Effectiveness of the Constructivist Approach to Learning: A Mixed-Meta Method Study

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Abstract

In this study, the aim is to examine the effectiveness of the constructivist approach involving the use of the mixed-meta method. Quantitative (meta-analysis) and qualitative (meta-thematic analysis) study findings were obtained by conducting a literature review in the context of the mixed-meta method. This consisted of examining the research topic in two dimensions by executing meta-analysis and meta-thematic analysis and producing comprehensive results. Quantitative studies browsed in accordance with certain criteria and searched in certain databases were analysed with the use of the MetaWin and CMA 2.0 programs, and moderator analyses involving such aspects as course areas, teaching levels, application duration and sample size were also carried out. As a result of the analyses, it was understood that the effect sizes of the studies were at a large level in terms of academic achievement and relevant moderators. Qualitative studies, on the other hand, were analysed with the use of the Maxqda program. It was seen that the themes relating to the relationship of the constructivist approach with technology, cooperation and 21st century skills, problems in related applications, and solution suggestions, were generated. The qualitative findings also showed that the the constructivist approach had huge effect. These results indicated that constructivist practices had a positive effect in terms of different levels, course areas, application duration and samples within the frame of a general context, and had a favourable effect on learning outcomes.

Introduction

In a rapidly changing and developing world, the need for individuals who can cope with the innovations and changes in the education system, are aware of their responsibilities and try to consciously fulfil their duties in the most effective way, is increasing day-by-day (Erdem & Demirel, 2002). The survival of human beings necessitates struggle and self-renewal. It is known that people have physiological needs such as nutrition and shelter. Similarly, education can be considered as a social need (Dewey, 1996). However, individuals active within the world of education need to adapt to change, become entrepreneurs and take responsibility for their actions. Changes that may occur in social life, in the cultural context and in inter-communal relations may make it necessary to renew and change the interests and needs of individuals and therefore those of society (Ertürk, 1981).

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In recent days, due to the Covid-19 pandemic, the transition from face-to-face classroom teaching to synchronous and asynchronous online teaching (Hrastinski, 2008), preparing online learning materials (Hermanto & Srimulyani, 2021), how to use educational institutions, online learning platforms and video conferencing software efficiently (Agopian, 2022), show the necessity of adapting to innovation and change. However, individuals do not expect to be guided in terms of how to adapt to the outside world. Rather, they have to actively participate in the process of structuring themselves. In fact, the individual should interpret and make sense of new and changing information on a personal basis (Yıldırım & Şimşek, 1999). At this point, it should be stated that there is a constant change in the interests and needs of individuals in social life, and that individuals need to renew themselves effectively in line with the new experiences they encounter (Abbott & Ryan, 1999). In the process of keeping up with these changes and innovations, it is important for individuals to harmonize information in their own way, without the need for shaping or directing. In the constructivist approach, it is precisely in this way that individuals can interpret, construct and make information meaningful in themselves, as a result of their active participation in the process of acquiring knowledge. At this point, Doğanay and Sarı (2012) stated that effective environments for teaching thinking can be created in classrooms organized along the lines of a constructivist approach. In addition, the literature shows that an understanding of this approach helps to improve attitudes and behaviours in the learning process (Ural & Bümen, 2016), and in term of achievement status and knowledge construction (Chuang, 2021; Çetin & Günay, 2007), and to improve the meaningful learning process and critical thinking levels (Zajda, 2021) by a scanning of the literature. However, in some research results, it can be seen that constructivism does not make a significant difference compared to traditional learning approaches (Saygılı, 2010; Uzun, 2010). In this context, encountering different results with regard to the subject under consideration necessitated the examination of this subject in all its dimensions, and the examination of related studies carried out both quantitatively and qualitatively. A statistical evaluation of studies and an analysis of participant views on the effectiveness of constructivism are important in terms of clarifying and elaborating the existing information on the subject, and seeing the whole picture. In addition, since the studies involved are carried out in terms of different variables, methods and samples, the results may differ, be contradictory, or be consistent with each other. However, studies involving a small sample are not expected to produce definitive and comprehensive results with regard to the research topic. Consequently, instead of conducting more research, it would be meaningful to see the whole picture by bringing together the results of the existing studies. In the current study, it is planned to obtain detailed information and achieve holistic results about the constructivism approach with the use of the mixed-meta method (meta-analysis + meta-thematic analysis).

Constructivist Approach

The constructivist approach has undoubtedly emerged as one of the most influential philosophies in education in the 21st century. Constructivist learning theory tries to make use of recent developments in cognitive psychology and how people learn. The proponents of this learning theory claimed that learning takes place in a process that includes the foundations of prior knowledge, and that learning is therefore fed by new experiences and ideas. Although we have heard its name more often recently, the constructivist approach has a venerable history. This concept is encountered in Jean Jacques Rousseau's (1712-1778) famous work Emile, in some important writings of John Dewey, in the learning by discovery model, and in many other places in education (Krahenbuhl, 2016). At the core of constructivist understanding is the active learning of students (Richardson, 2003), and the structuring and application of knowledge. This approach, which is not seen as a learning theory alone, can be evaluated as a philosophical perspective on how the concepts of understanding and knowing are realized (Savery & Duffy, 1995). The constructivist approach (McCarthy, 1994), which is accepted as a dominant learning approach in contemporary learning environments, has also influenced school textbooks (Thompson, McLaughlin, & Smith, 1995) and has demonstrated its effectiveness in the field of education. While the power authority platform traditionally reserved for the teacher as the primary information source has a decentralized structure, constructivism, which gives students the autonomy to use their own operations and exchanges (Saylan, Armağan, & Bektaş, 2016), allows learners to transfer knowledge, reinterpret existing knowledge, and create new knowledge instead of simply memorizing facts. It can be considered to be a cognition-based theory (Perkins, 1999).

In the constructivist approach, there is an active participation on the part of the student in their own learning, in a way that allows them to construct information instead of merely transmitting it. In this context, constructivism, which has common features with social learning, introduces a theoretical approach with regard to how individuals learn and how they process and construct information. According to educational theorist Wenger (2009), the individual participates in the learning process by interacting with the environment. In this context, how the mental structure is formed as part of this interaction is important. Therefore, the constructivist approach is closely related to learning based on experience and discovery, and the learner must personally construct the knowledge he encounters (Kacmaz & Dubé, 2022). At this point, simply receiving information is not the same as mentally structuring it. In this case, previously-created rules are used while trying to understand information encountered for the first time; however, new rules are created for different/new information (Brooks & Brooks, 1993). Acting differently for existing and newly-encountered information is an active process in constructivist learning that enables students to create new meanings by reconciling their existing knowledge with new ideas (Naylor & Keogh, 1999). In order for new ideas to have an integrative and effective place in the student's memory, the student should create the inferences, details and associations between existing understandings and the new ones. Information that cannot be associated with the current life of the student can be as easily forgotten as can memorized material (Arslan, 2007). In other words, it can be stated that information gains meaning through the stages of seeing, comprehending, associating it with existing information, and adding to it.

Designing content in line with the constructivist approach in education systems is an important task for teacher educators. However, teachers using this approach also need to create situations for students to actively solve problems, develop their own ideas about topics based on their previous knowledge, and focus on broad concepts, rather than engage in specific stereotypical skills (Fosnot, 1995). According to Brooks and Brooks (1993), constructivist learning activities involve students learning meaningfully (rather than memorizing facts), solving problems creatively (rather than following procedures), and investigating complex problems (rather than repeating culturally-accepted beliefs). Therefore, in the constructivist learning approach, it is important for educators to consider situations that include learning experiences and for them to respond to students' needs (cognitive, social, physical, emotional) during the curriculum development process. In the constructivist approach, the physical involvement of students in the learning process through "exploration", "inquiry" and "collaboration", brings to mind the interpretation that this approach may be good for all situations. In the application dimension, the learning process in accordance with the constructivist understanding should work. At this point, educators who teach factual knowledge have been criticized in Paulo Freire (1996)'s book (Pedagogy of the Oppressed). It was stated that these people only filled students with 'content detached from reality'. Fortunately however, in recent years such dominant and subordinated individuals have not been found in significant numbers in the education system (Krahenbuhl, 2016). Instead, it has recently been noted that teacher educators attach importance to inquiry-based problem solving, instructional grouping, and project-oriented activities (Wiggins & McTighe, 2005).

