



How to teach critical thinking: an experimental study with three different approaches

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Abstract

The aim of this study was to examine the effects of critical thinking (CT) teaching involving general, immersion, and mixed approaches on the CT skills and dispositions of high-school students. The study, which had three experimental groups (EG) and one control group, employed a pretest–posttest control-group quasi-experimental design. CT teaching was initiated with a general approach in EG I, an immersion approach in EG II, and a mixed approach in EG III. The Critical Thinking Skill Test and UF/EMI Critical Thinking Disposition Instrument were used to collect the data. General, immersion, and mixed approaches improved CT skills and dispositions, with a large effect size for the improvement of CT skills. CT teaching with general, immersion, and mixed approaches had large, moderate, and small effects, respectively, on improving CT dispositions. In terms of improving CT skills and dispositions, the most effective approach, respectively, was the general, mixed, and immersion approach.

Keywords Critical thinking teaching · General approach · High-school students · immersion approach · Mixed approach

Introduction

Critical thinking (CT), in many classifications of higher-order thinking skills in the literature (Lipman, 2003; Presseisen, 1985), is a functional and sensible way of thinking that is employed by individuals for deciding what to believe or to do in the face of problems (Ennis, 1991). CT is basically individuals' act of defending themselves against the world in an era when a great amount of information is easily accessible or several people try to influence us or our thoughts (Epstein & Kernberger, 2012). Individuals acquire healthy and accurate information about their surroundings through CT by questioning, examining, and evaluating

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information. That evaluation is the task of reviewing the underlying reasons and looking for sound evidence to decide whether the information is accurate or not (Mason, 2008). Thanks to CT, individuals evaluate the sensibility and accuracy of information, claims and judgments and, after that, come to conclusion (Lewis & Smith, 1993).

Another major point about CT is that it involves not only skills such as inference, deduction or interpretation, but also a disposition towards using those skills such as being open-minded, systematic, or willing to seek the truth (Ennis, 2018). According to Paul & Elder (2001), CT dispositions are regarded as vital as CT skills because having high CT skills is not enough to use those skills in everyday life. Therefore, it can be said that individuals can be seen as good critical thinkers only when they have high CT skills and dispositions together (Profetto-McGrath, 2003). If the individual does not have a strong inclination towards using CT skills, these skills might not be used by the individual; on the other hand, without having high CT skills, having high CT dispositions might be meaningless (Profetto-McGrath et al., 2003). Therefore, it is important for individuals to have high CT skills and strong dispositions together.

As one of the most essential skills that students from all educational levels should possess (Ennis, 2018; Kaepfel, 2021), CT attracts much-deserved attention in the business world as well (Al-Zou'bi, 2021). The Future of Jobs Report (World Economic Forum, 2020) lists CT among the top ten skills to be required in the business world in 2025. Moreover, the International Summit on the Teaching Profession held in 2016 listed CT as being among the most-important skills for elementary-school students who are still studying and will start their careers approximately in 2030 (Schleicher, 2016).

In this century, there is consensus on the importance of CT for societies, but debate on how it is to be taught is still in progress (Bellaera et al., 2021; Lombardi et al., 2021). CT skills can be taught to everyone through an appropriate education (Kennedy et al., 1991; Scriven & Paul, 2005) regardless of age (Bailin et al., 1999) or level of intelligence (Lewis & Smith, 1993). However, there are different opinions on how such appropriate education of CT will be performed. In the literature, approaches to CT teaching are addressed under the four topics of infusion, immersion, general, and mixed approaches (Ennis, 1991).

The main point in the infusion approach is to teach CT skills and the subject area explicitly. Hence, the teacher has two main objectives which are to teach the subject area and foster CT skills. Students utilize their CT skills by adapting them to the subject area (Gann, 2013). In the immersion approach, CT skills should not be taught explicitly when information on the subject area is conveyed to students (Hager & Kaye, 1992). Therefore, its significant difference from the infusion approach is that the students are not taught CT skills directly. In the immersion approach, it is considered that CT skills develop automatically through activities such as discussion, pair work, group work, and problem solving which are utilized when teaching the subject area (Gann, 2013). The main assumption which underlies this approach is that CT skills depend on given content and that, without acquiring information about the subject area first, individuals cannot utilize their CT skills on that specific area (McPeck, 1981; Willingham, 2008). Thus, teaching CT skills along with the subject area yields more-effective results than teaching skills independently of the subject area (Daniel & Auriac, 2011; Mason, 2008). Having a deep relationship with the subject area, CT skills cannot be converted into behavior by students who do not possess sufficient knowledge on the subject area (Willingham, 2008). The CT process is about the content of thinking, and these skills cannot be learned at once and easily transferred to different areas. According

to Ruggerio (1988), there are two main reasons why CT is taught along with content. One reason is the challenge of ensuring that CT skills become retentive in students, and the other reason is that infusion of CT skills across the course content increases interest, desire, and motivation with regards to the course.

In the general approach, CT should be taught independently of the subject area. Accordingly, there is no need for any content in CT teaching (Ennis, 1997) and one should attempt to teach students CT skills within the scope of a separate course (Ennis, 1997; Ian, 2002). Content in the general approach is the CT skills itself. Indeed, when CT skills are taught in a separate course, it is ensured that students' only focus is those skills (Gann, 2013; Lipman, 1988). Instead of struggling with learning information in the subject area, students spend their energy and effort on acquiring the CT skills (Ian, 2002). In addition, for a student who has acquired CT skills independently of a subject area, it is easier to transfer those skills to different subject areas, outside-school contexts, or the real world (Ennis, 1997; Haskell, 2001). While fostering CT skills, students need well-planned practices, which are only possible through CT teaching in a separate course (Van Gelder, 2005).

The mixed approach utilizes general and infusion or immersion approaches to CT teaching together (Nicholas & Raider, 2011). In this approach, CT teaching starts with the general approach and continues with the infusion or immersion approach, or the infusion or immersion approach is followed by the general approach (Gann, 2013). Reviewing the studies that involve CT teaching with several approaches, Kennedy et al., (1991) state that, because those approaches are not superior to each other, one should use the mixed approach. Indeed, the mixed approach allows combining the strengths of general, infusion and immersion approaches.

