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The Effect of Student-Centered Approaches on Students' Creative Thinking Skills: A Meta-Analysis Study

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Abstract

The aim of this study is to determine the effects of student-centered approaches (SCA) on students' creative thinking skills (CTS). Meta-analysis method is used in the study. The scope of the study consists of Master and PhD theses and research articles addressing this issue in Turkey. As a result of the screening, it is seen that there are 104 studies between 1990 and 2020 in line with inclusion criteria. The total number of samples within the scope of these studies is 6434 students. 3215 of these students are in the experimental group and 3219 are in the control group. According to the results of the study and the random effects model, a moderate ($d=0.73$; [0.63; 0.82]) statistically significant, positive effect size is determined according to SCA in favor of the students' CTS. In other words, it is seen that when student-centered approaches and methods are applied in the lessons, creative thinking skills of students are positively affected. As a result of the moderator analysis, it is determined that the effect sizes of the studies differed according to education stage ($p=0.00$) and lessons ($p=0.00$). In the study, it is concluded that SCA is a meaningful variable that positively affects students' CTS.

Key words: Student centered, learner centered, creative thinking, meta-analysis.

Introduction

In the twenty-first century, it is expected to raise individuals with advanced thinking skills who can question, produce and use knowledge in the solution of problems. Raising this globally valued human profile has taken its place among the educational objectives of all countries. The question “*How can we raise individuals with advanced thinking skills?*” has led to many new approaches in education. One of the best ways to use thinking skills effectively is to make individuals active in their learning processes. In this context, student-centered approaches (SCA) such as active learning, learning by living and learning to learn shape today's education.

Instead of using a single teaching method or certain techniques, SCA transform the role of the teacher from the person who conveys information to person who create learning environments that facilitate learning. It is not possible for teachers who have adopted SCA to use a single teaching method in lessons (Darsih, 2018). Methods that facilitate learning and activate students is within the scope of SCA (Blumberg, 2008). Student-centered teaching is an approach that focuses on student learning rather than what the teacher does, respects student learning needs, learning styles and strategies, and puts the student at the center of learning (Blumberg, 2008; Brown, 2003). In student-centered classes, students work individually, in pairs or with small groups on different tasks and projects. Successful control of such a classroom environment is possible with comprehensive planning and effective classroom management (Brown, 2003). SCA allows the student to make sense of the content in student-centered classroom settings and allows the teacher to help students in this regard. In addition, SCA, which develops higher order thinking skills that are suitable for learning objectives and students' characteristics, is frequently used in effective classroom settings (Weimer, 2002). Trilling and Fadel (2009) and Yalçın (2018) state that using SCA in classroom improves students' thinking skills. In this context, it can be said that there is a significant relationship between SCA and thinking skills.

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Other than basic skills, twenty-first century skills consist of three main skill areas: a) learning and innovation skills, b) knowledge, media and technology skills, and c) life and career skills. Learning and innovation skills consist of four sub-skills: critical thinking and problem solving, communication, cooperation and creativity. These skills are seen as the key to lifelong learning and creative thinking. Creativity means producing, evaluating, explaining and implementing new ideas. Creative thinking is a higher order thinking skill that aims to solve problems, present alternative ideas and solutions, synthesize or make sense through re-meaning, and use imagination (Kylonen, 2012; Özçelik, 2019; Trilling & Fadel, 2009; Yalçın, 2018). In the document Turkey's Education Vision 2023, emphasis is placed on an educational approach based on these four soft skills of 21st Century which are to be acquired by students (MEB, 2018). On a global scale, it is stated in many countries from Finland to Singapore that 9 of every 10 skills that will shape the future in 2020 and beyond are creativity or other creativity related skills. Creative thinking skills are at the top of the skills students need to learn (Trilling & Fadel, 2009; World Economic Forum, 2016).

SCA is expected to develop higher order thinking skills such as creative, critical and reflective thinking (American Psychological Association [APA], 1997; Perry & Karpova, 2017). It is generally known that creativity skills of students are not given importance in educational environments. Accordingly, it is seen that teachers keep the level of creativity and general intelligence equal (Sternberg, 2003). However, there are studies showing that the student's general intelligence or academic achievement and creativity are not directly related (Gajda, Karwowski & Beghetto, 2017; Kim, 2005). Torrance (1966) defines creativity as “*being sensitive to problems, malfunctions, lack of information, lost items, incompatibility, seeking solutions to difficulties and predicting*”. So creative thinking can be defined as mental processes that lead to an invention, solution or synthesis in any field (Vanderbos, 2006). In short, individuals with higher CTS can produce different or original ideas in a wide variety of fields and make predictions based on existing situation. While creativity evokes both mental and performance-based activities, creative thinking evokes mostly cognitive activities (Doğan, 2005). Creative thinking individual produces new, original, unexpected, appropriate, useful and adaptable concrete objects and ideas (Sternberg & Kaufman, 2010). The importance of knowledge and motivation is emphasized in creativity (Runco & Chand, 1995). In order to talk about creativity in any subject, we encounter two important factors; the level of knowledge on the subject and the desire to discover. The motivation mentioned in creativity is mostly intrinsic motivation. When the student is free to choose the tasks in the teaching process, his motivation increases because this makes the task meaningful to the student. Thus, in order to increase the creativity of students, it is necessary to take advantage of SCA, which will make them active in the teaching process.