The constructivist philosophy of pedagogy has dominated the teaching and learning fields for nearly the whole of the 20th century (Tobias & Duffy, 2009). In some studies, it is suggested that practitioners may adopt constructivism, but do not fully implement it (Wiersma, 2008). In some studies (Barnes & Marlatt, 2022; Kosnik, Menna, Dharamshi, & Beck, 2018), it has been understood that the planned constructivist practices that are implemented as they should be in the learning environment are consistent with constructivist principles, and learning environments that provide cooperation between students can be created through social interactions. It was seen that different results were obtained in different studies, and it was necessary to conduct a general survey of the literature at this point in time, and to examine the results of both quantitative and qualitative studies on the constructivist approach in terms of different variables. However, in today's educational environments, the need for teachers to move away from "passive learning environments" and move towards more "student-centred learning environments" emerges as a clear reality. Constructivism will undoubtedly have an increasingly-profound impact on environment in education ambient, with greater incorporation of constructivist ideas into teacher training and assessment systems and into general education discourses.

Purpose and Significance of the Study

In the relevant literature, it has been seen that the constructivist approach can be applied in different courses and disciplines, and generally positive results have been obtained. However, the aim of this study is to draw general conclusions by examining the different results obtained in various studies in detail. In addition, it has been thought to integrate the data about the effects of constructivist practices in terms of different courses, application duration, teaching level and sample size, and to examine the opinions of the participants who teach using the constructivist approach. In this framework, the inadequacy of research based on presenting the results of qualitative and quantitative studies, as in the current research, suggested the idea of filling this gap in the literature. Therefore, the aim is to achieve broad results by bringing together the qualitative and quantitative findings of the studies under consideration. At this point, the aim is to bring the studies together in terms of common denominators by using the mixed-meta method, which includes the presentation of research results by combining meta-analysis and meta-thematic analysis.

In this context, in the current study, within the framework of the main purpose of determining the effectiveness of practices based on the mixed-meta method and the constructivist approach, the following research questions were addressed:

1. In the studies included in the meta-analysis;

    a. What is the overall effect size of the practices based on the constructivist approach?

    b. What is the effect size of the constructivist approach in terms of teaching level, course area, application duration and sample size?

2. Within the scope of the meta-thematic analysis, what are the effects of constructivist approach practices according to the participants' views?

Method

In order to determine the effectiveness of the practices based on the constructivist approach in the general context, this study was carried out using the mixed-meta method which includes a two-stage process. Specifically, a mixed-meta method was used to determine the effectiveness of constructivist approach-based practices, using meta-analysis in terms of a quantitative scope, and meta-thematic analysis in terms of a qualitative scope. The mixed-meta method includes the analysis of the quantitative and qualitative data obtained with a focus on document review, and involving a holistic perspective. The mixed-meta method can be explained as a broad and rich method that includes combining both groups of data within the scope of a single study by using statistical programs such as CMA/MetaWin, and qualitative data by using programs such as Nvivo/Maxqda (Batdı, 2020a, 2021; Batdı, Öztaş, & Talan, 2021). At this point, when the term mixed-meta is used, a method that presents combined data formulated as meta-analysis (quantitative) + meta-thematic analysis (qualitative) should come to mind. While conducting research using the mixed-meta method, the studies selected for analysis should be of high scientific quality, published or accepted for publication. The methodological process of this research, which was carried out with the mixed-meta method, is presented below, with a detailed explanation of the processes carried out under two main headings in the form of meta-analysis and meta-thematic analysis.

Meta-analysis Process

In the context of the first stage of the mixed-meta method, the meta-analysis process was used to determine the effect of constructivist approach practices on student achievement. Meta-analysis involves converting the findings of similar studies conducted in a certain field into a standard unit of measurement in a consistent way, to calculate the effect size values, and to combine these values and compare them (Becker, 2000; Cohen, Manion, & Morrison, 2002). It is stated that great statistical power is obtained by combining the independent studies considered in the meta-analysis process into a single study (L'Abbe, Detsky, & O'Rourke, 1987). In addition, in using meta-analysis, it has been stated that the limitations of individual studies are removed, and that comparative and objective results can be obtained by combining individual studies (Cooper, Hedges, & Valentine, 2009). Therefore, it can be stated that the results of many independent studies are richer, more comprehensive and more generalizable than the results of a single study.

Data Collection

Studies in the literature conducted on practices based on the constructivist approach were carried out in English and Turkish, using the keywords "constructivist approach/learning/theory". In this process, searches were made from with regard to the Council of Higher Education, Google Scholar, Web of Science, Taylor & Francis Online, Science Direct, ProQuest Dissertations & Theses Global databases. At this point, a screening was carried out in accordance with the inclusion criteria presented in Table 1.

Table 1. Inclusion Criteria in the Meta-analysis Process

Criteria	Explanations
Time Interval	Studies carried out between 2005 and 2021
Publication Language	English and Turkish
Appropriateness of Teaching Method	Experimental and/or quasi-experimental studies with pretest-posttest control groups using constructivist approach applications
Study Data Sources	Articles in academic journals, and Master's and Doctoral theses.
Statistical Data	Statistical data in the form of sample size (n), arithmetic mean (X) and standard deviation (sd) required for effect size calculation

Table 1 lists the inclusion criteria used in the selection of studies suitable for meta-analysis. Consequently, studies which did not meet these criteria were excluded from the analysis. In this context, studies that did not have access permission, did not contain quantitative data, did not contain data necessary for analysis, registered in more than one database, and did not include an experimental process were excluded from the analysis. In this process, the number of studies included/excluded from the analysis and the reasons for exclusion are given in Figure 1 in the PRISMA flow diagram (Moher, Liberati, Tetzlaff, Altman, & Prisma, 2009).
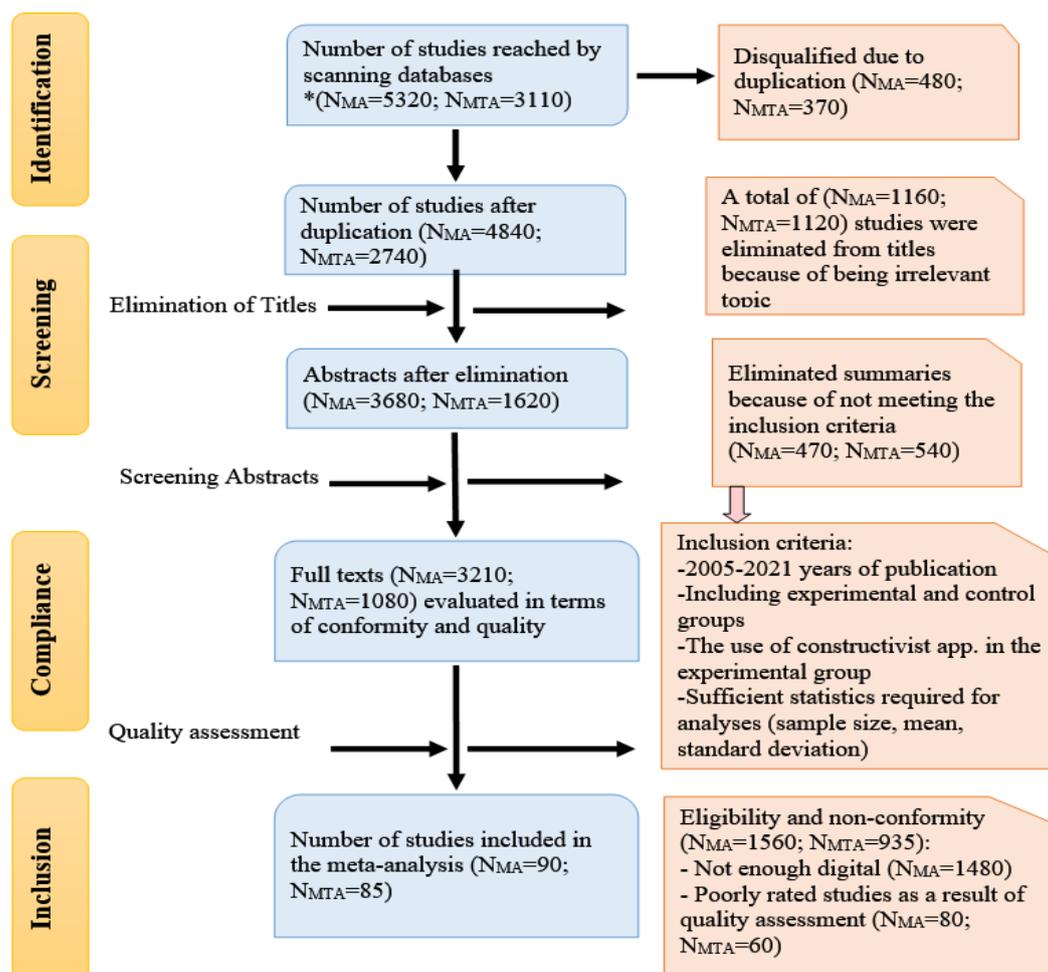
Figure 1. Studies Included in the Analysis