Previous studies on teaching CT

Arisoy & Aybek (2021) conducted an experimental study to examine the effect of CT teaching with the general approach on students' CT skills and dispositions and concluded that it enhanced students' CT skills ($\eta^2=0.52$) and dispositions ($\eta^2=0.66$) with large effect sizes. Also, in their study aiming to investigate the effect of CT teaching with the immersion approach on CT skills, Schreglmann & Karakuş (2017) concluded that it enhanced students' CT skills with a large effect size. Besides, in their study investigating the effect of CT teaching with general approach on CT skills and dispositions, Taghinezhad & Riasati (2020) found that teaching CT explicitly enhanced students' CT skills ($d=2.83$) and dispositions ($d=0.80$) with large effects. Aybek (2006) conducted a study with two experimental groups and one control group to compare the effect of immersion and general approaches on CT skills and dispositions. In her study with university students, Aybek (2006) used CoRT 1 program to teach CT skills explicitly and used the immersion approach in social sciences lesson. CT teaching both with the general approach (skills $d=2.19$, dispositions $d=2.01$) and the immersion approach (skills $d=1.10$, dispositions $d=1.08$) enhanced students' CT skills and dispositions. Also, it is possible to say that CT teaching with the general approach enhances students' CT skills and dispositions more than the immersion approach (skills $\eta^2=0.43$, dispositions $\eta^2=0.19$).

In their study with two experimental and one control groups, Marin & Halpern (2011) examined the effect of the general and immersion approaches on the CT skills of high-school students. According to Marin & Halpern (2011), both general ($d=0.67$) and immer-

sion approaches ($d=0.25$) increase students' CT skills. Also, the general approach is more effective than the immersion approach to enhance CT skills ($d=0.51$). When Kurnaz (2017) compared the effect of general and immersion approaches on CT skills, the general approach was more effective than the immersion approach in enhancing CT skills ($\eta^2=0.23$). Also, there have been many other experimental studies which concluded that the general approach (Ari, 2020; Eldeleklioğlu & Özkılıç, 2008; Karadağ & Demirtaş, 2018; Rahdar et al., 2018; Zulkifli & Hashim, 2020), the immersion approach (Bağ, 2020; Fung & Howe, 2012; Reed & Kromrey, 2001; Yuan et al., 2008) and the mixed approach (Ku et al., 2014; Plath et al., 1999) enhances CT. Although there have been several experimental studies of the effectiveness of these approaches, there is no consensus about which approach is more effective (Cáceres et al., 2020; Larsson, 2017). Moreover, there are a few studies that compared the effect of immersion and general approaches to CT teaching (Aybek, 2006; Kurnaz, 2007; Marin & Halpern, 2011; Williams & Worth, 2001).

Thus, with the aim of comparing the effects of immersion, general, and mixed approaches on CT, this study is important. Also, our study is important for addressing the mixed approach in addition to the immersion and general approaches which have been studied more frequently, thus making it possible to compare how the three most basic approaches to CT teaching affect CT. Besides, this study is important for learning environments that aim to enhance CT because it provides some important evidence for the best approach for teaching CT.

Research questions

Therefore, the aim of this study was to investigate the effects of CT teaching involving general, immersion, and mixed approaches on the CT skills and dispositions of high-school students. To this end, answers to the following questions were sought for:

1. Are there any significant differences in the Critical Thinking Skill Test for High School Students (CTST) pretest and posttest scores between a control group and (a) the experimental group (EG) I for which CT teaching involved the general approach, (b) the EG II group for which CT teaching involved the immersion approach, and (c) the EG III group for which CT teaching involved the mixed approach?
2. Are there any significant differences among the CTST posttest scores of the students in the EG I, II, III, and control groups?
3. Are there any significant differences between EG I, II, III and the control groups in terms of students' scores on the UF/EMI Critical Thinking Disposition Instrument (CTDI) pretest and posttest?
4. Are there any significant differences between the EG I, II, III, and the control groups in terms of students' CTDI posttest scores?

Method

Research design

In this study, a pretest–posttest control-group quasi-experimental design was employed. While CT skills and CT dispositions were the dependent variables, the general, immersion, and mixed approaches to CT teaching were the independent variables. In this research design, groups are randomly assigned (Büyüköztürk et al., 2014). Our study was quasi-experimental because the existing classes were utilized at the high school where the study was carried out. Of four randomly-chosen classes, three were assigned as EGs, and one was assigned as the control group. Table 1 presents the design used in the research.

CT teaching was initiated with the general approach in EG I, with the immersion approach in EG II, and with the mixed approach in EG III. In EG III, CT teaching was started with general approach and finished with the immersion approach. No experimental procedures were followed in the control group, and the students in this group continued their curriculum being practiced in their school. The CTST and CTDI were implemented as pretests and posttests in all groups.

Study group

The study group consisted of 114 ninth-grade students studying in four different classes of a high school in northern Turkey in the academic year of 2019–2020. There were six ninth-grade classes in the high school and four of them were randomly chosen. After that, the classes were randomly assigned as EGs and a control group. All students voluntarily participated in the study and none of them had received any previous training on CT. Ninth-grade high-school students were chosen as the study group because generating positive attitudes and behaviors including CT skills and dispositions is easier with younger ages (Lee, 2018; Lombardi et al., 2021). Before the study, when a priori power analysis for conducting a one-way ANOVA with 4 groups was carried out using Faul et al.'s (2007) G*Power 3 software program, it was found that the minimal sample size of students needed for this study ($\alpha=0.05$, power=0.95) to have a large effect ($\eta^2=0.25$) was 56 based on the previous experimental studies (Aybek, 2006; Kurnaz, 2017; Marin & Halpern 2011). Therefore, the sample size of 114 in this study was adequate.

Table 1 Design used in the research

Group	Pretest	CT teaching	Posttest
EG I	CTST+CTDI	general approach	CTST+CTDI
EG II	CTST+CTDI	immersion approach	CTST+CTDI
EG III	CTST+CTDI	mixed approach	CTST+CTDI
CG	CTST+CTDI	X	CTST+CTDI

EG I: general approach

EG II: immersion approach

EG III: mixed approach

CG: control group

CTST: Critical Thinking Skill Test for High School Students

CTDI: UF/EMI Critical Thinking Disposition Instrument

Table 2 Demographic characteristics of students in EGs and control group

Demographic Characteristics		EG 1		EG 2		EG 3		Control Group	
		f	%	f	%	f	%	f	%
Gender	Female	19	65.5	16	61.5	16	55.2	16	53.3
	Male	10	34.5	10	38.5	13	44.8	14	46.7
Educational background of mother	Primary	6	20.7	7	26.9	6	20.7	3	10
	Secondary	6	20.7	7	26.9	4	13.8	2	6.7
	High school	9	31	4	15.4	13	44.8	9	30
	University	8	27.6	6	23.1	6	20.7	10	33.3
	Master/PhD	0	0	2	7.6	0	0	6	20
Educational background of father	Primary	5	17.2	2	7.7	5	17.2	1	3.3
	Secondary	0	0	5	19.2	2	6.9	5	16.7
	High school	12	41.4	10	38.5	10	34.5	9	30
	University	12	41.4	7	26.9	10	34.5	10	33.3
	Master/PhD	0	0	2	7.7	2	6.9	5	16.7
Total		29		26		29		30	

As it can be seen in Table 2, there were 29 students in EG I, 26 students in EG II, 29 students in EG III, and 30 students in the control group. Of the students in EG I, 65.5% are females and 34.5% are males. Mothers of those students are graduates of high school (31%), university (27.6%), primary school (20.7%), and secondary school (20.7%), respectively. The majority of their fathers are graduates of high school (41.4%) and university (41.4%). Of the students in EG II, 61.5% are females and 38.5% are males. The majority of their mothers are graduates of primary school and secondary school (53.8%) and 23.1% of the mothers are university graduates. Fathers of EG II students are graduates of high school (38.5%), university (26.9%) and secondary school (19.2%). Of the students in EG III, 55.2% are females and 44.8% are males. The majority of their mothers are high school graduates (44.8%), with 20.75% of mothers who are university graduates (20.7%) and 20.7% of mothers who are graduates of primary school. The majority of their fathers are graduates of high school and university (69%). Of the control group students, 53.3% are females and 46.7% are males, with 33.3% of their mothers being university graduates while 30% of them graduated from high school. 33.3% of their fathers are university graduates, whereas 30% of them graduated from high school.

