International Journal of Instruction *July 2023 ● Vol.16, No.3*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 261-282

Article submission code: 20220704234538
Received: 04/07/2022 Revision: 28/12/2022
Accepted: 19/01/2023 OnlineFirst: 05/04/2023

Fostering Critical and Creative Thinking through the Cooperative Learning Jigsaw and Group Investigation

Helena Silva
University of Trás-os-Montes e Alto Douro & CIIE, University of Porto, Portugal, *helsilva@utad.pt*

José Lopes
University of Trás-os-Montes e Alto Douro & CIIE, University of Porto, Portugal, *jlopes@utad.pt*

Eva Morais
University of Trás-os-Montes e Alto Douro & CMAT, University of Minho, Portugal, *emorais@utad.pt*

Caroline Dominguez
University of Trás-os-Montes e Alto Douro & LabCTD-CIDTFF, University of Aveiro, Portugal, *carold@utad.pt*

The effects of cooperative learning on the promotion of critical thinking skills in college students are well documented, but not in conjunction with critical thinking dispositions. Since there are no studies on this topic in the Portuguese context, our aim is to verify whether cooperative learning using the Jigsaw and Group Investigation methods promote critical and creative thinking skills and dispositions in higher education. It was employed a quasi-experimental design with a pretest and posttest using the Critical and Creative Thinking Test (CCT) and the Critical Thinking Dispositions Scale (CTDS) with equivalent groups and a control group. The participants were 106 undergraduate students attending three different classes of the 3rd year of a university in northern Portugal. One class was Pre-service teaching and the others were Psychology undergraduates. The results demonstrate that only the intervention groups had significantly higher scores in the CCT posttest than in the pretest. Regarding dispositions, only the students having experienced the Jigsaw method improved. Implications and pedagogical suggestions are presented.

Keywords: critical thinking skills and dispositions, jigsaw; group investigation, pre-service teaching, psychology, learning

Citation: Silva, H., Lopes, J., Morais, E., & Dominguez, C. (2023). Fostering critical and creative thinking through the cooperative learning jigsaw and group. *International Journal of Instruction*, *16*(3), 261-282. https://doi.org/10.29333/iji.2023.16315a

INTRODUCTION

The context

To actively participate in a society that aims to be pluralistic and sustainable, it is essential that citizens have the ability to constructively critique systems, behaviors, and hierarchies, evaluate different perspectives, explore strategies for change, and put them into practice (Morancho & Mantilla, 2020). With this focus in mind, several international organizations and scholars have put in evidence the skills university students must acquire for the 21st century, indispensable for the exercise of a full, active and creative citizenship. They all highlight critical thinking and creativity as paramount (Barry, 2012; European Commission, 2016; OECD, 2018; WEF, 2020).

Critical and creative thinking is an indispensable requirement for economic and social survival in a world characterized by accelerating change and increasing complexity (Paul (1995). It plays a crucial role for socio-political participation (Camas Garrido et al., 2018), as well as for the challenges on environment and global sustainability (Magrabi et al., 2018). Society needs people who can reason and make informed decisions, as an alternative to those who only possess a lot of information that quickly becomes obsolete. Citizens who possess the ability to think critically and creatively are better able to solve complex situations, take and defend their positions, and take responsibility for their actions (OECD, 2018), which dictates that employers value skills such as critical thinking and creativity more than the technical knowledge of their employees (Lau, 2015). Therefore, fostering critical thinking skills is more fruitful for students' personal, professional, and social lives than believing, repeating, and memorizing seemingly immutable information (Mok & Yuen, 2016).

According to Kuhn (2016), the importance attributed to the development of critical thinking in higher education is unquestionable. This requires higher education institutions to have as a central goal that students learn to think and reason critically so that, when inserted in the increasingly complex and uncertain society, they are able to find the most effective alternatives, make the best decisions, and be able to solve the problems they face (Abrami et al., 2008; Ahuna et al., 2014; Meepian & Wannapiroon, 2013).

Critical Thinking skills have often been associated with critical thinking dispositions. Critical thinking dispositions are seen as a precondition for the development of critical thinking skills (Ennis, 2011; Facione, 1990; Paul & Elder, 2006).