As presented in Figure 1, as a result of scanning the databases, n=5320 studies were found in the first search to examine the effects of constructivist approach applications on academic success. In terms of meta-analysis (N_{MA}), 480 of these studies were eliminated due to duplication, 1160 of them for dealing with unrelated topics, and 470 of them due to inappropriate content as a result of a reading of the abstract. It was decided to exclude 3120 of the remaining 3210 studies from the analysis process due to their inappropriateness in terms of inclusion criteria (N_{MA}=1560), insufficient data (N_{MA}=1480) and insufficient scientific quality (N_{MA}=80). It is thought that the achievement of good and high quality results in terms of the research depends on the quality of the studies included in the analysis. For this reason, attention was paid to quality assessment in the inclusion criteria. At this point, Mack (2012) stated that studies contribute to the formation of meaningful results by increasing the readability and comprehensibility of unbiased and regular presentations. In this respect, the qualities of the studies should be evaluated according to some pre-determined characteristics (Greenland & O'Rourke, 2001). As can be seen in Figure 1, 90 studies were included in the meta-analysis. In addition, within the scope of the meta-analysis, the reliability calculation between the evaluators was made using the reliability formula [consensus / (consensus + dissensus) x 100] suggested by Miles and Huberman (1994). As a result, the reliability of the study was found to be 92%.

Data Analysis

Transactions made within the meta-analysis framework were analysed using the MetaWin and CMA 2.0 programs. The effect size (Hedges g) value obtained as a result of the analyses was interpreted by considering Thalheimer and Cook (2002)'s effect level classification. Value ranges for the relevant effect size classification: - 0.15 ≤ Cohen d < 0.15 insignificant, 0.15 ≤ Cohen d < 0.40 at a minor level, 0.40 ≤ Cohen d < 0.75 at a moderate level, 0.75 ≤ Cohen d < 1.10 at a large level, 1.10 ≤ Cohen d < 1.45 at a very large level, 1.45 ≤ Cohen d at an excellent level. In addition, the data obtained in the analyses were evaluated and interpreted according to the random effects (REM) model. Schmidt, Oh, and Hayes (2009) stated that the conditions in which the fixed effects model (FEM) can be used are very limited, and stated that the REM is more appropriate. Therefore, the REM was used in the present study.

Moderator Analysis

The I^2 value was found to be 87.02 in the heterogeneity test calculations made with the meta-analysis of the studies related to the constructivist approach applications. This value revealed that the current study can be examined in the context of various variables, apart from the overall effect size of academic achievement. At this point, it is stated that high heterogeneity can be seen at values of 75% and above (Cooper et al., 2009). The studies based on constructivist approach applications were examined with regard to teaching level, duration of application, course area and sample size to find out with regard to which grade, subject, duration or sample, the constructivist approach has more effective results.

Reliability in Meta-analysis

Reliability is an important issue in meta-analysis studies. In such studies that involve calculating the effect size, generally using published studies and/or studies with significant differences in them, raises the issue of publication bias. For this reason, some calculations are made in order to answer the question as to whether or not there is publication bias in meta-analysis studies. In Figure 2 below, the graphic results of three different reliability calculations with regard to this subject are shown.
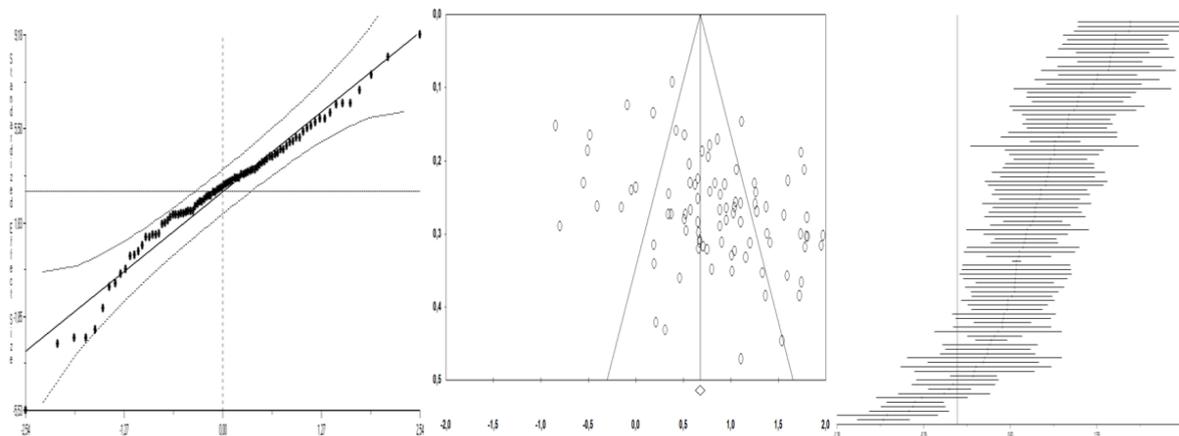

Figure 2. Normal Quantile Plot, Funnel Plot and Effect Size CI Plot

Figure 2 shows the funnel plot (Funnel Plot), which is considered to be a visual summary of the meta-analysis data set (Cooper et al., 2009) and shows the possibility of publication bias. The relevant situation calculated with the CMA analysis program can usually show the deviations in the calculated effect size (Borenstein & Higgins, 2013). In addition, the results of Normal Quantile Plot and Classic Fail-Safe N were examined to determine the extent of publication bias in the study, with the results being shown. As a result of the FS_N calculation, it was understood that if 27488 studies on the effect of constructivist approach applications on academic achievement scores were included in the analysis, the significant effect would decrease to zero. Considering that these values are extremely high in the framework of the research, and it is thought that too many studies are required to be considered, it can be said that there is no publication bias (Cheung & Slavin, 2016), and therefore the procedures used in

the analysis process are reliable. On the other hand, when we look at the normal quantile plot table in Figure 2, which is obtained using the MetaWin analysis program, it can be seen that the studies included in the analysis are between two lines, which indicates that the distribution of the effect size levels of the studies is in the reliable range (Rosenberg, Adams, & Gurevitch, 2000). Finally, when looking at the effect size CI plot values, it can be seen that there is good agreement between the study data. In this case, it can be said that the analyses related to the constructivist approach applications are generally within the reliable range.