The students can enroll and study in the high school in which the study was conducted after a nationwide examination. Therefore, it is possible to say that the students in four groups are comparable to each other in terms of academic success. Also, because it is a public high school, families of the students in all groups had similar socio-economic backgrounds.

As presented in Table 3 and 4, there was no statistically-significant difference between the three EGs and one control group for the pretest scores of students for the CTST ($\chi^2_{(sd=3, n=114)}=6.555, p>0.05$) and the CTDI ($F_{(114)}=2.273; p>0.05$).

Procedure

In the EGs, the courses were held for two class hours a week for ten weeks in total. The duration of the courses was 40 min. The researcher was the instructor of the courses for all EGs. Control group students continued the curriculum being taught in their school and no experimental procedures were followed in this group. The researcher did not have any extra teaching motivation when implementing CT activities in three EGs not to influence

Table 3 Kruskal-Wallis H test results for CTST pretest scores

Group	<i>N</i>	Mean rank	χ^2	df	<i>p</i>	η^2	Sig. difference
EG I	29	63.41	6.555	3	0.088	-	-
EG II	26	58.94					
EG III	29	63.62					
Control	30	44.62					

Table 4 One-Way ANOVA test results for CTDI pretest scores for four groups

Group	<i>N</i>	$\bar{X}$	SD	df	<i>F</i>	<i>p</i>	η^2	Sig. difference
EG I	29	3.84	0.41	3/110	2.273	0.084	-	-
EG II	26	3.65	0.44					
EG III	29	3.81	0.48					
Control	30	3.60	0.31					

the results of the current study. Besides, the researcher did not perform any extra activities to increase student motivation in any EGs and just followed the pre-prepared lesson plans. The activities and materials related to CT teaching were conducted in all groups just as planned by the researcher. The researcher formed a democratic classroom environment as much as possible during the teaching and organized the classroom to allow group work and 10–15 min breaks between two courses in all groups.

CT teaching with general approach

In CT teaching with the general approach in EG I, six steps suggested by Beyer (1991) and part one of CoRT thinking program developed by De Bono (2019) were utilized. In those courses of EG I, CT skills were taught explicitly, with the students being informed of the objective. Beyer (1991) suggests six steps for CT teaching with the general approach: introduction, guided practice, independent practice, transfer, guided practice, and autonomous practice. In fact, it is possible to consider the steps suggested by Beyer (1991) in two groups because the first three steps and the last three steps are similar to each other. While the first three steps are related to the learning of the skill, the last three steps are related to the transfer of the skill to different areas. Both three-step sections start with guided practices and end with autonomous practices of the skill. Six steps suggested by Beyer (1991) start with informing students of the skill and end with students' autonomous use of the skill. In this process, progression starts in company with a guide and continues as an independent practice. The instructional plan used in the present study was prepared in consideration of the steps suggested by Beyer (1991) and using the CoRT 1 thinking program for CT teaching with the general approach. In the courses, students were explicitly taught about CT skills before being asked to use these skills in five distinct activities. During those activities, teacher guidance was gradually reduced, with the last activity being completed independently by the student. Next, the process was discussed with the students and the principles for using the skills were agreed upon mutually.

CT teaching with immersion approach

Because the content used for CT teaching in EG II was environmental education, students were taught the CT skills indirectly through immersion in environmental education rather than explicitly. The instructional plans used for CT teaching with immersion approach were prepared based on the instructional plan development process developed by Paul et al., (1990) which involves CT strategies. When designing the instructional plans, the three CT strategies identified by Paul et al., (1990) (affective strategies, macro-abilities, and micro-skills) were embedded into the plans. In the courses, students' attention was drawn to the subject, the students were informed of that day's objective, and the stimulating material was presented. Then, the subject was presented to students and learning was guided. Finally, activities were performed to allow students to exhibit the target behaviors, and the course was completed with an activity which made it easier for the student to recall the subject. During the courses, activities such as group work, discussion, pair work, and problem solving were utilized a lot to teach the subject related to environmental education.

CT teaching with mixed approach

The CT teaching in EG III was conducted with the general approach in the first five weeks and the immersion approach with environmental education in the last five weeks. The same lesson plans used for CT teaching with general and immersion approach were also used in mixed CT teaching.

Control group

No procedures were followed for the control group students other than the implementation of the measures as pretests and posttests. These students experienced the courses within their curriculum, which was checked to see whether the control group students took any courses or carried out activities about CT in the spring term of 2019–2020 academic year. It was understood that no effort had been made regarding the CT teaching.

After the pretests had been implemented in four groups in the first week of the spring term in 2019–2020 academic year, the experimental procedure was started in the second week of the term. Because of the COVID-19 pandemic, instructional materials and plans were adapted to distant education so that the final four weeks of the experimental procedure were completed with online classes.

Measures

Critical Thinking Skill Test for High School Students (CTST)

The CTST developed by Orhan & Çeviker Ay (2022) was utilized to measure students' CT skills. This test was based on the CT skills classification by Watson & Glaser (1994). It has 51 items in total and five sub-skills, namely, inference (10 items), evaluating arguments (8 items), deduction (11 items), recognizing assumptions (12 items) and interpretation (10 items). The test has multiple-choice items and was developed to evaluate students' CT skills. Its mean item difficulty value and mean item discrimination value was 0.52 and 0.42, respectively. For the test's criterion validity, the decision-making skill was used based on the previous literature (Chang et al., 2020; Halpern, 2003; Özgenel, 2018), and the students who were cautious and picky when making a decision were found to have significantly higher scores than students who acted complacently, panicked and tended to avoid taking responsibility when making a decision. KR20 reliability coefficients ranged between 0.62 and 0.76 for the sub-tests and was 0.87 for the total test. Students receive 0 point for their incorrect response and 1 point for correct answers, with the maximum score being 51 and minimum score being 0 for CTST.

