THE EFFECT OF 5E LEARNING MODEL ON STUDENTS' ACADEMIC ACHIEVEMENT: A META-ANALYSIS STUDY

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ABSTRACT

The 5E learning model, which is based on the Constructivist approach, is restored to in many fields, especially in science education. The aim of this research is to carry out a meta-analysis of the studies on the effect of the 5E learning model on academic achievement. Studies conducted between 2017 -2021 and meeting the criteria determined were included in the study pool. The descriptive features of the obtained data, the sample number of the experimental and control groups, the arithmetic mean and standard deviation data were coded. In addition, the course and teaching level in which the 5E model was applied were taken as moderator variables. The findings showed that the 5E learning model greatly affected academic achievement according to the random effects model. When examined in terms of moderator variables, the effect size did not differ significantly according to the teaching level in which the 5E model was applied, while the effect level differed significantly according to the course in which the model was applied. Suggestions were made based on the research findings.

Keywords: *5E learning, Constructivism, Meta-analysis, Academic Achievement, Learning models.*

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5E ÖĞRENME MODELİNİN ÖĞRENCİLERİN AKADEMİK BAŞARILARINA ETKİSİ: BİR META-ANALİZ ÇALIŞMASI

ÖZ

Yapılandırmacı yaklaşımı temel alan 5E öğrenme modeli, başta fen bilimleri olmak üzere birçok alanda uygulanmaktadır. Bu araştırmanın amacı 5E öğrenme modelinin öğrenen akademik başarısı üzerindeki etkisini inceleyen çalışmaların meta-analizini yapmaktır. 2017-2021 yılları arasında yapılmış, belirlenen ölçütlere uygun olan araştırmalar çalışma havuzuna dâhil edilmişidir. Elde edilen verilere ait tanımlayıcı özellikler, deney ve kontrol gruplarına ait örneklem sayısı, aritmetik ortalama ve standart sapma verileri kodlanmıştır. Ayrıca 5E modelinin uygulandığı ders ve öğretim kademesi moderatör değişken olarak ele alınmıştır. Meta-analiz sonucunda 5E öğrenme modelinin akademik başarı üzerine etkisinin rastgele etki modeline göre geniş düzeyde olduğu belirlenmiştir. Moderatör değişkenler açısından incelendiğinde 5E öğrenme modelinin uygulandığı öğretim kademesine göre etki büyüklüğü anlamlı olarak farklılaşmazken, modelin uygulandığı derse göre etki düzeyinin anlamlı olarak farklılaştığı görülmüştür. Araştırma bulgularına dayalı olarak birtakım önerilerde bulunulmuştur.

Anahtar Kelimeler: *5E Öğrenme, Yapılandırmacılık, Meta-Analiz, Akademik Başarı, Öğrenme modelleri.*

INTRODUCTION

With the transition process from the industrial society to the information society, a social change has begun in the world. This change has led to the emergence of new approaches and trends in education, as in many social institutions. These innovations in the field of education are mostly explained by the changing roles of students and teachers. While the student was the passive receiver of the information and the teacher as the transmitter of the information, nowadays the student acquires the information with their own effort, and the teacher guides the student to have access to the information (Şişman, 2002) With this new perspective, teaching models and approaches that make the student active in the learning process have emerged. Teacher-centered teaching models such as Programmed teaching and Mastery learning, which were used effectively before the information society, have left their place to student-centered approaches such as Constructivism, Multiple intelligences, Cooperative learning and Brain-based learning (Özdemir, 2011). These approaches are based on the student's self-knowledge, questioning, discovery and knowing where to use the information (Çötük, 2006). Constructivism, one of these approaches, has started to form the basis of education programs in Türkiye since 2005 (MEB, 2005).

Constructivism is not what students learn and what teachers teach; It is a learning approach that focuses on how teachers teach and how students learn (Kim, 2005). In this approach, knowledge is not acquired, it is structured (Von Glasersfeld, 1989). In other words, Constructivism argues that knowledge should be subjectively Constructed by individuals rather than objectively transferring knowledge. The traditional understanding of education, which has continued been embraced for many years in Türkiye, has made it difficult for educators, families and students to adapt to contemporary approaches. Families are more interested in students' exam results rather than their self-concepts and learning strategies, and they evaluate the quality of the education given by the exams held in the country (Kim, 2005). On the other hand, teachers who receive education with traditional teaching approach cannot adapt to the education programs updated by considering student-centered models (Kim, 2002).

There are different teaching models based on the Constructivist approach. One of these models is the 5E model developed by Bybee (1993) for science fields. The 5E Model is one of the Constructivist approaches (Martin, 2006; Tinker, 1997). This model consists of five stages: engage, explore, explain, elaborate and evaluate. In the engage phase, the teacher reveals the students' prior knowledge and arouses curiosity in the students. At this stage, the teacher organizes activities and directs the students' prior knowledge to the new concept to be learned. In the explore phase, activities that facilitate students' conceptual change are carried out. They are provided to explore existing concepts. Students participate in lab

activities where they can explore new ideas and possibilities. In the explain phase, students reveal all the knowledge, skills and behaviors they have acquired. At this stage, students explain the concepts and knowledge they have acquired under the guidance of the teacher. In the deepening phase, teachers intensify students' knowledge, skills, and behaviors. With the additional activities provided, it is ensured that students have new experiences and develop more knowledge and skills. In the evaluation phase, while students evaluate their own learning, teachers evaluate how well students have achieved their educational goals (Bybee, 2009). Figure 1 shows the stages of the 5E model.