The aim of pedagogy, which develops innovation and creative thinking skills, is to provide students with the necessary equipment to be creative, be prepared for problems to be able to analyze and manage information and work with it. Teachers who want to see the effects of using SCA to develop students' CTS, provide feedback and guide their learning to help students think creatively about content in terms of achievement and content. Students are encouraged to become independent active learners. Student centered approaches and methods are used in this process (Drapeau, 2014; Özçelik, 2009).

Educational approaches that center the student include many different teaching strategies, methods and techniques. It is seen that meta-analysis studies on the subject are concentrated on the effects of these student-centered strategies, methods and techniques on students' academic success. There are many meta-analysis studies examining the effect of inquiry-based learning (Aktamış, Hiğde & Özden, 2016; Furtak, Seidel, Iverson & Briggs, 2012; Wang, Huang, Tsay, Lee, Lin & Kao, 2011), constructivist approach (Arık & Yılmaz, 2020; Erdamar, Aytaç, Demir & Demir, 2015; Tural, Kaçire & Atabey, 2016), project based learning (Ayaz, 2014; Kaşaracı, 2013; Tural, Kaçire & Atabey, 2016), multiple intelligence theory (Ayaz, 2014; Baş, 2016; Biçer, 2017; Çelik, 2013; Kaplan, Duran & Baş, 2015; Tural, Kaçire & Atabey, 2016), active learning (Batdı, 2014), technology-based methods (Batdı, 2014b; Çelik, 2013; Çırak-Kurt, Yıldırım & Cücük, 2018; Demir & Başol, 2014; Kaya & Öçal, 2018; Li & Ma, 2010; Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014), STEM (Becker & Park, 2011; Belland, Walker, Kim & Lefler, 2017), creative drama (Biçer, 2017; Cantürk Günhan, 2016; Çelik, 2013; Erden, Aytaç & Erden, 2016; Lee, Patall, Cawthon & Steingut, 2015; Tural, Kaçire & Atabey, 2016; Özbey & Sarıkaya, 2019) collaborative learning (Biçer, 2017; Camnalbur & Mutlu-Bayraktar, 2018; Capar & Tarim, 2015; Çelik, 2013; Johnson, Johnson & Stanne, 2000), game based learning (Biçer, 2017), problem based learning (Çelik, 2013; Dağyar, 2014; Dochy, Segers, Bossche, & Gijbels, 2003; Tural, Kaçire & Atabey, 2016), brain based learning (Gözüyeşil & Dikici, 2014), argumentation technique (Karakuş & Yalçın, 2016; Tural, Kaçire & Atabey, 2016), concept maps (Okursoy-Günhan, 2019) and student centered

approaches (Tutal, Kaçire & Atabey, 2016; Yeşilpınar Uyar & Doğanay, 2018) on students' academic achievement.

It is seen that meta-analysis studies in the literature focus on different variables as well as the effects of SCA on students' academic achievement. It is noteworthy that there are also meta-analysis studies investigating the effect of research and inquiry-based teaching on students' scientific process skills (Akkaya, 2019); project-based learning on science lesson attitude (Ayaz, 2014; Kaşarcı, 2013); 5E learning model (Ayaz, 2015) and constructivist approach on lesson attitudes (Ayaz & Şekerci, 2016); cooperative learning on mathematics attitude (Capar & Tarim, 2015); technology-based methods on learning mathematics (Özdemir, Aslaner & Açıkgül, 2020) and foreign languages (Chiu, Kao & Reynolds, 2012; Peterson, 2010); web-based problem solving (Kuo, Chen and Hwang, 2014); argumentation technique on scientific process skills (Karakuş & Yalçın, 2016); creative drama on motivation and social skills (Özbey & Sarıkaya, 2019) and skill development (Cruz, Lian & Morreau, 1998; Ulubey, 2018). However, when the studies conducted in Turkey and other countries, no meta-analysis study is found to examine the effects of SCA on students' CTS.

The question "is there a relationship between SCA applied in the class and the students' CTS?" has been asked for a long time, but there is no clear answer yet. At the conceptual level, scientists claimed that creativity and learning represent interrelated phenomena (Beghetto, 2016; Sawyer, 2012; Vygotsky, 2004). It is seen that there are many studies in Turkey in recent years dealing with the effects of SCA on thinking skills of students. The increasing number of studies dealing with the effect of various student-centered approaches, methods and techniques on students' creative thinking skills (CTS) has revealed the need to compile these results and synthesize them by taking into account the sample numbers. However, it is seen that there are no meta-analysis studies that deals with the effects of SCA on students' CTS. In addition, it is seen that there are no holistic and comparative studies that examine the effects of SCA on students' CTS. In this context, determining whether SCA has an impact on the students' CTS is the problem of this study. The aim of this study is to determine the effects of SCA on students' CTS.

Method

Research Design

Research model of the study is meta-analysis method, which is a method of systematically analyzing and synthesizing the data of quantitative studies carried out independently on the same subject. In the analysis of the data, one of the group comparison meta-analysis methods, Group Difference Method is used (Card, 2012; Cumming, 2012, 205). In a meta-analysis study; single and independent quantitative studies related to the same research question and subject are selected according to the inclusion criteria and the data obtained from these studies are synthesized with advanced statistical methods and their effect sizes are determined and interpreted (Dinçer, 2014; Ellis, 2012:5). The purpose of a meta-analysis is to reach a synthesis with the least error by comparing the quantitative data obtained from empirical studies conducted in different places and times on the same subject, combining them with appropriate methods, increasing the number of samples and thereby reducing the confidence interval of the overall result (Cumming, 2012; Hartung, 2008). Meta-analysis process steps are shown in Figure 1 (Dinçer, 2014, 11).