UF/EMI Critical Thinking Disposition Instrument

The CTDI developed by Irani et al. (2007) and adapted to Turkish language by Kılıç & Şen (2014) was used to determine students' CT dispositions. The instrument has the three sub-dimensions of engagement, maturity, and innovativeness. In adaptation study with 342 high school students by Kılıç & Şen (2014), one item was omitted from the instrument, but the other items were consistent with the original construct. Reliability estimates of the CTDI's

sub-dimensions ranged from 0.70 to 0.88 and it was 0.91 for the total scale. CFA conducted for the present study confirmed the three-factor structure of the instrument ($\chi^2/\text{sd}=2.05$; RMSEA=0.08; CFI=0.93; SRMR=0.10). The reliability coefficients calculated for the present study were 0.85, 0.68, 0.70, and 0.86 for engagement, maturity, innovativeness, and total scale, respectively.

Data collection

Upon ethical committee approval (No. 2019/86 dated 5.11.2019) and research approval (No. E23489630 dated 27.11.2019), data were collected in the spring term of the 2019–2020 academic year. Pretests were administered in the first week of the term before the CT teaching started in all groups, whereas posttests were administered after the CT teaching finished in all groups. Students were informed about privacy and confidentiality issues, as well as their right to withdraw from the study whenever they want. Administration time for the CTST was about 40 min and for the CTDI was about 20 min.

Data analysis

SPSS 20 statistical software was used to analyze the data. Firstly, each variable was reviewed to see if there were any missing data, and no missing data were found. Then, normality was tested for data distribution. In this study, we used z transformation to determine outliers for each variable. Tabachnick & Fidell (2012) suggest that z -scores with values higher than 3.29 can be seen as potential outliers, but no outliers were found in this study. We also checked multivariate outliers with Mahalanobis Distance scores (Mahalanobis D^2), but no influential outliers were seen in the dataset. In this study, paired samples t tests were used to determine the effect of time on CT skills and dispositions of high school students in the groups with normally-distributed data, while the Wilcoxon Signed-Rank Test was utilized in other groups. Furthermore, one-way ANOVA was conducted to analyze the effects of general, immersion, and mixed approaches on the CT skills and dispositions of students in the groups with normally-distributed data, while the Kruskal-Wallis H test was utilized in other groups.

Results

Results on CT skills

The results of the paired-samples t test results for the CTST pretest and posttest scores of EG I students are shown in Table 5, which indicates a significant difference between the pretest and posttest scores of EG I students ($t_{29}=-10.482$; $p<0.05$) in favor of the posttest.

Table 5 Paired samples t test for the CTST pretest and posttest scores of EG I students

Group	Test	N	$\bar{X}$	SD	t	p	d
EG I	Pretest	29	34.96	5.52	-10.482	0.000	3.04
	Posttest	29	47.41	1.74			

Moreover, the CT teaching with the general approach greatly improved CT skills of the high-school students ($d=3.04$).

As shown in Table 6, a significant difference was found between the CTST pretest and posttest scores of EG II ($z=-4.335$; $p<0.05$) and EG III students ($z=-4.717$; $p<0.05$) in favor of the posttest. Both the immersion approach ($d=3.22$) and the mixed approach ($d=3.52$) to CT teaching greatly improved the CT skills of high-school students. There was no significant difference between the CTST pretest and posttest scores for the control group ($z=-0.480$; $p>0.05$). In other words, the teaching in the control group did not improve students' CT skills.

Kruskal-Wallis H test results for the CTST posttests of students in three EGs and one control group are provided in Table 7. A significant difference can be observed among the CTST posttest scores of the students in EG I, EG II, EG III and the control group ($\chi^2_{(sd=3, n=114)}=79.544$, $p<0.05$). CT posttest scores of the EG I students to whom CT was taught with the general approach ($\bar{X}:47.41$) had higher scores than EG II students ($\bar{X}:39.61$) and EG III students ($\bar{X}:44.06$), which accounted for a significant difference. In addition, EG III students to whom CT was taught with the mixed approach ($\bar{X}:44.06$) had higher and significantly different CTST posttest scores than EG II students ($\bar{X}:39.61$). The CTST posttest scores of students in three EGs were higher than the scores of the control group students, and these differences were significant. The intergroup difference had a large effect size for CT skills ($\eta^2=0.69$). Thus, 69% of the change in the CT skills of the students was attributable to the intergroup difference.

Table 6 Wilcoxon Signed-Rank test for CTST pretest and posttest scores of EG II, III, and control groups

Group	Posttest–Pretest	<i>N</i>	Mean rank	Sum of ranks	<i>z</i>	<i>p</i>	<i>d</i>
EG II	Negative Ranks	1	2.00	2.00	-4.335	0.000	3.22
	Positive Ranks	24	13.46	323.00			
	Ties	1					
EG II	Negative Ranks	0	0.00	0.00	-4.717	0.000	3.52
	Positive Ranks	29	15.00	435.00			
	Ties	0					
Control group	Negative Ranks	11	16.55	182.00	-0.480	0.631	-
	Positive Ranks	17	13.18	224.00			
	Ties	2					

Table 7 Kruskal-Wallis H test results for CTST posttest scores of the students in three EGs and control group

Group	<i>N</i>	Mean rank	χ^2	SD	<i>p</i>	η^2	Sig. difference				
EG I	29	93.48	79.544	3	0.000	0.69	A – D				
EG II	26	46.31					B – D				
EG III	29	69.91					C – D				
Control	30	20.42					A – C				
							A – B				
							C – B				

EG I=A EG II=B EG III=C Control Group=D

Results on CT dispositions

The results of the paired-samples t test results for the CTDI pretest and posttest scores of all groups are shown in Table 8. This table shows a significant difference between CTDI pretest and posttest scores of EG I ($t_{29}=-9.272, p<0.05$), EG II ($t_{26}=-5.872, p<0.05$) and EG III ($t_{29}=-4.167, p<0.05$). CT teaching with the general approach had a large effect ($d=1.12$), CT teaching with the immersion approach had a moderate effect ($d=0.74$), and CT teaching with the mixed approach had a small effect ($d=0.44$) on improving students' CT dispositions. There was no significant difference between the CTDI pretest and posttest scores for the control group ($t_{30}=-0.019, p>0.05$).

One-way ANOVA results for the CTDI posttest scores of the high-school students in three EGs and one control group are presented in Table 9. A statistically-significant difference was found among the CTDI posttest scores of EG I, EG II, EG III, and the control group ($F_{(114)}=18.125; p<0.05$), with the intergroup difference having a large effect size for CT dispositions of students ($\eta^2=0.26$). To put it another way, 26% of the change in students' CT dispositions was attributable to the intergroup difference. There were significant differences between the posttest scores of EG I students ($\bar{X}:4.28$) compared with EG II ($\bar{X}:3.94$), EG III ($\bar{X}:4.00$) and control group ($\bar{X}:3.60$) students. CT teaching with the general approach was more effective in improving students' CT dispositions than teaching with the immersion approach and mixed approaches. Furthermore, no significant difference was found between the effects of CT teaching with the immersion approach ($\bar{X}:3.94$) and with the mixed approach ($\bar{X}:4.00$) in terms of improving students' CT dispositions. This suggests that these two approaches were similarly effective in terms of students' CT dispositions. Moreover, there was a significant difference between the CTDI posttest scores of EG I ($\bar{X}:4.28$), EG II ($\bar{X}:3.94$), EG III ($\bar{X}:4.00$) and the control group ($\bar{X}:3.60$) in favor of the EGs.