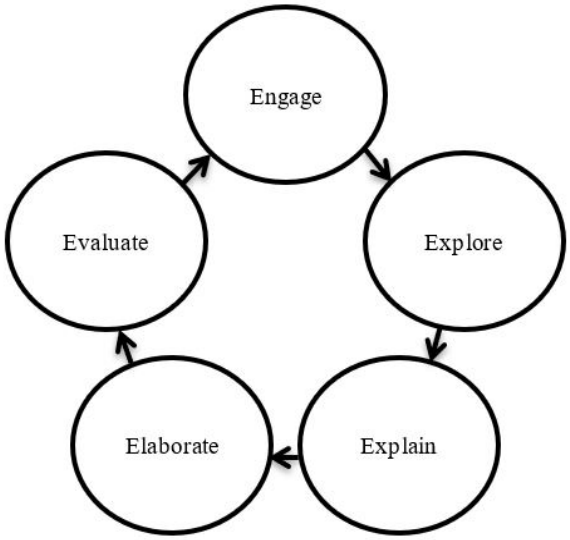

Figure 1. 5E Model and Stages

The 5E model enables students to be active and create their own concepts at every stage (Martin, 2006). This model enables learning a new concept or learning a known concept more meaningfully (Ergin, Kanlı, & Tan, 2006). 5E is a learning model that provides meaningful learning by establishing a link between new learning and previous learning, and where learned information can be used actively (Bıyıklı, 2013). The 5E model is a model that has applications in different teaching levels and different courses. Due to its wide usage area, different experimental studies have been conducted to examine the relationship between the 5E model and academic achievement. In these studies, conducted on different samples, different results were obtained in terms of the effectiveness of the 5E model. When the literature was examined, some meta-analysis studies that were carried out in different time periods were found. The results of these studies have shown that the 5E learning model increases academic achievement (Kozcu Çakır & Güven, 2019; Saraç, 2017; Yaman & Karaşah, 2018).

Board of Education in Turkey stated that the needs of individuals have changed, that the development in learning approaches has affected the roles of individuals and that individuals with high level of knowledge and skills should be raised. In this context, it has been stated that the education programs of all teaching levels have been updated (MEB TTKB, 2018). It is thought that the use of contemporary practices in the teaching process has become widespread with the change in the programs. In this sense, it is seen that the studies on the 5E learning model have increased. In recent years, no meta-analysis study investigating the effect of the 5E model on academic achievement has been found in Türkiye. This research is important to fill this gap in the literature. This research, which is considered important in terms of comparison with previous meta-analysis studies, includes the meta-analysis of studies investigating the effect of the 5E model on academic achievement between the years 2017-2021. For this purpose, answers to the following questions were sought.

1. What is the effect of the 5E model on the academic success of the students?
2. Does the effect size of the 5E model on academic achievement differ significantly according to the teaching level?
3. Does the effect size of the 5E model on academic achievement differ significantly according to the course type?

METHOD

In this study, the effect of the 5E model on students' academic achievement was examined. Meta-analysis method, one of the quantitative research methods, was used in the study. Meta-analysis provides a single result by bringing together the research findings on the same subject. (Cohen & Manion, 2001; Lipsey & Wilson, 2001). Thus, meta-analysis provides more reliable and clear results by providing inferences based on standard numerical data (Cohen et al., 2007).

Data Collection

In order to reach the studies to be used in the research, the databases of the Turkish National Academic Network and Information Center (ULAKBİM), ERIC, Google Academic and the Thesis Center of the Council of Higher Education were scanned. In addition, different studies have been reached by following the bibliography of the available studies. In order to reach the studies, the relevant databases were searched twice on 15 December 2021 and 20 February 2022. While searching the databases, the words "5E Model", "Constructivism", "academic success" were used as keywords. Studies in accordance with the criteria determined between

the years 2017-2021 were included in the study pool. These studies consist of Master's Thesis, PhD thesis and Articles on the 5E model.

Inclusion Criteria

Studies to be covered within the scope of meta-analysis are selected in line with certain criteria. The criteria for the studies included in the meta-analysis are given below.

- Studies include mean, standard deviation, and sample size values
- Studies conducted in Türkiye
- Studies were designed experimentally.
- Experimental and control groups were used together in the studies.
- Studies have been published in the National Thesis Center or in peer-reviewed academic journals.
- Studies contain sufficient statistical data.
- Studies have been carried out in the last 5 years.
- Studies consist of publications presented as open access.

Operating Characteristics

Study characteristics are the independent variables of the study. In order to evaluate the relationships between the effect sizes of individual studies, study characteristics are coded and used as explanatory variables (Agriculture, 2003). The study characteristics of this meta-analysis study are given below;

The teaching level in which the research was conducted: This category includes primary, secondary, high school and higher education dimensions.

The course in which the research was conducted: In this category, there are Geography, Biology Laboratory Applications II, Science, Physics 1, Chemistry, Mathematics, Science Teaching, Social Studies and Turkish dimensions.