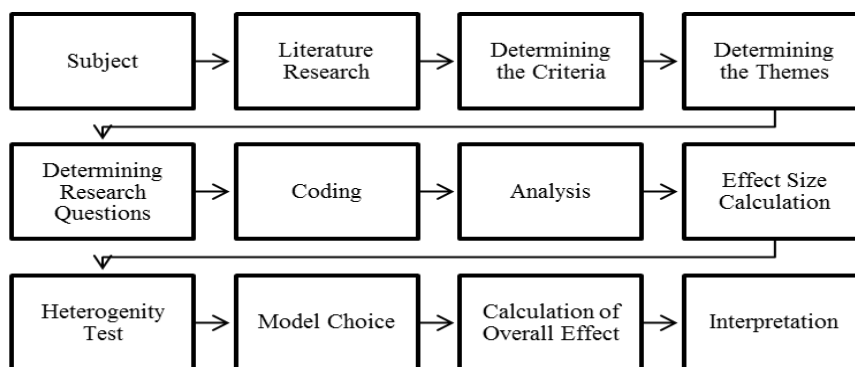


Figure1. Meta-analysis process steps

Data Collection

Master's and PhD theses, and research articles (conference paper, book chapter etc.) which discuss the subject of this study in Turkey constitute the main data sources and scope of this study. In order to have access to the relevant studies, the keywords "creativity", "creative thinking", "learner/student centered", "student centered strategies", "teaching strategies and methods" are searched both in Turkish and English on Web of Science, ERIC, ULAKBİM, EBSCOhost, Google Scholar and YOK National Thesis Center databases. After the search, it is determined that there are 104 studies in accordance with the inclusion criteria from 187 studies conducted on the subject of the study. In this study, studies focusing on experimental and quasi-experimental studies are selected which especially have pretest-posttest, and comparisons between groups. The inclusion criteria used in the selection of the studies included in the research are given in Table 1.

Table 1. Inclusion Criteria of the Studies

Inclusion Criteria
1. <i>Published or unpublished study sources</i> : Master's and PhD theses and research articles published in the literature are covered.
2. <i>Appropriateness of the dependent and independent variables in the studies to the meta-analysis study</i> : In order to reach the effect size in the meta-analysis studies it is taken into account that the included studies are empirical studies and that SCA is used as an independent variable and CTS is used as a dependent variable.
3. <i>Sample group</i> : Studies involving students who are studying in the formal education institutions from preschool education up to postgraduate education in Turkey are included.
4. <i>Containing the quantitative data required for meta-analysis</i> : It is taken into account that studies contain quantitative data (mean, standard deviation, number of samples, p value, etc.) in order to calculate the effect sizes required for the meta-analysis study.
5. Studies carried out in Turkey between 1990 and 2020 are taken into account.
6. Studies in both Turkish and English languages with a sampling from Turkey are included in scope.

The process of determining the studies included in the meta-analysis according to the inclusion criteria mentioned above is given in Table 2.

Table 2. The Process of Determining the Studies Included in the Scope of Meta-analysis

1. Number of studies reached within the context of determined keywords	2. Number of studies not included in the scope according to exclusion criteria	3. Number of studies in accordance with inclusion criteria
187 studies (34 PhD thesis, 98 Master thesis, 55 Articles)	83 studies (11 PhD thesis, 51 Master thesis, 21 Articles)	104 studies (23 PhD thesis, 47 Master thesis, 34 Articles)

Reliability of the Research. In a meta-analysis study, reliability between coders is important in the coding phase of the studies related to the reliability of the results. For this purpose, a coding protocol and form containing the identity, content and data of the study are created. In order to ensure the reliability of coding, the studies that will be included in the meta-analysis must be coded by at least two coders (Cooper, 2009; Wilson, 2009). The reliability of the codings was calculated using the formula "Reliability=Consensus/(Consensus + Disagreement) x 100" (Miles and Huberman, 1994) and was 96%. Values of 70% and above obtained from this formula are sufficient for reliability (Yıldırım & Şimşek, 2011). It can be said that the codings performed in this framework are reliable.

Validity of the research. All studies that meet the inclusion criteria for the meta-analysis are searched on all available databases and their inclusion is an indication of the validity of the research (Petticrew, & Roberts, 2006). In this context, each of the 104 studies included in the meta-analysis are examined in detail, and it is confirmed that the validity and reliability of the data collection tools used in studies are provided. Therefore, it can be said that this meta-analysis study is also valid.

Reporting. "Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA)" writing guide, which is a protocol used for systematic review and meta analysis, is used in the reporting of this study (Moher, Liberati, Tetzlaff & Altman, 2009). Turkish translation of the PRISMA checklist is made by Aşık & Özen (2019); Turkish version published on the official website of PRISMA is used (Aşık & Özen, 2019; Prisma Checklist, 2019: Figure 2).