In recent years, literature has well put in evidence how positively cooperative learning affects critical thinking skills development. However, although cooperative learning entails core social skills related to critical thinking and literature recognizes it as an effective strategy to promote critical thinking, there are scarce scientific studies on the effectiveness of cooperative learning on the development of critical thinking skills together with the related dispositions (Soo-mi & Ji-hoe, 2017; Rimiene, 2002), let alone in higher education. In particular, in Portugal there are no studies on this topic.

Thus, it is purpose of this study to:

- Analyze if cooperative learning using the methods Jigsaw and Group Investigation are more effective in promoting critical and creative thinking skills than Lecture;

- Ascertain whether there are significant differences in the development of critical and creative thinking dispositions between Group Investigation and Jigsaw cooperative learning methods;

- Analyze whether there are correlations between critical and creative thinking skills and dispositions in both cooperative learning methods.

Literature Review

Critical and creative thinking concepts

The concept of critical thinking, as in any scientific discipline, is controversial and does not deserve unanimity. Its analysis from the perspective of different authors allows defining it as the process of using cognitive skills to guide practice, which includes conceptualizing, applying, analyzing, synthesizing, and evaluating data collected from the knowledge resulting from experience, reflection, communication observation, and self-regulation (Brookfield, 2012; Ennis, 2011; Facione, 1990; Paul & Elder, 2006).

According to Halpern (2002) "critical thinkers use these skills appropriately, spontaneously and usually consciously in a variety of settings. That is, they are predisposed to think critically" (p. 70).

In addition to cognitive skills, most researchers in the field of critical thinking highlight dispositions as another (affective/attitudinal) component of critical thinking (Ennis, 2011; Facione, 1990; Halpern, 2002). Dispositions are viewed as a requirement and are positively associated with improving critical thinking skills (Colucciello, 1997; Facione, 2000; Nieto & Saiz, 2010), since a disposition is a tendency to act or think in a certain way. The dispositions of critical thinking involve "truth-seeking, open-mindedness, analyticity, systematicity, self-confidence in reasoning, curiosity, and maturity of judgment" (Facione, 2000, p. 74). Both dispositions and skills are characteristics of good critical thinkers (Facione, 1990). Improving them is a goal recognized as a lifelong endeavor (Scriven & Paul, 1987).

On the other hand, many are the researchers who establish relationships between critical thinking and creativity (Bailin, 2002; Bonk & Smith, 1998; Ennis, 1985; Paul & Elder, 2006; Thayer-Bacon, 2000) with no unanimity of perspectives (Ling & Loh, 2020; Standish & Thoilliez, 2018; Weschler et al., 2018). Sometimes critical thinking is considered as an algorithmic process - with step-by-step procedures, strictly organized with respect to certain criteria - while creative thinking is seen as an action that transcends established patterns and creates something new, through the use of imagination. For Lipman (1991), critical thinking is conservative in nature while creative thinking is characterized by being more skeptical and radical. Other authors, countering this dichotomy, argue that critical thinking always involves imagination and creativity in identifying problems, interpreting a situation, and dealing with new

situations - and that, similarly, creative thinking also involves critical evaluation, rational analysis, and judgment. Thus, the action of thinking well is simultaneously critical and creative. For Bailin and Siegel (2002), "the terms critical thinking and creative thinking can be used to refer respectively to generative and to the evaluative aspects of thinking for purposes of analysis and discussion, but it is important to be clear that these are not really two different kinds of thinking that can be engaged in separately" (p. 187). Also, for Paul and Elder (2006), the two concepts are intrinsically linked, developing in parallel. They consider that teachers should try to integrate them during the teaching process (Lai, 2011), since good thinking requires the ability to generate intellectual products. It requires the individual to be conscious, strategic, and critical about the quality of those intellectual products. As Paul and Elder (2006) note, "critical thinking without creativity reduces to mere skepticism and negativity, and creativity without critical thinking reduces to mere novelty" (p.35). Sternberg (1989), Anderson and Krathwohl (2001) consider creativity to be the last level of critical thinking.