Coding of Data

The information of the studies included in the research in the meta-analysis should be coded to convert them into quantitative data. The studies to be used in the meta-analysis were saved in an electronic file format with pdf extension and a common data pool was created. Later, the studies are listed in the Microsoft Excel worksheet in bibliographic format. The data obtained are grouped under two sections. In the first part, there are author information, publication year, publication type, type of material used, teaching level and course type. These

subheadings were categorized in columns in the Microsoft Excel sheet and the data of each category was coded into the relevant columns. In the second part, the sample number, arithmetic mean and standard deviation data of the experimental and control groups were coded in the relevant columns. In order to ensure coding reliability, the data were coded by two different experts. The codings created by two different experts were compared and it was determined that the inter-rater reliability was 97% (Miles & Huberman, 1994).

As in other studies, it is also important to ensure validity in meta-analysis studies. Studies included in the meta-analysis should be compatible in terms of both variables and methods (Başol & Johanson, 2009). In order to ensure external validity, it is necessary to code the study characteristics, test the homogeneity and search for the common effect size (Wolf, 1988). In internal validity, the effect of variation in study quality on meta-analysis results should be examined. High-quality studies included in the meta-analysis may yield low effect sizes. Low-quality studies can yield high effect sizes. It can also be stated that the quality of the study is not related to the effect size (Wolf, 1988). One of the important conditions in ensuring the validity of the research is the absence of publication bias in the selection of studies (Borenstein, Hedges, Higgins, & Rothstein, 2013). In this study, the funnel diagram and the Begg and Mazumdar rank correlation test were examined to reveal whether there is a publication bias (Dinçer, 2014; Duval & Tweedie, 2000).

Data Analysis

There are two different models in meta-analysis research, namely random effect and fixed effect. In the fixed effect model, it is assumed that the studies are homogeneously distributed, and the difference in the effect size between the studies is thought to arise only from the sampling error. In the random effect model, it is accepted that the studies are heterogeneously distributed, and it is thought that the effect size difference between studies may be caused by other randomly distributed variables in addition to sampling errors. (Cooper, 2010). For this reason, it is necessary to examine the variability (heterogeneity) between the data in model selection. In this study, the effect sizes of individual studies were calculated according to the Random Effects Model. The effect size, which can also be expressed as the effect coefficient, gives information about how the independent variable affects the dependent variable (Dinçer, 2014). Hedge's g was used to calculate the effect size and the significance level of statistical analyzes was determined as 95%. In order to express the effect level, Cohen's (1992) effect size classification was used. If it is:

- Between 0.20 and 0.49, small effect,
- Between 0.50 and 0.79, medium effect,
- Greater than 0.80, large effect

In this frame of reference, Comprehensive Meta-Analysis (CMA) program and Microsoft Excel 2010 Office program were used to find the effect sizes and variances of each study included in the meta-analysis and to compare the determined groups. Information on the studies included in the meta-analysis is presented in Table 1.

Table 1. Some Information on the Studies Included in the Research

Researchers	Field	Level	Experiment	Control	Total
Akaydın & Kaya (2018)	Social Studies	PS	16	16	32
Bayram & Kırbaşoğlu Kılıç (2017)	Turkish	MS	21	18	39
Büyükdede (2018)	Physical 1	HE	36	31	67
Ceylan (2017)	Geography	HS	34	32	66
Çeliksoy (2017)	Social Studies	MS	29	28	57
Çevik & Şahinkayası (2021)	Chemical	HS	29	30	59
Değirmençay & Hun (2020)	Science	MS	20	20	40
Demir & Emre (2020)	Science	PS	21	20	41
Erdoğan (2018)	Chemical	HS	20	22	42
Güneş (2021)	Chemical	HS	33	30	63
Gürleroğlu (2019)	Science	MS	23	25	48
Irak Kürkan (2019)	Science	MS	21	22	43
Işık Mercan (2017)	Geography	HS	38	34	72
İzgi & Kalaycı (2020)	Science	MS	25	25	50
Kardaş (2019)	Science	MS	15	15	30
Kırıktaş & Kesercioğlu (2021)	Bio. Lab. App.-II	HE	35	33	68
Kuzucu (2019)	Chemical	HS	30	30	60
Öner & Yaman (2020)	Science Teaching	HE	24	22	46
Özenç, Dursun & Şahin (2020)	Mathematics	PS	16	12	28
Tekdemir (2019)	Turkish	MS	20	21	41
Turgutalp (2021)	Science	MS	20	20	40
Ulukaya Oteles (2020)	Social Studies	MS	26	26	52
Yılmaz (2018)	Mathematics	MS	23	23	46

PS= Primary school; MS= Middle School; HS= High school; HE= Higher education

As seen in Table 1, twenty-three studies examining the effect of the 5E model on academic achievement were included in the meta-analysis. The study group of the research consists of 1130 people in total, 575 (50.88%) of the experimental group and 555 (49.12%) of the control group.

RESULTS

Meta-analysis studies, attempt to draw a general conclusion from the effect sizes of the individual studies included in the research. In this context, 23 experimental studies on the 5E model were included in the meta-analysis. The overall effect size was created by calculating the effect sizes of each of these studies. Analysis findings are presented in Table 2.