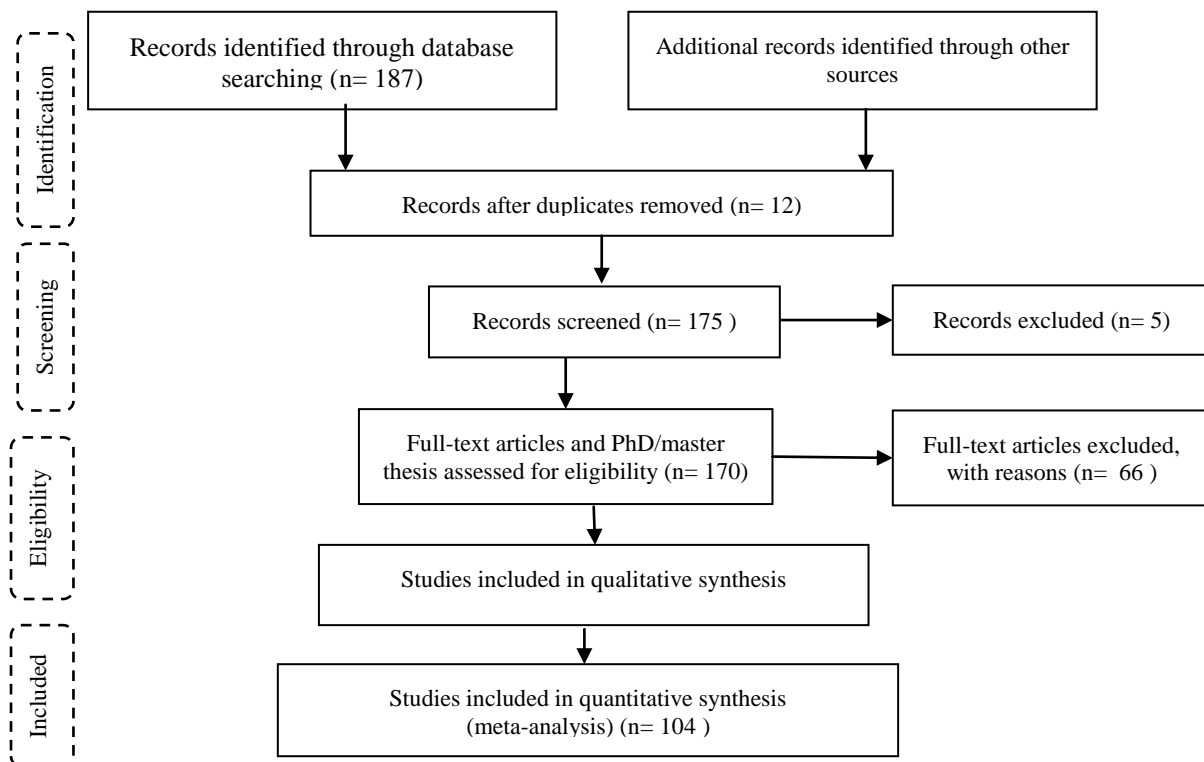


Figure 2. Prisma Flow Diagram for Meta-analysis

Data Analysis

For statistical calculations of this study, CMA [Comprehensive Meta Analysis] Ver. 2 software is used. In this meta-analysis study, random effects model is used to calculate the overall effect size. In the random effects model, universe effect sizes are assumed to vary from study to study, and studies included in the meta-analysis are considered to be part of a distribution. When studies are obtained from published literature, it is appropriate to use random effects model. When the samples of the studies within the scope of meta-analysis show a heterogeneous structure, random effects model can be used. Furthermore, if the researcher wants to generalize the universe and has a representative sample of the universe, it is appropriate to select the random effects model (Borenstein, Hedges, Higgins, & Rothstein, 2013; Başol, 2016; Başol, Doğuyurt & Demir, 2016; Ellis, 2012). Thus, it is predicted that it would be more appropriate to use the random effects model since the studies vary both in patterns and variables, that is, they are heterogeneous. In the study, students in the classes where SCA are applied are taken as experimental group and students in the classes where SCA are not applied are taken as control group. Therefore, the positive effect size is interpreted in favor of the students in the classes where SCA are applied, and the negative effect size is interpreted in favor of the students in the classes where SCA are not applied.

Publication Bias

In this study, publication bias is calculated by using Funnel plot, Orwin's Fail-Safe N., Duval and Tweedie's Trim and Fill method, Egger's test, and Kendall's Tau coefficient (Borenstein, Hedges, Higgins, & Rothstein, 2009; Cooper, 2009). As seen in Figure 2, the majority of 104 studies included in the study are located towards the top of the figure and highly close to the combined effect size. In this sense, the funnel plot shows that there is no publication bias for the studies included in the study (Borenstein et. al., 2009). It can be said that there is no publication bias in this study according to the evidence that pointers of effect sizes and sample sizes take the form of a funnel, the peak point is at the same level as the actual effect size, and the effect sizes are gathered symmetrically at the top (Bakioğlu & Özcan, 2016; Borenstein et al., 2013). When the funnel plot is examined, it is seen that the studies are mostly within the boundaries of the graph and the number of studies showing asymmetric distribution is low. In other words, the majority of the studies in the distribution are not

concentrated on only one side. When the funnel plot is examined, it is seen that the studies are mostly within the boundaries of the graph and the number of studies showing asymmetric distribution is low. In other words, the majority of the studies in the distribution are not concentrated on only one side.