Meta-thematic Analysis Process

Within the scope of the mixed-meta method, the meta-thematic analysis process was carried out as the second step in the current research. Meta-thematic analysis can be explained as a type of analysis based on extracting themes and codes by re-analysing participant views (raw data) in qualitative studies on a certain subject focused on document analysis (Batdı, 2020b). Re-analysing the qualitative data in the studies published in this way, and presenting the findings by combining them, provides results from a more comprehensive and holistic perspective than is available individually. In addition, the most distinctive feature of the meta-thematic analysis process is that it aims to obtain results with a high level of reliability by focusing on the raw data in the studies (Batdı, 2019). When evaluated in the context of the mixed-meta method, the comparison of meta-analysis and meta-thematic analysis findings allows the different and common results of the constructivist approach to be presented in all aspects.

Data Collection and Analysis

Qualitative studies on constructivist approach applications were collected based on document analysis. These studies were selected by pre-reading, reviewing, first reading, and full-text readings. After reading the title, the short summary and the extended summary, the review process was completed. Based on this it was decided whether or not to include a particular piece in the research by examining the findings section. In addition, as stated in PRISMA, it was decided to select the studies at the end of a 4-stage process. In the final stage, a quick full-text reading of the remaining work is also done. In the context of meta-thematic analysis in the PRISMA diagram in Figure 1, 370 of the N_{MTA}=3110 studies on the effectiveness of the constructivist approach were excluded from the analysis due to duplication, 1120 due to being unrelated topics, and 540 due to inappropriate content as a result of the summary review. When the remaining 1080 studies were evaluated for reasons such as not being of a qualitative type within the framework of the inclusion criteria of the research, not including participant opinions, not including data on the effectiveness of the constructivist approach (N_{MTA}=935) and being of insufficient scientific quality (N_{MTA}=60), 995 studies were excluded from the analysis. As a result, 85 studies were included in the meta-thematic analysis.

Data were collected based on document review. This type of review is a systematic and planned process that enables detailed examination of printed/electronic materials, makes use of the information contained in the documents, and gives meaning to this information (Corbin & Strauss, 2008) or includes the analysis of written materials that contains information about the facts intended to be investigated (Yıldırım & Şimşek, 2018). The data obtained in this way were analysed in terms of content analysis, and the MAXQDA program was used. Content analysis is an analytical approach that involves the systematic examination of analyses based on impression, intuition and interpretation and makes textual inferences (Sandelowski, 1993). In this context, different themes and codes were created by re-analysing the participant opinions (raw data) obtained from the documents included in the current research.

Coding Process

Coding is an important stage for the meta-thematic analysis process. Codes were created by restating the views obtained from the participants, and themes were obtained by bringing codes of a similar nature together in the same groups. At this point in the meta-thematic analysis process, the findings to be considered in line with the main purpose of the research include the themes and codes that will emerge in the context of the opinions of the participants in the studies included in the analysis. The consistency of the codes created during coding also shows the reliability of the coding process (Mayring, 2000). In the current study, as part of the meta-thematic analysis process, the relationship

between constructivist approach practices and technology in the 21st century, 4 themes emerged in the form of "relationship with learning skills", "relationship with cooperative learning", "problems encountered and suggestions". The reliability of two coders was considered while creating the related themes and codes. The coders, one of whom was the researcher himself, and the other an expert academic, examined the studies chosen for analysis without knowing each other and obtained various themes and codes. After both coders completed the coding process, the themes and codes they created were compared, and the consistency and harmony between them was checked. While the similarities were recorded as common, discussions were held on the situations with differences. These discussions continued until a certain harmony was achieved. At this stage, the reliability between the coders was calculated according to the Cohen Kappa fit values (Cohen, 1960), and the fit was found to be good/very good, lying between .829 and .901 (Appendix 1).

Reliability in the Meta-thematic Analysis Process

For reliability in terms of meta-thematic analysis, reliability methods taken into account in qualitative research were examined. At this point, based on the concept of researcher triangulation (Denzin, 1978; Streubert & Carpenter, 2011), conversations were carried out with the two researchers from the first stage of the meta-thematic analysis process through to the end, and ideas were constantly exchanged. In addition, during the theme and code creation process as part of the meta-thematic analysis, it was decided that direct quotations should be presented in the findings section, and these expressions were included during the interpretation. In terms of qualitative research, direct citations can be considered as a raw data/basic data source (Labuschagne, 2003). The presentation of the relevant quotations was carried out by specifying the codes assigned to the work, and the page number of the quotation. In this framework, the sources from which the codes and themes are taken are coded with specific numbers and the page number from which the theme-code is quoted, and shown where direct quotations are presented. In the study, "M" is an abbreviation for articles, "TFO" for studies in Taylor & Francis Online, "PQDTG" for studies in ProQuest Dissertations and Theses Global database. (Example: PQDTG-12-p.90: Contains an excerpt from page 90 of the study in ProQuest Dissertations and Theses Global identified as number 12). In addition, for the codes taken from Council of Higher Education National Thesis Centre, the thesis number was given and abbreviation codes were used.

Results

In this part of the study, the results regarding the meta-analysis and meta-thematic analysis of the use of constructivist approach-based practices in the teaching environment are interpreted. In the first stage, meta-analytical findings based on document analysis were presented, while in the second stage, meta-thematic analysis findings were presented. When the meta-analysis findings presented in Table 2 are examined, the effect level of the students' academic achievement scores (AA) regarding constructivist approach applications is g=.83 [.69; .97]. The fact that the level of effect achieved as a result of the analysis is at a high level compared to the Thalheimer and Cook (2002) classification, shows that the effects of the practices based on the constructivist approach on academic achievement are positive. In addition, it was found that there was a significant difference in the related test type scores ($p < .05$).

Table 2. Meta-Analysis Data

Test Type	Model	n	g	95 % Confidence Interval		Heterogeneity		
				Lower	Upper	Q	p	I^2
AA	SEM	90	0.68	0.63	0.72	695.68	0.00	87.02
	REM	90	0.83	0.69	0.97			

Table 3. Overall Effect Sizes of Studies Included in the Analysis by Moderator Analysis

Mod.	Groups	Effect Size and 95% Confidence Interval			Test of null		Heterogeneity		
		n	g	Lower	Upper	Z-value	P-value	Q-value	df	P-value
Teaching Levels	Primary	7	1.08	0.78	1.37	7.21	0.00			
	Middle	53	0.80	0.61	0.99	8.36	0.00			
	High school	19	0.92	0.63	1.22	6.13	0.00			
	University	9	0.72	0.35	1.08	3.95	0.00			
	Tot. Betw. Overall	88	0.87	0.74	1.00	13.11	0.00	3.21	3	0.36
Durations of Applications	1-4	23	0.86	0.56	1.15	5.59	0.00			
	5-6	15	0.88	0.60	1.16	6.11	0.00			
	7-8	11	0.87	0.54	1.20	5.15	0.00			
	9-+	14	0.61	0.19	1.03	2.85	0.00			
	Unspecified	14	0.93	0.64	1.21	6.42	0.00			
	Class-hour	13	0.81	0.37	1.25	3.60	0.00			
	Tot. Betw. Overall	90	0.85	0.72	0.98	12.48	0.00	1.65	5	0.89
Course Areas	Science	48	0.78	0.58	0.98	7.61	0.00			
	Maths	21	0.87	0.57	1.17	5.77	0.00			
	Social Science	21	0.89	0.67	1.11	7.92	0.00			
	Tot. Betw. Overall	90	0.84	0.71	0.97	12.38	0.00	0.56	2	0.76
Sample Sizes	Small	24	0.92	0.72	1.12	9.10	0.00			
	Average	49	0.88	0.70	1.05	9.81	0.00			
	Large	17	0.58	0.24	0.91	3.39	0.00			
	Tot. Betw. Overall	90	0.85	0.73	0.98	13.69	0.00	3.17	2	0.20