Table 8 Paired-samples t test for CTDI pretest and posttest scores of students in three EGs and control group

Group	Test	<i>N</i>	$\bar{X}$	SD	<i>t</i>	<i>p</i>	<i>d</i>
EG I	Pretest	29	3.84	0.41	-9.272	0.000	1.12
	Posttest	29	4.28	0.37			
EG II	Pretest	26	3.65	0.44	-5.872	0.000	0.74
	Posttest	26	3.94	0.33			
EG III	Pretest	29	3.81	0.48	-4.167	0.000	0.44
	Posttest	29	4.00	0.36			
Control	Pretest	30	3.60	0.31	-0.019	0.985	-
	Posttest	30	3.60	0.33			

Table 9 One-Way ANOVA test results for CTDI posttest scores of students in three EGs and control group

Group	<i>N</i>	$\bar{X}$	SD	df	<i>F</i>	<i>p</i>	η^2	Sig. difference
EG I	29	4.28	0.37	3/110	18.125	0.000	0.26	A–B
EG II	26	3.94	0.33					A–C
EG III	29	4.00	0.36					A–D
Control	30	3.60	0.33					B–D
								C–D

EG I=A EG II=B EG III=C Control Group=D

Hence, all three approaches to CT teaching improved high-school students' CT dispositions more than the usual courses and activities practised in the school.

Conclusion and discussion

Discussion on CT skills

Whereas general, immersion, and mixed approaches to CT teaching improved the CT skills of high-school students, no improvement was observed in the skills of the control group. General, immersion, and mixed approaches were found to have a large effect size for the improvement of high-school students' CT skills. As shown by meta-analysis seeking a general effect size by combining the results of experimental studies in the literature, the general approach (Çeviker Ay & Orhan, 2020; Bangert-Drowns & Bankert, 1990) and immersion approach (Çeviker Ay & Orhan, 2020) to CT teaching are largely effective in improving the CT skills.

In line with the results of the present study, there are several experimental studies suggesting that CT teaching with the general approach (Al-Edwan, 2011; Alwehaibi, 2012; Ari, 2020; Arisoy & Aybek, 2021; Eldeleklioğlu & Özkılıç, 2008; Karadağ & Demirtaş, 2018; Lou, 2018; Marin & Halpern, 2011; Rahdar et al., 2018; Smith et al., 2018; Taghinezhad & Riasati, 2020), immersion approach (Bağ, 2020; Fung & Howe, 2012; Jensen Jr., 2015; Lopez et al., 2020; Marin & Halpern, 2011; Reed & Kromrey, 2001; Zulkifli & Hashim, 2020) and mixed approach (Ku et al., 2014; Plath et al., 1999; Welch et al., 2015) significantly improved CT skills. Also, after examining experimental studies of CT teaching, Tiruneh et al. (2014) concluded that CT skills or dispositions were significantly improved in 80% of studies conducted with the general approach to CT teaching, 55% of studies conducted with the immersion approach to CT teaching and 67% of studies conducted with the mixed approach to CT teaching. Payan-Carreira et al. (2019) state that 70% of the studies utilizing the immersion approach and three of the four studies utilizing the mixed approach included in their research significantly improved CT skills and dispositions.

Most of the experimental studies concluding that CT teaching with different approaches significantly affected CT skills failed to report the effect size associated with this teaching. Therefore, in order to compare the results of our study with previous research in the literature, the effect sizes associated with the studies whose effect size was calculated, the general approach (Alwehaibi, 2012; Aybek, 2006; Lou, 2018; Yıldırım, 2010) and the immersion approach (Aybek, 2006; Şahin, 2016; Yuan et al., 2008) had a large effect on CT skills.

The fact that all three approaches utilized in the present study significantly improved students' CT skills with a large effect size coincides with the results of several studies in the literature. According to Kennedy et al., (1991), everyone can be taught CT skills through an appropriate education. Moreover, the success of CT teaching does not vary with whether individuals are gifted (Lewis & Smith, 1993) or with their age (Bailin et al., 1999; Kennedy et al., 1991). Indeed, various experimental studies conducted at different educational levels including primary education (Bayrak, 2014; Jensen, 2015) and undergraduate education (Aybek, 2006; Eldeleklioğlu & Özkılıç, 2008; Welch et al., 2015) and with different age groups showed that CT skill is teachable. The fact that all of the CT teaching performed

with different approaches in three EGs were effective in improving high-school students' CT skills coincides with these considerations in the literature.

This study revealed that CT teaching with the general approach was more effective in improving students' CT skills than CT teaching with the immersion and mixed approaches. Moreover, CT teaching with the mixed approach improved CT skills of high-school students more than CT teaching with the immersion approach. In improving CT skills of high-school students, the most-effective approach to CT teaching was the general approach, which was followed by the mixed and immersion approach, respectively.

In line with these results, several studies comparing the effects of immersion and general approaches to CT teaching on students' CT skills indicated that the general approach was more effective than the immersion approach to CT teaching (Aybek, 2006; Kurnaz, 2007; Marin & Halpern, 2011; Williams & Worth, 2001). Behar-Horenstein & Niu (2011) suggest that when compared with other approaches, the immersion approach to CT teaching is the least effective in improving students' CT skills. As argued by Tiruneh et al. (2014), the most-effective approach to improving students' CT skills is the general approach followed by the mixed, infusion, and immersion approaches, respectively. According to Abrami et al. (2008), the least effective approach to improving students' CT skills is the immersion approach. It is possible to say that the results obtained in the present study coincide with the results achieved by Behar-Horenstein & Niu (2011), Tiruneh et al. (2014) and Abrami et al. (2008).

Criticism of the immersion approach to CT teaching is based on the assumption that students who have neither learned CT skills explicitly nor had any explicit knowledge and understanding of those skills have difficulty in transferring their skills to other areas (Ennis, 1993). Accordingly, as for the students who acquired CT skills with the immersion approach through environmental education in this study, their skills would be limited to that subject area and they would fail to transfer their skills to everyday life and real-life situations (Ennis, 1989). Hence, the fact that the least-effective approach improving CT skills among high-school students was the immersion approach in the present study can be explained with these considerations that underpins the relevant criticism. The test used to measure CT skill in the research includes questions that are independent of environmental education and about real events derived from everyday life. Thus, one can argue that the students who had acquired CT skills within the scope of environmental education might have found it difficult to transfer their skills to everyday life compared with students who received CT teaching with general approach. Although CT teaching with the immersion approach improved the CT skills of high-school students effectively and significantly, that might explain why general and mixed approaches to CT teaching were more effective in enhancing students' CT skills.