Table 2. Heterogeneity, Confidence Interval and Average Effect Size Values from Individual Studies

			95% Confidence Interval		Null Test		Heterogeneity	
Model	N	EB	Bottom Limit	Upper Limit	Z	P	Q	P
Fixed	23	0,981	0,857	1,104	15,534	,000	72,581	,000
Random	23	0,997	0,771	1,224	8,635	,000		

According to Table 2, the heterogeneity test is significant (Qmodel=72.581, df(Q)=23;p=.000). Effect size values were calculated as 0.981 for the fixed-effect model and 0.997 for the random-effects model. Since the random effect model was taken into account in the study, it is observed that there is a large effect value. The forest plot showing the effect sizes and confidence intervals of individual studies is given in Figure 2.

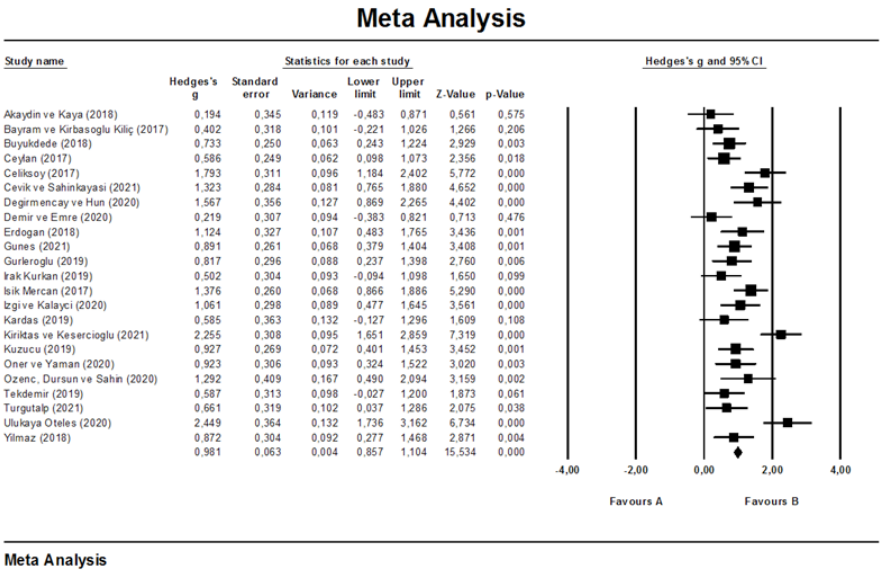

Figure 2. Forest Plot of Effect Sizes of Individual Studies

According to the forest plot shown in Figure 2, the highest confidence interval belongs to Özenç, Dursun, and Şahin (2020). The lowest confidence interval belongs to Ceylan (2019). Considering the weights of the studies, it is seen that the highest percentage of weight belongs to Ceylan (2021), while the lowest percentage of weight belongs to Özenç, Dursun and Şahin (2020). In the meta-analysis, publication bias is considered important in terms of the reliability of the results. In this sense, the funnel diagram that gives information about whether the research sample is biased is shown in Figure 3.

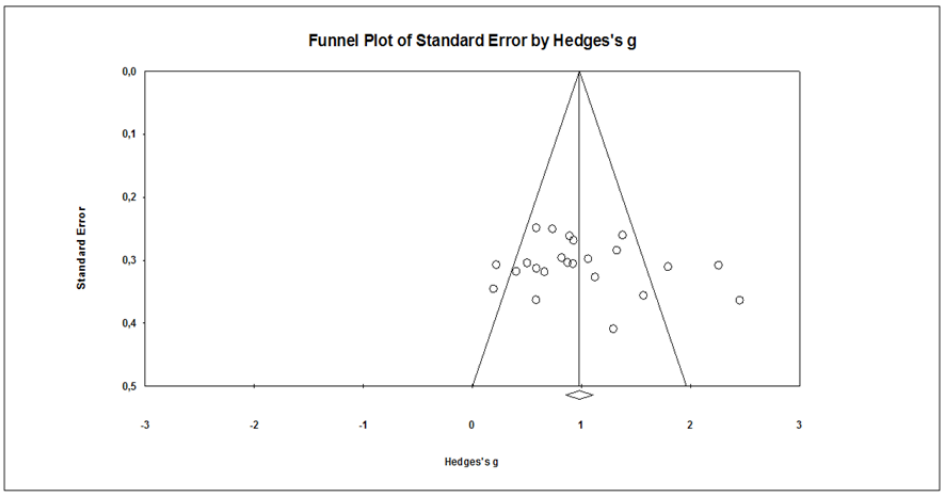

Figure 3. 5E Model-Academic Success Funnel Diagram

Looking at the funnel diagram shown in Figure 3, it is seen that 18 of the studies are between the axes and 5 of them are outside the axes. The fact that the funnel diagram is asymmetrical can be interpreted as a biased sample. In this study, although the sample showed a nearly symmetrical distribution, some of the studies were left out of the graph, giving the impression of publication bias. To learn more about publication bias, the Begg and Mazumdar rank correlation test was performed. If Kendall's tau b coefficient calculated as a result of this analysis is significant, it is understood that there is a publication bias. According to the results of the Begg and Mazumdar rank correlation, it is seen that there is no publication bias in the sample selection (tau b=.05; p>.05). In this sense, it can be said that the results of the analyzes are reliable. Heterogeneity in meta-analysis studies is interpreted as the studies included in the sample do not measure the same effect size. In these cases, subgroup analyzes are recommended. Within the scope of the research, the level and course in which the 5E model was applied were considered as moderator variables. The analysis findings regarding the moderator role of the course and the teaching levels in which the model is applied are given in Table 3.