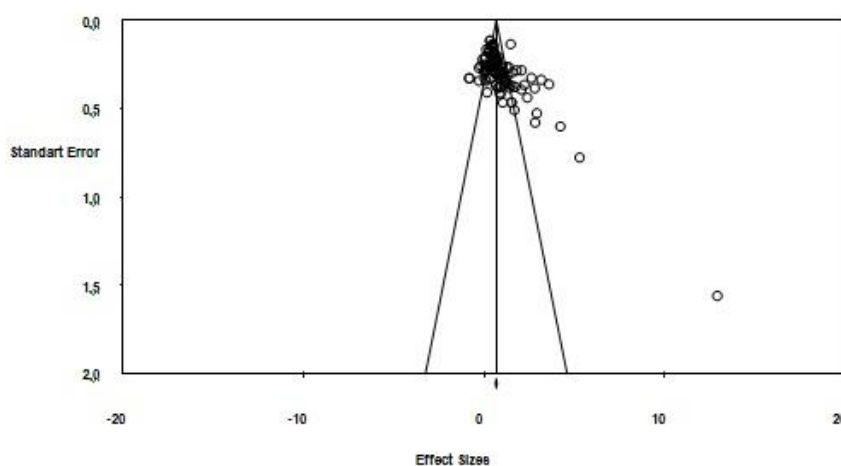


Figure 3. Funnel Plot

Publication bias test results of the studies included in the meta-analysis are given in Table 3. Orwin's Fail-Safe N calculation is also made to test publication bias. Orwin's Fail-Safe N calculates the number of studies that may be missing in a meta-analysis (Borenstein et al., 2009). As a result of this analysis, Orwin's Fail-Safe N is calculated as 6991. The number of studies required for the average effect size of 0.88 found in meta-analysis to reach 0.01 level (trivial), that is almost zero effect level, is 6991. 104 studies that are determined according to inclusion criteria are all of the studies conducted for this research question in Turkey. Apart from these, since 6991 studies are unlikely to be reached, this result is accepted as another indication that there is no publication bias in this meta-analysis.

The fact that the result of the Egger's test ($p=0.08$) was not significant is accepted as another indication that there is no publication bias in this meta-analysis. Another method, Kendall's Tau Coefficient is found to be 6.28 and $p=0.41$, so it is statistically revealed that there is no publication bias since the expectation that the p-value does not make a significant difference, i.e., greater than 0.05 is met. According to the results of Duval and Tweedie's Trim and Fill Method, when 29 precedent studies are included, the 0.88 average effect size found in the meta-analysis has changed to 0.49. This change can't be ignored, but it can be accepted that the reported effect size is reliable. According to other tests, it may say that there is no publication bias, but a change from .88 to .49 should also be taken into consideration.

Results

Findings acquired from researches within the scope of meta-analysis study (random effects model, and moderator analysis) are given in this chapter.

Findings of Effect Sizes Combined by Fixed and Random Effects Model and Homogeneity Test Results

The mean of effect sizes regarding the effects of SCA on students' CTS which is combined according to the fixed and random effects model, standard error, and lower and upper limits in accordance with 95% confidence interval are given in Table 4.

Table 3. Combined Findings of the Effect Size Meta-Analysis of Studies by Fixed and Random Effects Model and Homogeneity Test

Model/Sub-dimension	k	Effect Size	Standart Error	Homogeneity			Q-Value	I^2
				Lower Limit	Upper Limit	P-Value		
Random effects								
RBL	1	0.09	0.21	-0.32	0.50	0.66		
AL	4	1.53	0.43	0.69	2.36	0.00		
AR	2	0.37	0.47	-0.56	1.30	0.44		

STH	1	1.37	0.36	0.66	2.07	0.00		
BBL	2	1.28	0.27	0.74	1.81	0.00		
TE	20	0.85	0.16	0.54	1.16	0.00		
DI	8	1.18	0.32	0.55	1.82	0.00		
CL	3	0.42	0.18	0.06	0.77	0.02		
GBL	3	1.25	0.65	-0.03	2.53	0.06		
CS	2	0.81	0.22	0.37	1.25	0.00		
ST	9	1.62	0.40	0.82	2.41	0.00		
PBL	13	0.53	0.13	0.28	0.78	0.00		
PJTL	8	0.82	0.21	0.41	1.23	0.00		
STEM	7	0.67	0.15	0.37	0.97	0.00		
TBL	7	0.70	0.10	0.51	0.88	0.00		
CD	9	1.19	0.37	0.46	1.91	0.00		
CWR	5	1.03	0.21	0.61	1.45	0.00		
DIMENSIONS	104	0.73	0.04	0.63	0.82	0.01	37.88	86.17

SCA: Thinking education (TE), Problem based learning (PBL), Creative drama (CD), Story telling (ST), Differentiated instruction (DI), Project Based Learning (PJTL), Science, technology, engineering, and mathematics (STEM), Technology-based learning (TBL), Creative writing-reading (CWR), Cooperative learning (CL), Game based learning (GBL), Argumentation (AR), Research-inquiry based learning (RBL), Active learning (AL), Brain-based learning (BBL), Case study (CS), Six thinking hats (STH).

As seen in Table 3, the average effect size value of the effect size values of the studies included in the study according to the random effects model according to the SCA variable is calculated as $ES=0.73$. According to the random effects model, the students in the SCA applied classes show that CTS is higher than the classes in which traditional teacher-centered approaches are used. In the interpretation of the effects size, Cohen (1988, 1992) proposed the standards for interpreting OR, SMD, and r shown in Table 4 (Bakioğlu & Özcan, 2016; Littell, Corcoran & Pillai, 2008). The effect size value of this study, $ES = 0.73$, can be evaluated as a medium effect size according to Cohen's classification.