When the heterogeneity test type value shown in Table 2 is examined, it is understood that the effect sizes of academic achievement (Q=695.68; $p<.05$) are heterogeneously distributed. The I^2 value (87.02%) indicates that the observed 87% variance is due to true variance between studies. While 25% in terms of the I^2 value shows low heterogeneity, 50% shows medium heterogeneity and 75% and above shows high heterogeneity (Cooper et al., 2009). In the current study, it can be said that the calculated I^2 value of 87.02 is high (Higgins, Thompson, Deeks, & Altman, 2003). In this context, the high level of heterogeneity indicates the presence of moderator variables that affect the overall effect size. In other words, it can be stated that a moderator analysis of the test should be performed since the result of the I^2 value reached shows heterogeneity (Borenstein, Hedges, Higgins, & Rothstein, 2009). For this reason, teaching level, duration of application, course area and sample size were chosen for moderator analyses (Table 3). According to the results of the moderator analysis, the largest effect size was in the primary school level (g=1.08) in terms of the teaching level, in the unspecified group in the application period (g=0.93), in the Social Sciences in the course area (g=0.89), and in the small sample group in the sample size (g=0.92). These values can be interpreted as indicating that constructivist approach applications are more effective in the specified groups in the relevant moderator analysis. On the other hand, in terms

of the significance test, teaching level (Q$_B$=3.21; *p*>.05), application duration (Q$_B$=1.65; *p*>.05), course area (Q$_B$=0.56; *p*>.05) and sample size (Q$_B$= 3.17; *p*>.05) showed no significant difference. When the results of the analysis were evaluated in general, the practices based on the constructivist approach had a similarly large effect size in all groups. However, no significant difference was found between the groups.

Effectiveness of the Constructivist Approach in the Scope of Meta-thematic Analysis Based on Document Analysis

In this part of the study, the themes and codes of the qualitative studies obtained within the scope of practices based on the constructivist approach, obtained through meta-thematic analysis, are presented. By analysing the data obtained in the process of using the constructivist approach in the teaching environment, constructivist approach was seen to be closely related with technology, 21st century skills. Themes were formed in the form of "relationship with technology and 21st century skills", "relation with cooperative learning", "problems encountered", and "suggestions put forward". These themes and the codes noted below are presented as models. In addition, direct quotations are given in the comments as reference sentences. In Figure 3, the codes belonging to the theme of "relationship with technology" of applications based on the constructivist approach are presented in the form of models, and the text consisting of reference sentences is given in the comments.
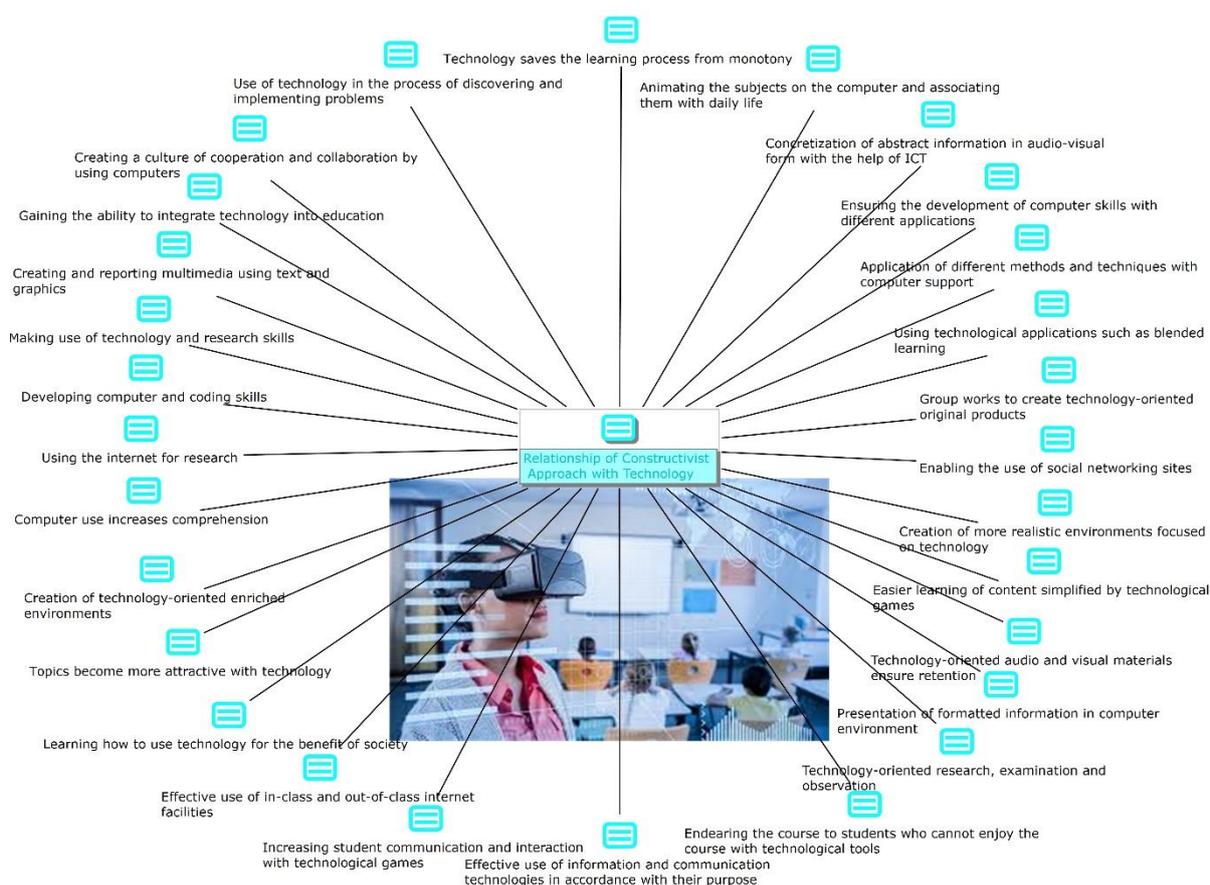

Figure 3. Relationship of the Constructivist Approach with Technology

In Figure 3, the codes obtained for the "relationship of the constructivist approach with technology" are modelled. Some of these codes can be listed as the use of technological applications such as 'blended learning', the permanence of learning through technology-oriented audio and visual materials, the use of computers to increase understanding, the more attractive subjects involving technology, and the creation of technology-oriented enriched environments. Some quotations that can relate to these codes are "*We deal with that now by providing a blended model with the teacher in the classroom and the parent in the home*" (PQDTG-12-p.90), "*She used the computer during the unit at home and school to improve her understanding of the president's and governor's roles and responsibilities*" (PQDTG-84 -p.67),