Table 3. Moderator Role of The Course and the Teaching Levels in Which the Model is Applied

Moderator Variable	f	Effect Size	SH	Variance	%95CI		Qb	sd	p
					Bottom	Upper			
Teaching Level							2,446	3	0,485
Primary School	3	0,527	0,332	0,110	-0,124	1,178			
Secondary School	11	1,015	0,183	0,034	0,656	1,374			
High School	6	1,022	0,127	0,016	0,773	1,271			
University	3	1,294	0,469	0,220	0,375	2,214			
Courses							25,522	8	0,001
Geography	2	0,997	0,395	0,156	0,203	1,752			
Bio. Lab. Comp. II	1	2,255	0,308	0,095	1,651	2,859			
Science	7	0,761	0,158	0,025	0,451	1,071			
Physics 1	1	0,733	0,250	0,063	0,243	1,224			
Chemistry	4	1,051	0,141	0,020	0,774	1,327			
Mathematics	2	1,021	0,244	0,059	0,543	1,499			
Teaching Science	1	0,923	0,306	0,093	0,324	1,522			
Social Studies	3	1,477	0,650	0,422	0,204	2,750			
Turkish	2	0,496	0,223	0,050	0,059	0,933			

As seen in Table 3, when the studies are examined according to the teaching levels in which they are conducted, it is seen that the studies are carried out at primary school (f=3), secondary school (f=11), high school (f=6) and university (f=3) levels. When evaluated according to the teaching level, it was observed that the highest effect was 1,294 at the university level, and the lowest effect was 0.527 at the primary school level. It was observed that there was no significant difference between the effect sizes of the groups according to the education level (QB =2,446; p=>,001). This means that academic achievement does not differ significantly according to education level.

When the researches are examined in terms of the courses they are conducted, it is seen that the studies were carried out in Geography (f=2), Biology Laboratory Applications II (f=1), Science (f=7), Physics 1 (f=1), Mathematics (f=2), Science Teaching. (f=1), Social Studies (f=3) and Turkish (f=2) courses. When evalu-

ated according to the course variable, it was observed that the greatest effect was 2,255 in the Biology Laboratory Practices II course, and the lowest effect was 0.496 in the Turkish course. It was observed that there was a significant difference between the effect sizes of the groups according to the course (QB =25.522; p=<.001). This means that academic achievement differs significantly according to the courses.

CONCLUSION, DISCUSSION AND SUGGESTIONS

In this study, the meta-analysis of the effect of the 5E model on academic achievement was examined. Within the scope of the research, 23 studies were handled. When the publication bias of the studies included in the meta-analysis was examined, it was determined that there was no publication bias in the study and the research results were reliable. According to the random effects model of these studies, the overall effect size value calculated at the 95% confidence interval was determined as 0.997. This finding shows that the 5E learning model has an excellent effect on academic achievement. Findings of studies investigating the effect of the 5E model on academic achievement showed that teaching based on the 5E model increased academic achievement compared to traditional teaching. These studies included mathematics (Aygün, 2019; Çakar, 2018; Dağ, 2015; Sabahat, 2017), science (Balcı Çömez, Çavumirza & Yıldırım, 2021; Demir 2020; Ong, Govindasay, Salleh, Tajuddin, Rahman & Borhan, 2018; Zengin, 2016), biology (Kürkçü, 2016), Chemistry (Kuzucu, 2019), Physics (Bunkure, 2019), Social Studies (Ulukaya Oteles, 2020), Turkish (Tekdemir, 2019), German Education (Yalçın, 2020), Science Education (Öner & Yaman, 2020). Contrary to these studies, there are studies that did not find a significant relationship between the 5E model and academic achievement (Demir & Emre, 2020; Şahiner, 2013). However, in these studies, it was stated that the average of academic achievement was higher in the groups whose instruction was carried out with the 5E model. Studies generally show that teaching based on the 5E model increases student academic achievement. This very situation is thought to increase the reliability of the meta-analysis results.

In the research, the courses and teaching levels in which the studies were carried out were considered as moderator variables. In terms of courses; It was observed that there was a significant difference between the effect sizes of the groups according to the courses. It was observed that the greatest effect was in the Biology Laboratory Applications II course and the lowest effect was in the Turkish course. Yaman and Karaşah (2018) did not find a significant difference in their studies, which they examined according to Physics, Chemistry and Biology courses, and it was observed that the effect values were close to each other. In a similar study conducted by Kozcu Çakır and Güven (2019), they found significant differences

according to the course in which the 5E model was applied. It was stated that the greatest effect was in the Physics course, and the lowest effect was in the biology course. In this study, it was observed that the effect sizes of studies conducted in the field of social studies were higher than those in fields such as physics, chemistry and biology. In a meta-analysis study, Saraç (2017) found that the 5E model differed significantly according to the course to which it was applied, and stated that this difference was in favor of social sciences courses. Based on the research findings, although the 5E model was developed for science fields, it is believed to be an important model for increasing academic achievement in social fields as well (İlter & Ünal, 2014, Polat & Baş, 2012).