Table 4. Cohen's (1988) Standards for Interpreting Effect Size (ES)

ES Metric	Small Effect	Medium Effect	Large Effect
OR	1.5	2.5	4.3
SMD	0.20	0.50	0.80
R	0.1	0.25	0.4

OR: odds ratio; SMD: standardized mean difference; R: correlation coefficient.

It is seen that, among SCA used in the teaching-learning process, approaches and methods that have the greatest impact on students' CTS are; story telling ($d=1.62$), active learning ($d=1.53$), six thinking hats ($d=1.37$), brain-based learning ($d=1.28$), game-based learning ($d=1.25$) and creative drama ($d=1.19$). On the other hand, it is seen that research-inquiry based learning ($d=0.09$), argumentation ($d=0.37$) and cooperative learning ($d=0.42$) have a lower level of effect on students' CTS.

Homogeneity Test and Q and I^2 Statistics

For homogeneity test, Q is calculated as 37.88 ($Q=37.88$). From the chi-square table, 16 degrees of freedom is found to be 7.96 at 95% significance level. Since the Q -statistic value ($Q = 37.88$) exceeds the critical value of the chi-square distribution with 16 degrees of freedom ($\chi^2_{0.95}=7.96$), the absence hypothesis of the distribution of effect sizes was rejected in the fixed effects model.

Recently, the I^2 index has been proposed to quantify the degree of heterogeneity in a meta-analysis (Huedo, Sanchez, Julio, Fulgencio and Botella (2006). I^2 shows the the ratio of the total variance of the effect size. I^2 reveals the percent variability of effect size estimates due to heterogeneity (Bakioğlu ve Özcan, 2016: 197). In addition, the 86.17 % value obtained as a result of calculating the I^2 value indicates high level of heterogeneity. The I^2 statistic describes the percentage of total variation across studies that is attributable to heterogeneity rather than chance (Higgins et al., 2003). A value greater than 25% is considered to reflect low heterogeneity,

50% moderate, and 75% high heterogeneity. In the interpretation of I^2 , 25% indicates low level of heterogeneity; 50% indicates medium level of heterogeneity; and 75% indicates high level of heterogeneity (Cooper et al., 2009, 263; Higgins et al., 2003). As a result of homogeneity tests (Q and I^2) for SCA variable, since there is a level of heterogeneity which is close to high level between studies, moderator analyzes are carried out to determine the possible causes of this heterogeneity.

Results of the Moderator Analysis According to SCA Variable

Results of the moderator analysis which was carried out in order to reveal the reasons of heterogeneity occurring as a result of SCA variable are given in Table 5.

Table 5. Categorical Moderator Results Related to the Effects of SCA on students' CTS

Moderator	k	d	SE	%95 CI	Q	p
Publication Type					3.77	0.15
MA	47	0.88	0.10	[0.67; 1.09]		
PhD	23	1.13	0.17	[0.78; 1.48]		
Article	34	0.74	0.09	[0.55; 0.93]		
Education Stage					22.10	0.00
Preschool	19	1.59	0.23	[1.14; 2.04]		
Primary	55	0.88	0.09	[0.70; 1.05]		
Secondary	9	0.31	0.20	[-0.08; 0.70]		
Higher	21	0.60	0.10	[0.40; 0.80]		
Lessons					130.5	0.00
Information Technologies	11	0.50	0.10	[0.31;0.70]		
Biology	1	0.54	0.15	[0.25;0.84]		
Geography	2	-0.79	0.23	[-1.25;-0.33]		
Thinking Education	2	1.22	0.25	[0.73;1.71]		
Philosophy	2	1.03	0.34	[0.35;1.70]		
Science	18	0.52	0.11	[0.32;0.73]		
Physics	1	0.62	0.20	[0.23;1.01]		
Visual Arts	3	0.92	0.20	[0.52;1.30]		
Life Science	2	0.49	0.42	[-0.33;1.30]		
English	1	0.19	0.41	[-0.61;0.99]		
Mathematics	10	0.95	0.21	[0.54;1.36]		
Preschool	19	1.60	0.23	[1.15;2.04]		
Assessment and Evaluation	1	2.64	0.33	[2.00;3.28]		
Free Activity	3	0.55	0.13	[0.29;0.80]		
Social Studies	9	1.69	0.46	[0.80;2.58]		
All Lessons	1	0.33	0.16	[0.01;0.64]		
Turkish	12	0.99	0.18	[0.65;1.34]		
Creative Drama	5	0.48	0.19	[0.10;0.86]		
Intelligence Games	1	1.41	0.27	[0.88;1.92]		
Region of the Study					5.22	
Mediterranean	9	0.88	0.13	[0.61; 1.14]		
Eastern Anatolia	12	0.91	0.20	[0.52; 1.30]		
Aegean	7	0.91	0.48	[-0.04; 1.87]		
Southeast	2	0.30	0.57	[-0.82; 1.44]		
Central Anatolia	31	1.12	0.14	[0.84; 1.39]		
Black Sea	13	0.74	0.14	[0.45; 1.03]		
Marmara	30	0.80	0.10	[0.59; 1.01]		
School Type					2.52	
State	86	0.88	0.07	[0.73; 1.02]		
Private	17	0.87	0.16	[0.55; 1.19]		
Science and Arts Center	1	1.69	0.50	[0.69; 2.69]		