"…But especially our use of information and communication technologies in the lesson both attracted the attention of the learners and motivated them to the lesson, as well as enriching the learning environment and helping them learn" (407523-p.236). On the other hand, the contribution of the constructivist approach in the technological dimension are as follows: Keeping student communication and interaction alive with technology-oriented games, creating original products based on technology with group work, associating the content with current issues with the help of technology, using the internet for research, questioning, problem solving, and making the course popular with the use of technological tools. It can be said that it has many technology-oriented contributing features such as benefiting from technology and gaining the ability to do research.
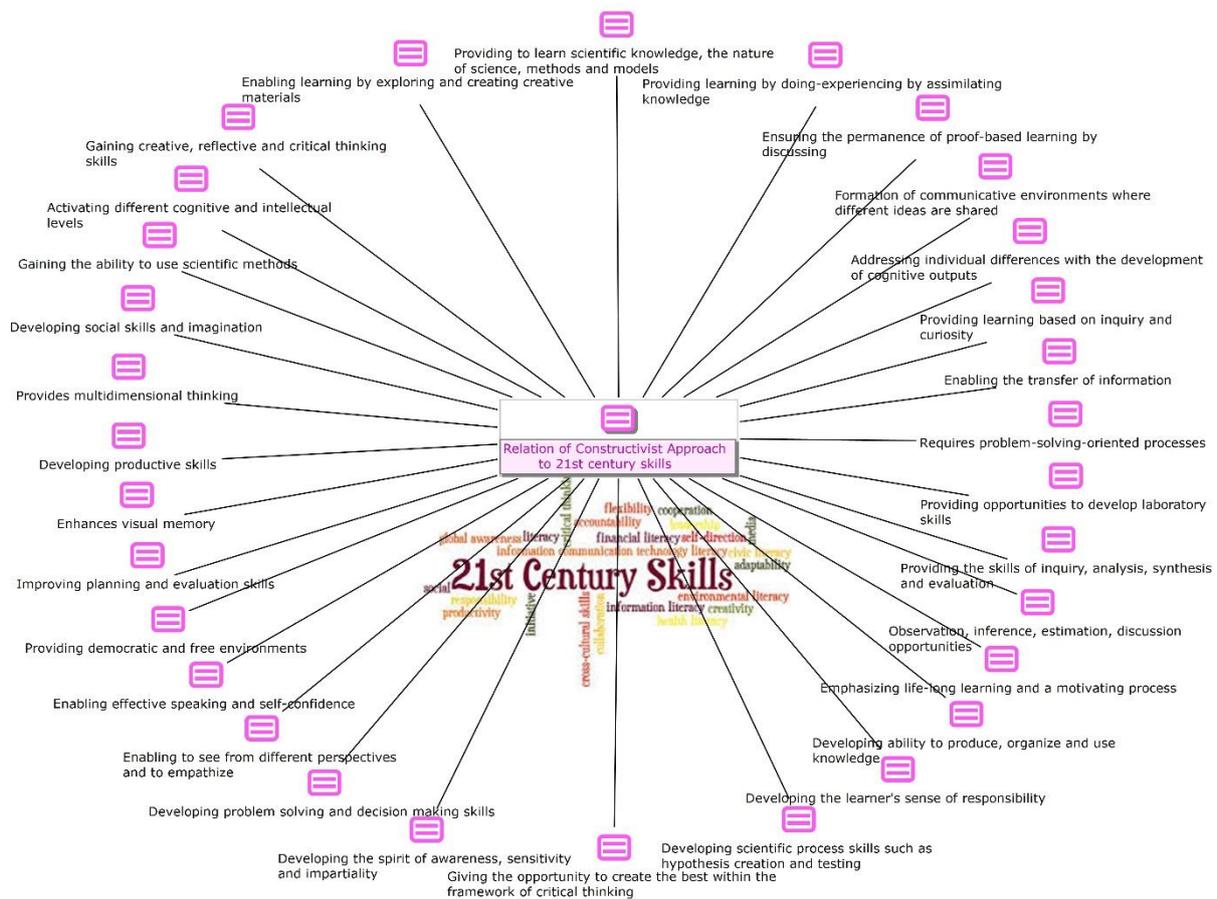

Figure 4. Relation of the Constructivist Approach to 21st century skills

When Figure 4 is examined, it can be seen that the codes for the contributions of the constructivist approach applications reached within the framework of 21st century skills are included in the model. Some of the codes created for this model can be stated like that: "*It enables the development of laboratory skills, makes different cognitive and intellectual levels active, develops scientific process skills such as hypothesis creation and testing, provides reflective and critical environments, develops the problem solving skills of the learners and provides the opportunity for multidimensional thinking*". The statements that can refer to these codes and the studies they are cited are "*My personal goal is to actively engage students in the world of science, allowing them to develop their laboratory skills*" (PQDTG-1-p.68), "*Mr. Loes utilized the scientific processes of observing, inferring, predicting, communicating, hypothesizing, experimenting, interpreting data, and forming conclusions when teaching each major science concept in the unit and any other content area he integrated into the unit*" (PQDTG-10-p.86), "*...whether we put forth our own thoughts or the results from the concept maps, or everyone in the group either supports or criticizes someone's idea*" (M15-p.56), "*While we usually think one-sided for problem solving, now we can look at different aspects, positive and negative sides while solving problem*". (M35-p.90). In addition, constructivist approach has provided many features that appeal to the 21st century skills such as "encouraging creativity, providing opportunities for critical

thinking, observation, inference, estimation, discussion, lifelong learning, knowledge generation, organization, transfer of knowledge, research, questioning, arousing curiosity, raising awareness of responsibility for learning, helping use of scientific methods, questioning, analysing, synthesizing and evaluation".
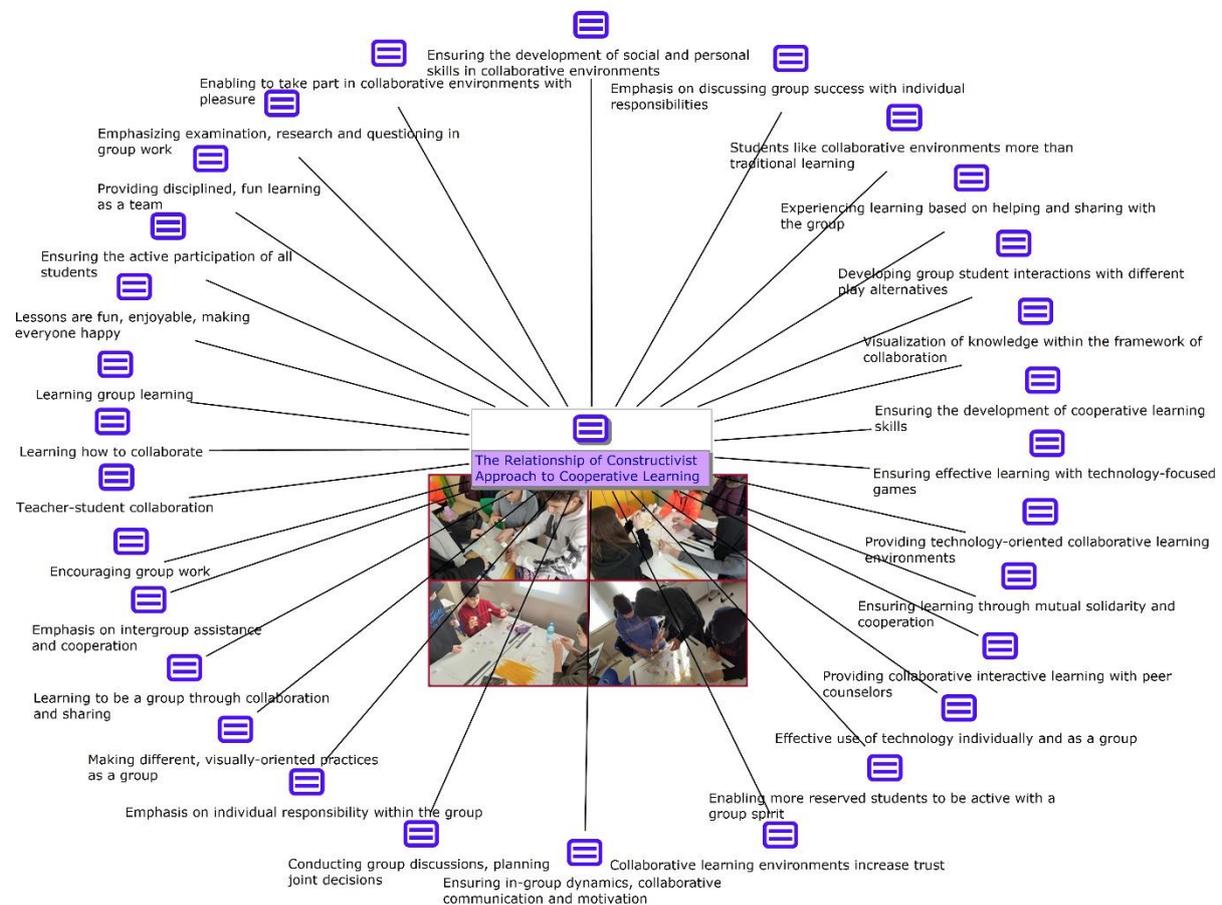

Figure 5. The Relationship of the Constructivist Approach to Cooperative Learning