Discussion on CT dispositions

In this study, while the general, immersion, and mixed approaches to CT teaching improved the CT dispositions of high-school students, no improvement was observed in the dispositions of the control-group students. CT teaching with general, immersion, and mixed approaches had large, moderate, and small effects on improving students' CT dispositions, respectively. In most of the experimental studies examining the effect of CT teaching with the general approach (Arisoy & Aybek, 2021; Aybek, 2006; Bayrak, 2014; Eldeleklioğlu &

Özkılıç, 2008; Lou, 2018) and the immersion approach (Aybek, 2006; Yıldırım & Şensoy, 2011) on the CT skills and dispositions of students, CT teaching with the general and immersion approaches improved students' CT dispositions. Thus, as found in the present study, significant improvement of students' CT dispositions through CT teaching with the general and immersion approaches is consistent with the results of previous research. In line with this study, in studies that have reported sufficient data to calculate the effect size value, the general approach to CT teaching (Aybek, 2006; Eldeleklioğlu & Özkılıç, 2008; Lou, 2008; Yıldırım, 2010) had large effect on improving CT dispositions. Also, according to results of most studies (Aybek, 2006; Yıldırım & Şensoy, 2011), the immersion approach to CT teaching had large effect size for improving CT dispositions. Therefore, it can be said that previous studies reported larger effect sizes than this study for immersion approach. Also, it was found that CT teaching with the general approach was more effective in improving the CT dispositions of the students compared with the CT teaching with immersion and mixed approaches. Furthermore, CT teaching with mixed approach improved the CT dispositions of high-school students more than CT teaching with the immersion approach, but the difference between these two approaches was not significant. One can therefore argue that the most-effective approach to improving the CT dispositions of high-school students was the general approach, which was followed by the mixed approach and the immersion approach, respectively.

It is possible to speak of a significant correlation between CT skills and CT dispositions (Bailey et al., 2020; Facione & Facione, 1997; Profetto-McGrath, 2003). Accordingly, when one of them is improved, the other one also will be improved. Hence, it is an unsurprising but important result that CT teaching with the high-school students based on general, immersion, and mixed approaches improved both their CT skills and dispositions. Indeed, having high CT skills alone is not enough for using those CT skills in life (Paul & Elder, 2001) and what makes an individual a good critical thinker is having both high CT skills and high CT dispositions (Profetto-McGrath, 2003). It is therefore important that CT teaching using different approaches in the present study significantly improved both skills and dispositions. That is exactly why effective CT teaching should be designed to improve both CT skills and CT dispositions. Individuals can only become good critical thinkers after they acquire CT skills, are willing to use them when necessary, make such willingness into a habit, and attach value and importance those skills (Fisher, 2001).

In short, this study revealed that the CT skills and dispositions of ninth-grade students can be enhanced with general, immersion, and mixed approach. However, the general approach was more effective than the other two teaching approaches for enhancing CT skills and dispositions. These results, which are confirmed by previous literature and in line with theoretical background and expectations derived from previous research, are noteworthy because they provide important evidence about how to teach CT best in learning environments. The results obtained in this study can guide educators, researchers, and professionals in organizing learning environments to provide individuals with the best opportunity to enhance CT. According to the results of this study, CT teaching can be performed with the general, immersion, or mixed approach. However, it is recommended to give weight to CT teaching with general approach in learning environments via workshops and club activities because it has the largest effect on the improvement of both CT skills and dispositions. In other words, learning environments designed to enhance CT with the general approach are more effective in developing individuals' CT skills and dispositions.

This study contributes to the relevant literature on CT teaching because, although there are other experimental studies that examined the effect of different CT teaching approaches, studies comparing the effectiveness of these CT teaching approaches are scarce. Therefore, a novelty of this study is that it included the mixed approach, which has been investigated less compared with the other two teaching approaches, and it compared how the three most-basic approaches to CT teaching affect CT skills and dispositions.

Limitations and future studies

There were certain limitations in the present study. The first limitation is that the study was conducted with four ninth-grade classes of one high school in northern Turkey. Similar experimental studies in the future could be carried out with student groups from different educational levels to compare the effects of different CT teaching approaches with the results of this study. Also, because this study compared only three CT teaching approaches (general, immersion, and mixed), the omission of the infusion approach can be seen another limitation of this study. Future experimental studies could compare the effect of the infusion approach with other CT teaching approaches. Another limitation is that the duration of CT teaching was limited to ten weeks in the study. Future longer-term studies could compare the effects of different CT teaching approaches. Lastly, because the research data were only collected with quantitative measures, future qualitative or mixed research could allow an in-depth investigation of the effect of CT teaching approaches in fostering the CT skills and/or dispositions of students.

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References

- Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research*, 78(4), 1102–1134.
- Al-Edwan, Z. S. M. (2011). The effectiveness of a training program based on cognitive research trust strategies to develop seventh grade students' critical thinking in history course. *Journal of Social Sciences*, 7(3), 436–442.
- Al-Zou'bi, R. (2021). The impact of media and information literacy on acquiring the critical thinking skill by the educational faculty's students. *Thinking Skills and Creativity*, 39, 1–7.
- Alwehaibi, H. (2012). Novel program to promote critical thinking among higher education students: Empirical study from Saudi Arabia. *Asian Social Science*, 8(11), 193–204.
- Ari, D. (2020). *The effect of skills-based critical thinking education on critical thinking skills of 4th grade students*. Unpublished Master's thesis, Çukurova University, Adana.
- Arsoy, B., & Aybek, B. (2021). The effects of subject-based critical thinking education in mathematics on students' critical thinking skills and virtues. *Eurasian Journal of Educational Research*, 92, 99–120.
- Aybek, B. (2006). *The Effect of content and skill based critical thinking teaching on prospective teachers' disposition and level in critical thinking*. Unpublished doctoral thesis, Çukurova University, Adana.
- Bailey, K. G. D., Rembold, L., & Abreu, C. M. (2020). Critical thinking dispositions and skills in the undergraduate research methods classroom. *Scholarship of Teaching and Learning in Psychology*, 6(2), 133–149. <https://doi.org/10.1037/stl0000158>.
- Bailin, S., Case, R., Coombs, J. R., & Daniels, L. B. (1999). Conceptualizing critical thinking. *Journal of Curriculum Studies*, 31(3), 285–302.