In terms of teaching levels, although the greatest effect was observed at the university level and the lowest effect was observed at the primary school level, no significant difference was observed between the effect sizes between the groups according to the level. Similarly, in their meta-analysis study, Kozcu Çakır and Güven (2019) stated that the highest effect of the 5E model on academic achievement was at the university level, and the lowest effect was at the primary school level, and the difference between the effect sizes was significant. In some studies, it has been stated that the highest effect is seen at the primary school level, and the lowest effect is seen at the university level, according to the level in which the 5E model is applied. However, it was stated that this result was not significant (Saraç, 2017; Yaman & Karaşah 2018). The research is limited to the articles published in scientific peer-reviewed journals in Türkiye between 2017-2021 and the master's and doctoral theses that have access to the YÖK national thesis center. Although studies show different results, 5E is thought to be a learning model that can be effective at all levels, including higher education. Based on the research findings, some suggestions are given below.

1. The application of the 5E model in social areas should be increased.
2. Faculty should be informed by field experts about the importance, function and application of the 5E model.
3. Studies should be carried out for teacher candidates to structure their field acquisitions in special teaching methods courses in accordance with the 5e model.

REFERENCES

Akaydın, B. B. & Kaya, S. (2018). The Effect Of 5e Model with And Without Animation on Students' Achievement and Attitude in Social Studies. *Kastamonu Education Journal, 26*(1), 171-179. http://dx.doi.org/10.24106/kefdergi.375723.

Aygün, İ. (2019). *The Effect Of 5e Learning Model on The Academic Success and Mathematics Self-Effic y Of 7. Grade Students in The Field of Alge-bra* (Unpublished Master›s Thesis). Ondokuz Mayıs University, Institute of Educational Sciences, Samsun.

Balcı Çömez, C., Çavumirza, E., & Yıldırımm, M. (2021). Investigation Of the Effect of Web 2.0 Supported 5e Learning Model on Students' Success and Opinion in Teaching Pressure Unit in Distance Education. *Participatory Educational Research*, *9*(1), 73-97.

Başol, G., & Johanson, G. (2009). Effectiveness Of Frequent Testing Over Achievement: A Meta-Analysis Study. *International Journal of Human Sciences*, *6*(2), 99-121.

Bayram, B. & Kırbaşoğlu Kılıç, L. (2017). The Effect Of 5e Model on Success and Permanency In 6th Grade Grammar Teaching. *Erzincan University Journal of Education Faculty*, *19*(1), 1-20. http://dx.doi.org/10.17556/erziefd.289948

Bıyıklı, C. (2013). *The Effect Of 5e Learning Model Designed According to Learning Experiences on The Science Process Skills, Level of Learning and Attitude* (Unpublished Doctoral Thesis). Hacettepe University, Social Sciences Institute, Ankara.

Borenstein, B., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2013). *Intro duction To Meta-Analysis* (Tr. S. Dinçer). Anı Publishing.

Bunkure, Y. I. (2019). Efficacy Of 5e Learning Strategy in Enhancing Academic Achievement in Physics Among Students in Rano Education Zone, Kano State, Nigeria. *Atbu Journal of Science, Technology and Education*, *7*(3), 296-304.

Büyükdede, M., & Tanel, R. (2018). Effect of the Stem Activities Related to Impulse Momentum Topics on Academic Achievement. Electronic Turkish Studies,13(27), 327-340. http://dx.doi.org/10.7827/turkishstudies.14283

Bybee, R. W. (1993). *Instructional Model for Science Education, in Developing Biological Literacy.* Colorado Springs, Co: Biological Sciences Curricu-lum Studies.

Bybee, R. W. (2009). A Commissioned Paper Prepared for A Workshop on Exploring the Intersection of Science Education and The Development Of 21st Century Skills. *The Bscs 5e Instructional Model And 21st Century Skills.* https://sites.nationalacademies.org/cs/groups/dbassesite/docu-ments/webpage/dbasse_073327.pdf

Ceylan, D. (2017). *The Effect of Context-Based Learning Approach Practiced in Geography Education in Parallel With 5e Model on Academic Success* (Unpublished Doctoral Thesis), Gazi University, Institute of Education Sciences, Ankara.

Cohen, J. (1992). Quantitative Methods in Psychology. *Psychological Bulletin, 112*(1), 155-159 https://doi.org/10.1037/0033-2909.112.1.155

Cohen, L., & Manion, L. (2001). *Research Methods in Education* (5th Ed.). New York: Rotledge Falmer.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education* (6th Ed.). Routledge.

Cooper, H. (2010). *Research Synthesis and Meta-Analysis: A Step-By-Step Approach*. Sage.

Çakar, S. (2018). *The Effect of the 5e Learning Model on the 8th Grade Students' Formation Of The Concepts Of Parity And Similarity In Triangles: An Action Research* (Unpublished Master's Thesis). Eskişehir Osmangazi University, Institute of Education Sciences, Eskişehir.

Çeliksoy, F. (2017). *The Effect Of 5's Model in Social Studies Course on Students'academic Achievement and Their Views About the Course* (Unpublished Master's Thesis), Gazi University, Institute of Education Sciences, Ankara.

Çevik, M., & Şahinkayası, Y. (2021). Effect Of Problem-Solving Software Developed With 5e Model on Success of Students' States of Matter. *Mustafa Kemal University Journal of Social Sciences Institute*, *18*(47), 92-116.

Çötük, N. A. (2006). *The Phenomenon of Education in The Transition from Industrial Society to Information Society* (Unpublished Master's Thesis). Sakarya University, Social Sciences Institute, Sakarya.