In Figure 5, in the context of meta-thematic analysis, a large number of codes that contribute to the use of the constructivist approach in the educational environment and in cooperative learning have been identified. Some of the codes presented are as follows: "Teacher-student cooperation, providing learning with mutual solidarity and cooperation, interactive learning based on cooperation with peer counsellors, learning to be a group by increasing cooperation and sharing, emphasizing cooperation and cooperation between groups, more liking of cooperative environments compared to traditional learning" can be specified. Statements that may refer to these codes and the studies cited "*They were interdependent, cumulative, and mutually reinforcing throughout the course of the study*" (PQDTG-13-p.92), "*I saw everything very well. Everyone was constantly discussing, researching and producing projects in groups. This painting was beautiful. There was very good cooperation and cooperation in the groups*" (407523-p.272), "*I enjoyed the online collaborative writing more than the traditional writing*". (TFO-12-P.79). In addition, there were collaborative activities such as "Visualization of information within the framework of cooperation, development of social and personal skills, teacher-student cooperation, active participation, development of cooperative learning skills, increased motivation and interest, group and individual responsibility, examination, research and questioning in group work". It can be said that a large number of codes related to environments have been created.
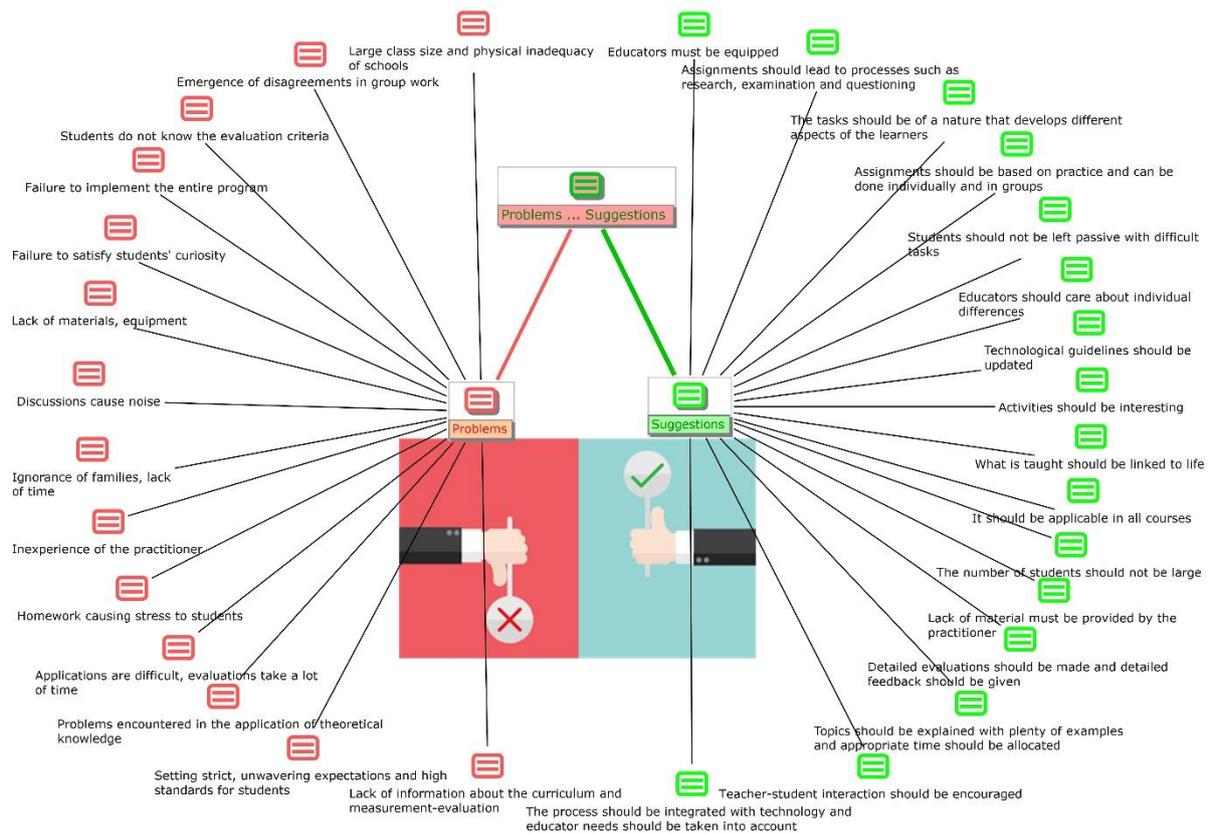
Figure 6. Problems Encountered in the Constructivist Approach and Suggestions

When Figure 6 is evaluated, the problems encountered in the process of constructivist learning environments and the suggestions that can be put forward are modelled. Some of the related problems are stated with codes such as "The large number of classrooms and the physical inadequacy of the schools, the difficulties encountered in the application of theoretical knowledge, the inability to implement the whole programme". Expressions that can be references to related codes are "*Excessive class size. The classroom is not large enough for activities such as drama and group work. In addition, the fact that the desks are in the middle makes it difficult to do activities in the classroom*" (M33-p.123), "*I have problems in transforming what I learned in the course into practice*" (298532-p.124). Suggestions regarding the problems that may be encountered in applications based on the constructivist approach during the analysis process are also presented. Some of these suggestions can be stated as "Educators should care about individual differences, The needs of educators should be taken into account by integrating the process with technology, What is taught should be associated with life, It should be applied in all courses, The number of students should not be high, Educators should be equipped". Some quotes that can be a reference for the suggestions are "*I think one thing most teachers do not pay attention to is the individual differences and differences in learning styles*" (TFO-p.62), "*I would like to learn where and how it is used and what it will do for me*" (M42-p.245), "*This application should not only be applied to our class, but also to our friends in other classes*" (553598-p.61). As a result, it has been understood that some problems may be encountered in the process of implementation based on the constructivist approach, but there are also suggestions that can be used to solve these problems.

Discussion & Conclusion

In this study, the mixed-meta method was used in order to reveal the current situation of constructivist approach applications in the research literature. For this purpose, firstly meta-analysis and then meta-thematic analysis were used. In the context of meta-analysis, as a result of the calculations made based on the REM of the studies included in the analysis, it was understood that the constructivist approach practices had a positive and broad effect on academic achievement, taking into account the level classification of Thalheimer and Cook (2002) (g =.83). In some studies, some results that were not included in the analysis, but were similar to the results of the analysis, were obtained (Arı & Bayram, 2011; Alonso, Manrique, & Viñes, 2009; Cabur, 2019; Hsieh, Hsu, & Huang, 2016; Payne et al., 2009; Tekin, 2020). These results show that the use of constructivist approach practices in the teaching process contributes positively and significantly to the success of the learners. In addition to academic success, studies have been found showing that related practices contribute positively to permanence (Demirci, 2009; Nair, 2019; Tepecik & Zor, 2014) and attitude (Kim, 2005; Lkama, 2019).

Moderator analyses of the studies on academic achievement included in the analysis were also conducted. The fact that the highest effect size was in primary school (g=1.08) and the lowest effect size was in the university group with .72 in the analyses according to education levels, which is one of the moderators, can be interpreted as indicating that the constructivist practices are more effective at primary school level compared to other groups. On the other hand, the fact that the Social Sciences had the highest (g=.89) and the Sciences had the lowest (g=.78) effect size in the analysis made according to subject areas, can be interpreted as suggesting that the constructivist approach practices in the Social Sciences courses had a greater effect. Although the effect sizes were different from each other, no significant difference was observed between the groups in terms of course areas (Q_B=0.56; p>.05). As a result of the evaluation of the effect size of the constructivist approach applications according to the application periods in which the studies were conducted, the highest effect size was found to be .93, while the lowest effect size was .61 in the 9-+ and 1-4 week groups respectively. On the other hand, no significant difference was found based on sample size (Q_B=3.17; p>.05). When the results of the moderator analysis are evaluated in general, it can be said that training with the relevant applications has a similarly good effect on all groups. This result can be explained as suggesting that constructivist approach applications have a high level of effect in terms of variables such as level, course area, application duration and sample size, but this effect is not significant.