- Bangert-Drowns, R. L., & Bankert, E. (1990, April). *Meta-analysis of effects of explicit instruction for critical thinking*. Paper presented at annual meeting of American Educational Research Association, Boston, MA.
- Bağ, H. K. (2020). *The effect of critical thinking embedded English course curriculum to the improvement of critical thinking skills of the 7th grade secondary school learners*. Unpublished Master's thesis, Uludağ University, Bursa.
- Bayrak, Ç. (2014). *The effects of using the expanding (CoRT 1) thinking program in the unit 'electricity in our lives' in primary education 7th -grade lesson, science and technology, to students' academic achievement, scientific creativity and tendency of critical thinking*. Unpublished Master's thesis, Adnan Menderes University, Aydın.
- Behar-Horenstein, L. S., & Niu, L. (2011). Teaching critical thinking skills in higher education: A review of the literature. *Journal of College Teaching & Learning*, 8(2), 25–42.
- Bellaera, L., Weinstein-Jones, Y., Ilie, S., & Baker, S. T. (2021). Critical thinking in practice: The priorities and practices of instructors teaching in higher education. *Thinking Skills and Creativity*, 41, 100856, 1–16.
- Beyer, B. (1991). *Teaching thinking skills: A handbook for elementary school teachers*. Boston: Allyn and Bacon.
- Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2014). *Bilimsel araştırma yöntemleri [Scientific Research Models]* (16th ed.). Pegem Publishing.
- Cáceres, M., Nussbaum, M., & Ortiz, J. (2020). Integrating critical thinking into the classroom: A teacher's perspective. *Thinking Skills and Creativity*, 37, 1–18.
- Chang, C. Y., Kao, C. H., & Hwang, G. J. (2020). Facilitating students' critical thinking and decision making performances: A flipped classroom for neonatal health care training. *Educational Technology & Society*, 23(2), 32–46.
- Çeviker Ay, Ş., & Orhan, A. (2020). The effect of different critical thinking teaching approaches on critical thinking skills: A meta-analysis study. *Pamukkale University Journal of Education*, 49, 88–111.
- Daniel, M., & Auriac, E. (2011). Philosophy, critical thinking and philosophy for children. *Educational Philosophy and Theory*, 43(5), 415–435.
- De Bono, E. (2019). *What is CoRT?*. <http://www.cortthinking.com/front-page-aims-cort>.
- Eldeleklioğlu, J., & Özkılıç, R. (2008). The effect of critical thinking education on critical thinking skills of psychological guidance and counseling students. *Turkish Psychological Counseling and Guidance Journal*, 3(29), 25–36.
- Ennis, R. H. (2018). Critical thinking across the curriculum: A vision. *Topoi*, 37(1), 165–184.
- Ennis, R. H. (1989). Critical thinking and subject specificity: Clarification and needed research. *Educational Researcher*, 18(3), 4–10.
- Ennis, R. H. (1993). Critical thinking assessment. *Theory Into Practice*, 32(3), 179–186.
- Ennis, R. H. (1991). Goals for a critical thinking curriculum and its assessment. In A. L. Costa (Ed.), *Developing minds: A resource book for teaching thinking*. Ascd.
- Ennis, R. H. (1997). Incorporating critical thinking in the curriculum: An introduction to some basic issues. *Inquiry: Critical Thinking Across the Disciplines*, 16(3), 1–9.
- Epstein, R. L., & Kernberger, C. (2012). *Critical thinking*. Advanced Reasoning Forum.
- Facione, N. C., & Facione, P. A. (1997). *Critical thinking assessment in nursing education programs: An aggregate data analysis*. California Academic Press.
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191.
- Fisher, A. (2001). *Critical thinking: An introduction*. Cambridge University Press.
- Fung, D., & Howe, C. (2012). Liberal studies in Hong Kong: A new perspective on critical thinking through group work. *Thinking Skills and Creativity*, 7, 101–111.
- Gann, D. (2013). *A few considerations on critical thinking instruction*. <http://www.saitamacityeducators.org/wp-content/uploads/2013/06/A-Few-Considerations-on-CriticalThinking-Instruction.pdf>.
- Hager, P., & Kaye, M. (1992). Critical thinking in teacher education: A process-oriented research agenda. *Australian Journal of Teacher Education*, 17(2), 26–33.
- Halpern, D. (2003). *Thought & knowledge: An introduction to critical thinking*. Lawrence Erlbaum Associates Publishers.
- Haskell, R. E. (2001). *Transfer of learning: Cognition, instruction, and reasoning*. Academic Press.
- Ian, W. (2002). Challenging students with the tools of critical thinking. *Social Studies*, 93(6), 257–261.
- Irani, T., Rudd, R., Gallo, M., Ricketts, J., Friedel, C., & Rhoades, E. (2007). *Critical thinking instrumentation manual*. http://step.ufl.edu/resources/critical_thinking/ctmanual.pdf.
- Jensen, R. D. Jr. (2015). *The effectiveness of the socratic method in developing critical thinking skills in English language learners*. Unpublished Master's thesis, Grace University, Nebraska.