Dağ, T. (2015). *The Effect of Activities Prepared with Reference To 5e Learning Cycle Model on Secondary School 1st Grade Students' Academic Achievement in Mathematics Lesson About Fractions* (Unpublished Master's The-sis). Gazi University, Institute of Education Sciences. Ankara.

Değirmençay, Ş. A., & Hun, F. (2020 Effect Of 5e Teaching Model Supported by Problem Based Learning on The Achievement and Attitude. *International Journal of Society Researches*, *16*(29), 1689-1717.

Demir, N. (2020). *Effects Of 5e Learning Model in Teaching Astronomy Topics on Academic Successes and Attitudes of Seventh Class Students* (Unpublished Master's Thesis). Sakarya University, Social Sciences Institute, Sakarya.

Demir, Y., & Emre, İ. (2020). The Effect of Learning Activities Based On 5e Learning Model On 4thgrade Science Teaching. *Mersin University Journal of The Faculty of Education*, *16*(3), 573-586.

Dinçer, S. (2014). *Applied Meta-Analysis in Educational Sciences.* Ankara: Pe-gem Akademi.

Duval, S., & Tweedie, R. (2000). Trim And Fill: A Simple Funnel Plot Based Method of Testing and Adjusting for Publication Bias in Meta-Analysis. *Biometrics*, 56(2), 455-463.

Erdoğan, M. N. (2018). Using 5e Strategies in The Jigsaw Classroom Environment to Teach Periodic System of Elements. *Mediterranean Journal of Educational Research*, *12*(24), 98-119. https://doi.org/10.29329/mjer.2018.147.6

Ergin, İ. (2012). A Directory of Written Resources About The 5e Model in Science Education. *Journal Of Research in Education and Teaching*, *1*(1), 53-67.

Ergin, İ., Kanlı, U., & Tan, M. (2007). To Examine the Effects Of 5e Model on The Students' Academic Success in Physics Education. *Gazi University Journal of Gazi Education Faculty*, *27*(2), 191-209.

Güneş Koç, R. S. & Sarıkaya, M. (2020). The Effect Of 5e Learning Model and Context-Based Teaching Approach on Success and Persistence of Knowledge on The Unit Light. *E-Kafkas Journal of Educational Research*, 7(3), 430-457. http://dx.doi.org/10.30900/Kafkasegt.828542

Gürleroğlu, L. (2019). *The Effect of Using Web 2.0 Applications in Accordance*

With 5e Model in Teaching "Force and Energy" Unit on The Academic Achievement, Motivation, Attitudes and Digital Literacy (Unpublished Master's Thesis). Marmara University, Institute of Education Sciences, İstanbul.

Irak Kürkan, E. (2019 Effects on The Learning Outcomes of Science Instruction Based on Socioscientific Issues To The 7 Th Grade Students (Unpublished Master's Thesis). Trakya University, Institute of Science, Edirne.

Işık Mercan, S. (2017). 5e Geography Course of Activity Based on Learning Model Effect of Learning Environment on The Community Process. *Jour-nal Of World of Turks/Zeitschrift Für Die Welt Der Türken*, *9*(3), 161-176.

İlter, İ. & Ünal, Ç. (2014). The Effect of The Activities Based On 5e Learning Cycle Model on Learning Process in Social Studies Teaching: An Action Research. The Journal of Türkiye Social Research*, 181*(181), 295-330.

İzgi, S., & Kalaycı, S. (2020). The Effect of The Stem Approach Based on the 5e Model on Academic Achievement and Scientific Process Skills: The Transformatıon of Electrıcal Energy**.** *International Journal of Education Technology and Scientific Resea ches, 12*(5), 1578-1629.

Kardaş, S. (2019). *Examining The Effects of Scientific Stories on The Academic Success Understanding the Nature of Science and Writing Anxiety of 6th Graders in Terms of Cell and Organelles* (Unpublished Master›s Thesis). Marmara University, Institute of Education Sciences, İstanbul.

Kırıktaş, H. & Kesercioğlu, T. (2021). The Effect of Inquiry-Based Science Teaching on Preservice Teachers' Scientific Process Skills, Academic Achievement and Attitudes Towards Laboratory. *Journal Of Academia Educational Research ,6*(1), 78-92.

Kim, J. S. (2005). The Effects of a Constructivist Teaching Approach on Student Academic Achievement, Self-Concept, And Learning Strategies. *Asia Pacific Education Review* , *6*(1), 7-19.

Kim, J. S. (2002), The Effects of Teacher Training as Constructivist on Teacher Behavior and Student Achievements. *Faculty Research Papers on The Study of Education*. 18(2) Educational Development Research. Institute, Chungnam National University.

Kozcu Çakır, N. & Güven, G. (2019). Effect Of 5e Learning Model on Academic Achievement and Attitude Towards the Science Course: A Meta-Analysis Study. *Cukurova University Faculty of Education Journal*, *48* (2), 1111-1140.

Kuzucu, G. (2019). *Teaching The Subject of Tendency of Periodic Features Change with Inquiry Based Learning* (Unpublished Master's Thesis). Balıkesir University, Institute of Science, Balıkesir.