P.S.: k=number of studies, d= Cohen's d

(SOF), SE=Standard Error CI=Confidence Interval, Q= Heterogeneity between studies, Comparison analyzes are made for studies with sub-dimension numbers of 2 or more. * $p < .05$

As a result of the moderator analysis, it is determined that the effect sizes of the studies differ according to the education stage ($p=0.00$) and lessons ($p=0.00$). The results of the studies dealing with the preschools in terms of education stage show that the students' CTS are higher ($d=1.59$) in favor of SCA variable. In terms of lessons, especially in preschool education stage ($d=1.60$), it is seen that when SCA are applied in Social Studies ($d=1.69$), Assessment and Evaluation ($d=2.64$), Turkish ($d=0.99$) and Mathematics ($d=0.95$) lessons, students' CTS increased more compared to other lessons. As an interesting result, it is observed that the implementation of SCA in geography lessons does not have any effect on students' CTS ($d=-0.79$).

It is determined that the effect sizes of studies according to the publication type ($p=0.15$), school type ($p=0.28$), region of the study ($p=0.51$) does not differ significantly.

Conclusion and Discussion

In this study, 104 effect sizes are calculated from 104 studies constituting a sample of 6434. According to the results of the study, a statistically significant moderate effect size is determined according to the random effects model ($d=0.73$; [0.63; 0.82]) in favor of the students in the experimental group according to the SCA variable. This result is a medium level according to the classifications of Cohen (1988). The results of this meta-analysis study show that SCA practices are a significant variable that positively affects students' CTS.

According to the random effects model in the context of SCA variable, the result of a moderate positive difference in favor of the students' CTS is in parallel with the results of the researches conducted by Akar & Şengil Akar (2013), Akkılıç (2018), Akran & Aşiroğlu (2018), Aksoy (2018), Aktamış, Hiğde & Özden (2016), Altındağ et. al., (2012), Arkan Sezgin & Baysal (2019), Atalay (2014), Avcu (2014), Aydın (2011), Bacak (2008), Batdal Karaduman (2012), Birişçi & Karal (2011), Bulut (2015), Chung & Ro (2004), Çetinkaya (2014), Çolakoğlu (2018), Dere & Ömeroğlu (2018), Engin (2019), Kaya (2018), Terzi (2019), Tezci (2002), Tut (2018), Ülger & İmer (2013), Üret (2019), Yıldırım (2018), Yıldırım & Akman (2020), Yıldız (2012), Yiğit & Erdoğan (2008). The view that the use of SCA in lessons is effective in the development of higher order thinking skills of students, which also include CTS (Brown & Freeman, 2000; Galton, et. al., 2009; Pascarella, et al., 2013) supports this meta-analysis study. In the national and international literature, a meta-analysis study examining the effect of SCA on students' CTS is not found. In this context, it is not possible to compare the results of this study with the findings of other meta-analysis studies. No meta-analysis study dealing with the effect of various SCA on the CTS or a study on the holistic effect is not found in the literature.

It is seen in both individual studies and in this meta-analysis study that students' CTS increase in a classroom where SCA are used. However, in the moderator analysis conducted to reveal which approaches and methods are more effective, it is seen that approaches and methods that have the most effect among SCA on students' CTS are respectively; storyline, active learning, six thinking hats, brain-based learning, game-based learning and creative drama. The common point of these approaches are that they provide individual and group work environment, develop multiple learning skills, and bring in skills such as collaboration, discussion and empathy. In the meta-analysis study conducted by Hsen-Hsing Ma (2009), it is seen that problem solving and communication skills stand out among the important variables that affect creativity. In this context, especially active learning, brain-based learning, creative drama and game/storyline methods can be considered meaningful in the context of having more of these two skills. On the other hand, the effects of research-inquiry based learning, argumentation, and cooperative learning approaches on students' CTS are slightly lower than other methods. In the meta-analysis study conducted by Ören and Sarı (2019), the effect of research-inquiry based learning on students' higher order thinking skills is moderate and positive (ES=0.66), while in this meta-analysis study, the effect on CTS which is among higher order thinking skills is insignificant and low. This may be due to the fact that there is the only one study included in the scope of meta-analysis (Şensoy & Yıldırım, 2017). Generally, it is seen that research, interaction and activity-based learning positively affect students' higher order thinking skills, especially CTS (Aktamış, Hiğde & Özden, 2016). The findings of this meta-analysis study also support this view. In the context of this meta-analysis study, it can be said that learning environments where approaches and methods such as constructivist approach, storyline, educational games, active learning and drama are applied, the opportunities offered to students have a positive effect students' CTS. In these learning

environments, students actively work (Aydın, 2011) make inquiries, scientific method process is applied, and in this way, many higher order thinking skills, especially scientific process skills (Karakuş & Yalçın, 2016), are developed (Perry & Karpova, 2017).