- Kaepfel, K. (2021). The influence of collaborative argument mapping on college students' critical thinking about contentious arguments. *Thinking Skills and Creativity*, 40, 100809, 1–9.
- Karadağ, F., & Demirtaş, V. Y. (2018). The effectiveness of the philosophy with children curriculum on critical thinking skills of pre-school children. *Education & Science*, 43(195), 1–22. <https://doi.org/10.15390/EB.2018.7268>.
- Kennedy, M., Fisher, M. B., & Ennis, R. H. (1991). Critical thinking: Literature review and needed research. In L. Idol, & B. Fly Jones (Eds.), *Educational values and cognitive instruction: Implications for reform* (pp. 11–40). Lawrence Erlbaum.
- Kılıç, H. E., & Şen, A. (2014). Turkish adaptation study of UF/EMI Critical Thinking Disposition Instrument. *Education and Science*, 39(176), 1–12.
- Ku, K. Y. L., Ho, I. T., Hau, K. T., & Lai, E. C. M. (2014). Integrating direct and inquiry-based instruction in the teaching of critical thinking: an intervention study. *Instructional Science*, 42, 251–269.
- Kurnaz, A. (2007). *Effects of skill and content-based critical thinking training on students' critical thinking skills, achievement and attitudes in the fifth grade course of social knowledge of primary school*. Unpublished doctoral thesis, Selçuk University, Konya.
- Larsson, K. (2017). Understanding and teaching critical thinking—A new approach. *International Journal of Educational Research*, 84, 32–42.
- Lee, Y. L. (2018). Nurturing critical thinking for implementation beyond the classroom: Implications from social psychological theories of behaviour change. *Thinking Skills and Creativity*, 27, 139–146.
- Lewis, A., & Smith, D. (1993). Defining higher order thinking. *Theory into Practice*, 32(3), 131–137.
- Lipman, M. (2003). *Thinking in education*. Cambridge University Press.
- Lipman, M. (1988). Critical thinking—What can it be? *Educational Leadership*, 46(1), 38–43.
- Lombardi, L., Thomas, V., Rodeyns, J., Mednick, F. J., Backer, F. D., & Lombaerts, K. (2021). Primary school teachers' experiences of teaching strategies that promote pupils' critical thinking. *Educational Studies*, 1–19. <https://doi.org/10.1080/03055698.2021.1990017>.
- Lou, J. (2018). Improvement in university students' critical thinking following a strategic thinking training program. *NeuroQuantology*, 16(5), 91–96.
- Lopez, M., Jimenez, J. M., Martin-Gil, B., Fernandez-Castro, M., Cao, M. J., Frutos, M., & Castro, M. J. (2020). The impact of an educational intervention on nursing students' critical thinking skills: A quasi-experimental study. *Nurse Education Today*, 85, 104305, 1–6.
- Marin, L. M., & Halpern, D. F. (2011). Pedagogy for developing critical thinking in adolescents: Explicit instruction produces greatest gains. *Thinking Skills and Creativity*, 6, 1–13.
- Mason, M. (2008). *Critical thinking and learning*. Blackwell Publishing.
- McPeck, J. (1981). *Critical thinking and education*. St Martins Press.
- Nicholas, M., & Raider, M. (2011, November). *Approaches used by faculty to assess critical thinking—Implications for general education*. 36th ASHE annual conference, North Carolina, the USA.
- Orhan, A., & Çeviker Ay, Ş. (2022). Developing the Critical Thinking Skill Test for High School Students: A validity and reliability study. *International Journal of Psychology and Educational Studies*, 9(1), 130–142.
- Özgenel, M. (2018). Modeling the relationships between school administrators' creative and critical thinking dispositions with decision making styles and problem solving skills. *Educational Sciences: Theory & Practice*, 18, 673–700.
- Paul, R., Binker, A. J. A., Jensen, K., & Kreklau, H. (1990). *Critical thinking handbook: 4th – 6th grades: A guide for remodeling lesson plans in language, arts, social studies & science*. Foundation for Critical Thinking, Sonoma State University.
- Paul, R., & Elder, L. (2001). *Critical thinking: Tools for taking charge of your learning and your life*. Prentice Hall.
- Presseisen, B. Z. (1985). *Thinking skills throughout the K-12 curriculum: A conceptual design*. Research for Better Schools.
- Payan-Carreira, R., Cruz, G., Papathanasiou, I. V., Fradelos, E., & Jiang, L. (2019). The effectiveness of critical thinking instructional strategies in health professions education: a systematic review. *Studies in Higher Education*, 44(5), 829–843.
- Plath, D., English, B., Connors, L., & Beveridge, A. (1999). Evaluating the outcomes of intensive critical thinking instruction for social work students. *Social Work Education*, 18(2), 207–217.
- Profetto-McGrath, J. (2003). The relationship of critical thinking skills and critical thinking dispositions of baccalaureate nursing students. *Journal of Advanced Nursing*, 43(6), 569–577.
- Profetto-McGrath, J., Hasketh, K. L., Lang, S., & Estabrooks, C. A. (2003). A study of critical thinking and research utilization among nurses. *Western Journal of Nursing Research*, 25(3), 322–337.
- Rahdar, A., Pourghaz, A., & Marziyeh, A. (2018). The impact of teaching philosophy for children on critical openness and reflective skepticism in developing critical thinking and self-efficacy. *International Journal of Instruction*, 11(3), 539–556.

- Reed, J. H., & Kromrey, J. D. (2001). Teaching critical thinking in a community college history course: Empirical evidence from infusing Paul's model. *College Student Journal*, 35(2), 201–215.
- Ruggerio, V. R. (1988). *Teaching thinking across the curriculum*. Harper & Row.
- Şahin, E. (2016). *The effect of argumentation based science learning approach on academic success, meta-cognition and critical thinking skills of gifted students*. Unpublished doctoral thesis, Gazi University, Ankara.
- Schleicher, A. (2016). *Teaching excellence through professional learning and policy reform: Lessons from around the World, International Summit on the Teaching Profession*. OECD Publishing.
- Schreglmann, S., & Karakuş, M. (2017). The effect of educational interfaces on the critical thinking and the academic achievement. *Mersin University Journal of the Faculty of Education*, 13(3), 839–855.
- Scriven, M., & Paul, R. (2005). *The critical thinking community*. Retrieved from <http://www.criticalthinking.org>.
- Smith, T. E., Rama, P. S., & Helms, J. R. (2018). Teaching critical thinking in a GE class: A flipped model. *Thinking Skills and Creativity*, 28, 73–83.
- Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate statistics* (6th ed.). Pearson.
- Taghinezhad, A., & Riasati, M. J. (2020). The interplay of critical thinking explicit instruction, academic writing performance, critical thinking ability, and critical thinking dispositions: An experimental study. *International Journal of Educational Research and Innovation*, 13, 143–165. <https://doi.org/10.46661/ijeri.4594>.
- Tirunch, D. T., Verburgh, A., & Elen, J. (2014). Effectiveness of critical thinking instruction in higher education: A systematic review of intervention studies. *Higher Education Studies*, 4(1), 1–17.
- Van Gelder, T. (2005). Teaching critical thinking: Some lessons from cognitive science. *College Teaching*, 53(1), 41–48.
- Watson, G., & Glaser, M. E. (1994). *Watson-Glaser critical thinking appraisal form S manual*. The Psychological Corporation.
- Welch, K. C., Hieb, J., & Graham, J. (2015). A systematic approach to teaching critical thinking skills to electrical and computer engineering undergraduates. *American Journal of Engineering Education*, 6(2), 113–123.
- Williams, R. L., & Worth, S. L. (2001). The relationship of critical thinking to success in college. *Inquiry: Critical Thinking Across the Disciplines*, 21(1), 5–16.
- Willingham, D. T. (2008). Critical thinking: Why is it so hard to teach? *Arts Education Policy Review*, 109(4), 21–32.
- World Economic Forum (2020). *The future of jobs report*. http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf.
- Yıldırım, B. (2010). *The effect of skill based critical thinking education on the development of critical thinking in nurse students*. Unpublished doctoral thesis, Ege University, İzmir.
- Yıldırım, H., & Şensoy, Ö. (2011). The effect of science instruction based on critical thinking skills on critical thinking disposition of the 7th -grade primary school students. *Kastamonu Education Journal*, 19(2), 523–540.
- Yuan, H., Kunaviktikul, W., Klunklin, A., & Williams, B. A. (2008). Improvement of nursing students' critical thinking skills through problem based learning in the People's Republic of China: A quasi-experimental study. *Nursing and Health Sciences*, 10, 70–76.
- Zulkifli, H., & Hashim, R. (2020). Philosophy for children (P4C) in improving critical thinking in a secondary moral education class. *International Journal of Learning Teaching and Educational Research*, 19(2), 29–45.