Kürkçü, E. (2016). *The Affect Of Teaching "Cell Is The Basic Unit Of Life" Subjects According To 5e Model On Students Success And Attitudes* (Unpublished Master›s Thesis). Gazi University, Institute of Education Sciences, Ankara.

Lipsey, M. W., & Wilson, D. B. (2001). *Practical Meta-Analysis.* Thousand Oaks, Ca: Sage.

Martin, D.J. (2006). Elementary Science Methods. A Constructivist Approach. *Thomson Higher Education* 10. Belmont: Davis Drive.

Meb (2005). Elementary 1-5. Classroom Program Introduction Handbook. Ankara: State Books Directorate Publishing House.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* Thousand Oaks, California: Sage.

Ong, E. T., Arumugam, G., Sabri, M. S., Nor'ain, M. T., Nurulhuda, A. R., & Mohamad Termizi, B. (2018). 5e Inquiry Learning Model: Its Effect on Science Achievement Among Malaysian Year 5 Indian Students. *Internation-al Journal of Academic Research in Business and Social Sciences*, *8*(12), 348-360

Öner, Y. E., & Yaman, S. (2020). The Effect of Simulation and Animation Supported 5e Model on Science Achievement and Motivation of ProspectiveClassroom Teachers. *Turkish Journal of Primary Education*, *5*(2), 183-193.

Özdemir, S. M. (2011). Education And Curricula Within the Context of Social Change and Globalization: A Conceptual Analysis. *Ahi Evran University Journal of Kirsehir Education Faculty, 12*(1), 85-110.

Özenç, M., Dursun, H., & Şahin, S. (2020). The Effect of Activities Developed with Web 2.0 Tools Based on the 5e Learning Cycle Model on The Multiplication Achievement Of 4th Graders. *Participatory Educational Research*, *7*(3), 105-123.

Polat, S. Ve Baş, G. (2012). Effect Of 5e Constructivist Learning Model on Students' Academic Achievement Level in Social Studies Course. *Çankırı Karatekin University Journal of Social Sciences Institute 3(2),* 69-92.

Sabahat, B. A. (2017). The Effect of Linear Equation Systems and Inequalities on The Mathematical Success of the 8th Grade Students of The 5e Learning Cycle Modeling Process (Unpublished Master's Thesis). *Gazi* University*,* Institute of Education Sciences*, Ankara*.

Saraç, H. (2017). The Effect Of 5e Learning Model Usage on Students' Learning Outcomes: Meta-Analysis Study. The *Journal of Limitless Education and Research*, *2*(2), 16-49.

Şahiner, A. (2013). *The Effect Of 5e Model in Acqusition and Permanance on The Subject of Sets in Math Class Of 6th Grade's* (Unpublished Master's Thesis). Gaziantep University, Institute of Education Sciences, Gaziantep.

Şişman, M. (2002). *Introduction to Teaching.* Pegem Publishing.

Tarım, K. (2003). *Effectiven ss Of Cooperative Learning Method on Teaching Mathematics and Meta Analytic Study for Cooperative Learning Method* (Unpublished Doctoral Thesis). Çukurova University, Fen Bilimleri Enstitüsü, Adana.

Tekdemir, N. (2019). *The Effect of the 5e Teaching Model on Reading Attitude Reading Anxiety and To Understand What You Read of Secondary School Students* (Unpublished Master's Thesis). Kütahya Dumlupınar University, Institute of Education Sciences, Kütahya.

Tinker, R. (1997). Thinking About Science. Concord: The Concord Consortium Educational Technology Lab, M.A.

Turgutalp, E. (2021). *Stem Teaching the Subject of Pressure in Eighth Grade – A Study of The Implementation of The Learning Model's Impact on Students' Success and Entrepreneurial Skills* (Unpublished Master›s Thesis). Bursa Uludağ University, Institute of Education Sciences, Bursa.

Ulukaya Oteles, U. (2020). A Study on The Efficiency of Using 5e Learning Model in Social Studies Teaching. *International Online Journal of Educational Sciences*, *12*(4), 111-122.

Von Glasersfeld, E. (1989). Cognition, Construction of Knowledge and Teaching. *Syntheses*. *80*(1), 121-140

Wolf, F. M. (1988). *Meta-Analysis Quantitative Methods for Research Synthesis* (3rd Ed.). Sage Publications.

Yalçın, C. (2020). The Effects of Games Developed According To 5e Teaching Model on The Development of Language Skills in German Preparatory Classes. *Journal Of Rumelide Language and Literature Studies*, (20), 493-508.

Yaman, S., & Karaşah, Ş. (2018). Effects Of Learning Cycle Models on Science Success: A Meta-Analysis. Journal Of Baltic Science Education, 17(1), 65.

Yılmaz, A. (2018). *The Influence of 5e Model Supported by Concept Cartoons Application on the Attainment of Mathematics Achievement, Learning Performance and Attitutes of Middle School Students* (Unpublished Master›s Thesis). Bartın University, Institute of Education Sciences, Bartın.

Zengin, E. (2016). *The Effects of Teaching with the 5 E Learning Model On The Academic Success Of Middle School, 8th Grades In The Subject Of Cell Divisions* (Unpublished Master's Thesis). Atatürk University, Institute of Education Sciences, Erzurum.

ELECTRONIC REFERENCES

URL-1 https://

ttkb.meb.gov.trmeb_iys_dosyalar/2017_07/18160003_basin_aciklamasi-program.pdf