVA/MANOVA” dır. Parametrik olmayan testler arasında “Mann-Whitney U Testi” daha fazla tercih edilen analiz yöntemi olmuştur. Nitel verilerin analizinde “İçerik Analizi” ve “Betimsel Analiz” kullanılmıştır. Çalışmalarda daha çok okulların (eğitim kurumlarının) çevrimiçi sistemleri kullanılmaktadır. En çok kullanılan diğer öğrenme yönetim sistemleri “Moodle” ve “Blackboard” olmuştur. Araştırmaların sonuçlarına göre fen eğitiminde tasarlanan harmanlanmış öğrenme ortamlarının genel anlamda öğrencilerin başarı, beceri, motivasyon vb. değişkenleri üzerinde olumlu ve anlamlı bir etkiye sahip olduğu görülmektedir.

Elde edilen bulgular ışığında şu önerilerde bulunulabilir: Fen eğitiminde harmanlanmış öğrenme çalışmalarının az olduğu ülkelerde nicel/nitel çalışmalar arttırılabilir ve bu ülkelerde neden daha az araştırma yapıldığı araştırılabilir. İlköğretim, ortaöğretim, lise, önlisans ve lisansüstü düzeylerinde harmanlanmış öğrenme konusunda daha fazla araştırma yapılabilir. Harmanlanmış öğrenme ortamlarına ilişkin görüşleri belirlemek için daha fazla nitel araştırmalar yapılabilir. Fen eğitimine katkı sağlayabilecek ders yönetim sistemlerini belirlemeye yönelik çalışmalar yapılabilir. Eğitim kurumları tarafından tasarlanan ders yönetim sistemlerinin tüm eğitim kademelerine uygun olup olmadığı konusunda çalışmalar yapılabilir. Eğitim teknolojisindeki hızlı gelişme nedeniyle beş ya da on yılda bir harmanlanmış öğrenme çalışmalarının içerik analizi çalışmaları yapılabilir.