Another result obtained in the study is that in terms of education stage, students' CTS is higher in favor of SCA in preschool education stage. Theorists (Hertzog, 2008; Özçelik, 2019; Vygotsky, 2004) that deal with the developmental processes of CTS state that the creativity of younger children is more developable and they use these skills more to make sense of the world around them. In the study conducted by Yaşar and Aral (2010), the finding that preschool education stage has a high impact on students' CTS also supports the results of this meta-analysis study. In the study conducted by Krauksta, Rozenvalde and Ciekurs (2016); It is revealed that active learning approaches involving activities carried out in extra-curricular environments and storyline and game activities contributed to the development of CTS in the preschool education stage. In the study conducted by Atay (2009), it is stated that students in preschool education stage have higher level of CTS than students at other stages, and that other than the use of SCA, imagination, flexible thinking and learning speed/agility are also effective as a feature of their cognitive development period. These meta-analysis results reveal that students contribute more to the development of CTS compared to other education stages, especially in this stage where the activity-intensive learning-teaching process is carried out. As we move from preschool education to higher education, it is seen that students' CTS decrease. This situation can be explained by the increase in the effect of a teacher-centered and exam-oriented education approach in primary and secondary education stages and the less use of SCA. However, the developmental process does not follow a linear rise in the context of creativity, it is stated that there is a collapse in CTS after the 4th grade (Hong & Milgram, 2010; Raina, 1980; Torrance, 1968). In addition, it is known that the students in the upper classes get higher scores in creative thinking than the students in the lower grades among classes 1 to 5 (Hong & Milgram, 2010; Sak & Maker, 2006). Due to this developmental difference in creativity skills, it is thought that in this meta-analysis study, results are in favor of preschool students. In addition, the finding that preschool teachers have high creative thinking tendencies in the study conducted by Eskidemir and Tezel (2019) supports the results of this meta-analysis study. In a sense, this can be evaluated as that the attitudes of the teachers are important in the development of the students.

In terms of scale type, Whetton and Cameron (2002) Creative Thinking Skill Scale "How Creative Are You?" which is used in 19 studies and The Torrance (1966) Creative Thinking Test scale "Test of Creative Thinking" used in 65 studies produced similar results. In the literature, it is seen that these two scales are often used to measure CTS in the world and in Turkey and that the validity/reliability is higher (Çetin, Üstündağ, Kerimoğlu and Beyazıt, 2015, Kim, 2011). It is seen that the effect size of the studies using these two scales ($ES=0.70-0.79$) is very close to the effect size found in this meta-analysis study ($ES=0.73$). However, there are significant differences between other scales in terms of effect sizes. In addition to the valid/reliable scales that measure students' CTS in a way that matches the results of the study, it is also seen that different measurement tools give results that are not close to each other (Carson, Peterson & Higgins, 2005; Dollinger, Urban & James, 2004; Haasse et al., 2018).

When the gender of the researcher is female, it is seen that the students' CTS are higher in favor of SCA. This can be explained by the fact that only 26 of the 104 studies included in the meta-analysis study are done by male researchers and that female researchers have more interest and motivation for learning and studying on this subject. In addition, the fact that studies in the preschool education stage and studies where the students have higher CTS are carried out by female researchers can be effective in this.

In terms of the moderator variable, it is observed that the students are more likely to increase their CTS when SCA are applied in lessons in preschool education stage and Social Studies, Philosophy, Assessment and Evaluation, Turkish, Mathematics and Visual Arts lessons in different education stages. Since teacher centered approaches and methods are generally used in these lessons, it is clear that when SCA are applied, it will contribute more to the development of higher order thinking skills of students (Perry & Karpova, 2017; Weimer, 2002). As an interesting result, it is observed that the application of SCA does not have any effect on students' CTS in geography lessons. Geography lessons in Turkey are carried out with many concepts taught with a complex structure (Akbulut, 2004). Although student centered approaches are tried to be used, it is difficult to increase creativity in schools without geography laboratories (Gardner et al., 1997; as cited in Akbulut, 2004). This interesting result of the study is thought to have originated from the conditions in which Geography lessons are carried out in Turkey.

It is determined that the effect size of the studies does not differ according to publication type, student group (normal-gifted), school type (state, foundation, science and arts center) and region of the study. Since no meta-

analysis studies that reveal the effect of SCA on students' CTS carried out in Turkey and abroad are found, it is impossible to compare results.

Furthermore, it is seen that the positive effect of SCA used in lessons on students' CTS continues within years of which meta-analysis studies are carried out (1990-2020). The adoption of the constructivist approach in the education programs in Turkey since 2005 has increased interest in the higher order thinking skills such as CTS. Therefore, the research carried out in Turkey dealing with CTS is known to increase in numbers after 2005 (Saracaloğlu et. al., 2014).

Recommendations

Recommendations for Researchers

- In the context of the results of this meta-analysis study, meta-analysis studies can be conducted by using variables that have effect on students' CTS other than SCA applications such as teacher quality, school culture, out-of-school activities, family and social environment.
- In the context of the results of this meta-analysis study, it can be suggested to make qualitative and quantitative studies on the factors that may have effect on students' CTS. Studies can be conducted to determine the effects of SCA on higher order thinking skills other than CTS (problem solving, meta-cognitive thinking etc.).
- It can be suggested to make meta-synthesis studies on the factors that may have effect on students' CTS.
- It can be suggested to make research conducted outside the Turkey in order to compare and to generalize the findings of the meta-analysis.

Recommendations for Implementers

- As a result of the meta-analysis study, it is observed that the learning-teaching approaches such as storyline, active learning, six thinking hats, brain-based learning, game-based learning and creative drama are more effective on students' CTS than other approaches. In this context, it can be suggested that teachers use these approaches more in the lessons for the development of students' CTS. In addition, it can be suggested to use more of SCA and activities that develop students' CTS in primary and secondary education.
- It can be suggested to use teaching methods and techniques based on social interaction in cognitive sense in order to develop students' creative thinking skills.

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(The symbol of * refers to the studies included in the meta-analysis).

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