In the moderator analyses of the meta-analysis process, it can be suggested that more studies should be conducted with regard to course areas and levels, since less studies on the constructivist approach were conducted in the Mathematics and Social Sciences courses than the other areas at primary and university levels. On this point, Kusmaryono and Suyitno (2016)'s research, one of the rarer studies, examined the effect of the constructivist approach on the conceptual perception levels and mathematical skills of primary school 4th grade students. In the study, it was noted that students' problem solving skills and perception levels improved after constructivist approach applications. Therefore, considering that constructivist practices can also produce positive results in terms of variables such as different levels, course areas, and application times, it can be recommended to conduct studies with regard to these aspects.

In the second stage of this study, in which the mixed-meta method was used, the meta-thematic analysis process based on document analysis was used in order to support the meta-analysis information and to make the research results more comprehensive. In this regard, it can be seen that different themes and codes have emerged from the qualitative studies within the scope of the meta-thematic analysis achieved in the literature. These reflect the effect of the constructivist approach with regard to a range of variables. When the codes related to technology are evaluated, inferences can be made that more realistic environments are formed, multimedia can be created, and problems can be explored and resolved. In this regard, some studies (Khalili, 2002; Merrell, 2013; Parker, 2009; Tolley, 2009) have found similar findings in the sense that constructivist approach applications make a great contribution in terms of technology. In addition, in the studies of Baş (2015) and Akyol (2019), the contributions of constructivist teaching activities in the technological dimension were also mentioned.

Another theme by which the effectiveness of constructivist approach-based practices in the learning environment is evaluated relates to its effect on 21st century skills. Within the scope of the related theme, the constructivist approach contributed to learners' creativity, laboratory skills, critical, creative and reflective skills, different cognitive and intellectual levels, research, questioning and curiosity. In addition, it has been understood that these practices contribute to the formation of learning and environments by discussing, enabling students to think multidimensionally, and learn by exploring. In addition, it was recorded that different scientific process skills and inquiry, analysis, synthesis and evaluation skills were developed as a result of the use of this approach. It has been seen that national (Çandar & Şahin, 2013; Kaya & Karakaya, 2012; Yurdakul, 2008) and international (Nelson, 2017; Seimears, 2007) publications also support the relevant research results.

Another theme identified within the scope of the meta-thematic analysis used in the study is the relationship between the constructivist approach and cooperative learning. Within the scope of this theme, it has been understood that it has positive contributions to different aspects such as encouraging group work in the context of practices based on the constructivist approach, developing social and personal skills in collaborative environments, forming technology-oriented cooperative learning environments, and experiencing learning based on cooperation and sharing with the group. Some results similar to the related codes were also found in Liang and Gabel (2005)'s study dealing with the effectiveness of the constructivist approach to science teaching on the part of primary school teacher candidates. In this study, it was emphasized that constructivist practices were very useful in encouraging group work. In the context of this theme, other studies were also found that were consistent with the research results. Collaborative environments are more popular than traditional learning (Patterson, 2011); related practices encourage teacher-student cooperation (Seimears, 2007), and provide interactive learning environments based on collaboration with peer counsellors (Khalili, 2014). It has also been suggested that it has the advantages in terms of providing fun learning in a disciplined team environment (Çimen, 2010). In addition, providing learning through mutual solidarity and cooperation (Tolley, 2009) and emphasizing examination, research and questioning in group work enables learners to have a more active role in learning environments. It has shown that the constructivist approach has positive aspects in many subjects such as providing disciplined work and active learning, creating enjoyable group environments, providing positive intra-group dynamics, encouraging cooperative communication and motivation, providing technology-oriented games, emphasizing individual responsibility, and influencing group discussions and joint decision making.

As a result of the meta-thematic analysis of the research, a separate theme was suggested with regard to the problems encountered in constructivist practices and the suggestions put forward. In the context of the problems encountered, the difficulties of the applications, the time-consuming evaluations and the difficulties encountered in the application of theoretical knowledge are some of the problems mentioned. Similar problems were also identified in some studies in the literature that were considered but were not included in the analysis based on the criteria. High class size and physical inadequacy of schools, lack of materials and equipment (Çandar & Şahin, 2013) and difficulties encountered in applying theoretical knowledge (Koçyiğit, 2011) are some of the limitations stated in research in this context. On the other hand, some suggestions were also presented in the research regarding the problems encountered in delivering practices based on the constructivist approach. The necessity of considering the needs of the educators resulting from integrating the process with technology, emphasizing that the tasks are to develop different aspects of the learners, and giving detailed feedback by making detailed evaluations are some of these suggestions. Studies with similar findings were encountered in the literature. In this context, recommendations include updating technological guidelines (Merrell, 2013), associating what is taught with life (Özgen & Alkan, 2012), applying it in all courses (Akyol, 2019), not having a large number of classrooms, ensuring the presence of suitably-trained educators (Günceoğlu Karaöz, 2011) and constructivist teaching in lessons (Bimbola & Daniel, 2010). When evaluated in general, it can be stated that there may be limitations in the use of constructivist approach-based practices in the teaching process, but these limitations can be eliminated. It can be stated that the suggestions presented on this subject are important and should be taken into consideration.

Limitations & Suggestions

It has been understood that constructivist approach applications have a significant effect on factors such as academic success, cooperation, 21st century skills, technology in terms of teaching level, course areas, application duration and sample size with regard to which future studies are carried out. In terms of the methodological structure of the research, the use of the mixed-meta method has enabled the results of this research to be presented in a more general framework, enabling the subject to be examined in the necessary amount of detail. In this way, the fact that the overall effect size was large (g=.83) with regard to the quantitative studies conducted on the effect of the constructivist approach on academic achievement showed that this approach had a positive effect on academic achievement. In order to support this finding, meta-thematic analysis findings were also obtained. In terms of the participant views that emerged in related studies, positive reflections relating to the integration of constructivism with technology on learning, and factors that will affect learning (motivation, interest and willingness, participation, communication, etc.) were observed. In addition, when evaluated in terms of 21st century skills and cooperation, it was determined that the constructivist approach contributed to the development of these aspects. Therefore, it is thought that the reliability and generalizability of the results obtained by the mixed-meta method, which reveals the consistency of both research results, is at a good level. In this respect, it can be suggested that future research should be conducted by selecting different subject areas using the relevant method. On the other hand, the current research is limited to examining the effect of the constructivist approach on academic achievement in the meta-analysis dimension. However, the level of its effect on attitude and permanence can be investigated. As moderator variables, research includes teaching level, application time, course area and sample size. Publishing the status of constructivism by year and by country, analysis based on publication type (article, thesis, book, and proceeding) can be examined separately.

In addition, as a result of finding that the constructivist approach has a positive and wide impact in general, it can be suggested that the constructivist application be used more widely. Knowing that students take an active role in the learning process in the 21st century, teachers responsible for implementing the programmes prepared for them in accordance with the constructivist approach are expected to act in line with the this approach. Therefore, taking into account that practitioner teachers have an impact on the success of these programmes, they should be given training opportunities on this approach at regular intervals. In addition, trainee teachers should be provided with the necessary equipment and skills within the framework of teacher training programmes.

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Appendix

Appendix 1. Compliance Values of Themes and Codes in the Context of Meta-thematic Analysis

		Relationship with technology					Relation to 21st Century Skills					Relationship with Cooperative Learning					Problems and Suggestions		
		K2					K2					K2					K2		
		+	-	Σ			+	-	Σ			+	-	Σ			+	-	Σ
K1	+	28	1	29	K1	+	30	1	31	K1	+	29	2	31	K1	+	30	3	33
	-	2	18	20		-	1	14	15		-	1	18	19		-	2	24	26
	Σ	30	19	49		Σ	31	15	46		Σ	30	20	50		Σ	32	27	59
Kappa:.872			p:.000		Kappa: .901			p:.000		Kappa: .874			p:.000		Kappa:.829			p:.000