Fostering critical and creative thinking through the cooperative learning

Learning is an individual process promoted by social interactions, among students and between students and teachers (Hanna et al., 2010). It is well known that social interactions play a significant role in how students learn (Gillies & Boyle, 2008). Higher-level reasoning results from cooperative learning, and new ideas and solutions are more often generated in this learning approach, and greater transfer of learning occurs compared with individual and competitive learning (Johnson & Johnson, 2014). Since cooperative learning promotes socio-cognitive conflict when students are confronted during group work with viewpoints that are different from their own, it stimulates them to question and reorganize their thinking by integrating the ideas and perspectives of others (Sills et al., 2016), providing the appropriate context for the emergence of critical and creative thinking.

Defined as a classroom teaching and learning strategy, Cooperative Learning involves students working in small (3-4 students) heterogeneous groups to achieve the same goals and optimize their own and their peers' learning (Johnson & Johnson, 1999). However, cooperative learning is not simply getting students to work together in groups (Johnson & Johnson, 1999), as there are five characteristics that make cooperative learning groups different from other types of working groups. According to Johnson et al. (2013) these characteristics measure the effectiveness of cooperative learning and are: (1) Positive Interdependence: it is established when students develop the belief that they are one for all and all for one. That is, when students realize that they can only achieve their goals if their group mates also achieve them, meaning that one's results are affected by one's own and others' actions and that group participation alone is not enough to produce high performance in group work (Cecchini et al., 2020); (2) individual and group accountability: each member of the group is responsible for doing his or her part for the proposed task, and there is no room for anyone to take advantage of the work of others (Johnson & Johnson, 1999; Slavin, 1995); (3) stimulating interaction, preferably face-to-face - occurs when students act responsibly and honestly, giving help and positive

encouragement to other group members and make efforts to obtain shared benefits and goals. In addition, they provide feedback to each other to improve their performance, challenge each other's reasoning and conclusions, and explore different perspectives (Johnson & Johnson, 2009); (4) social skills - students must develop the social skills necessary for cooperation, as these enable them to work effectively in groups. Candler (2021) states that lack of social skills is probably the main factor contributing to the lack of success of cooperative groups. Examples of basic social skills include speaking in turn, listening attentively, managing conflict, making decisions, and respecting the opinions of others (Johnson & Johnson, 2009; Lopes & Silva, 2009; Sadeghi, 2012); (5) group processing - means reflecting on the extent to which the group's objectives are being achieved, whether or not the conduct of each element is being positive, and what actions the group should or should not maintain in future tasks in order to improve its effectiveness (Johnson & Johnson, 1999; Johnson & Johnson, 2009).

On the other hand, the effectiveness of cooperative learning also depends on the teacher's feedback. When teachers do not carefully structure cooperative activities, do not interact with groups as they work, value only learning outcomes, and ignore their own role in supporting learning, the effects of cooperation can be greatly reduced (Cecchini et al., 2021; Wu & Liu, 2020). This perspective is also shared by Freire (2019) who argues that for effective learning to take place, students must negotiate meanings and cooperate with both peers and teachers, constituting themselves as a small intellectual community.

These five characteristics of cooperative groups promote students' critical thinking, when in groups they argue about the different points of view presented (Paul, 1995), have many opportunities to debate their ideas, argue, express different points of view, synthesize ideas. The frequent interactions that students engage in allow them to stimulate and enhance higher-order thinking skills (Alsaleh, 2020; Bezanilla et al., 2019; Gokale, 1995; Jacobs & Kimura, 2013). As already demonstrated in several studies, cooperative learning has a significant influence on the development of critical and creative thinking (Espey, 2018; Garcha & Kumar, 2015; Loes & Pascarella, 2017). There is convincing evidence that cooperation allows individuals to achieve higher levels of thinking and become critical thinkers (Devi et al., 2015).

Cooperative learning can be achieved through different methods, among them Jigsaw and Group Investigation. In Jigsaw, students initially work in base groups on a subject that has been divided by the teacher into different parts in order to solve a problem or answer a question. When they finish analyzing it, students leave the basic groups and those who have the same part of the subject matter join into expert groups. After the time provided by the teacher for them to become experts in the different parts of the subject matter is finished, they return to their base groups to teach each other (Slavin, 1995) solving/responding to the problem or question at stake. The problem-solving process requires students to explain their perspectives, analyze, evaluate, and create ideas, all functions which promote critical and creative thinking (Asyari et al., 2016). The Jigsaw method is illustrated in Figure 1.

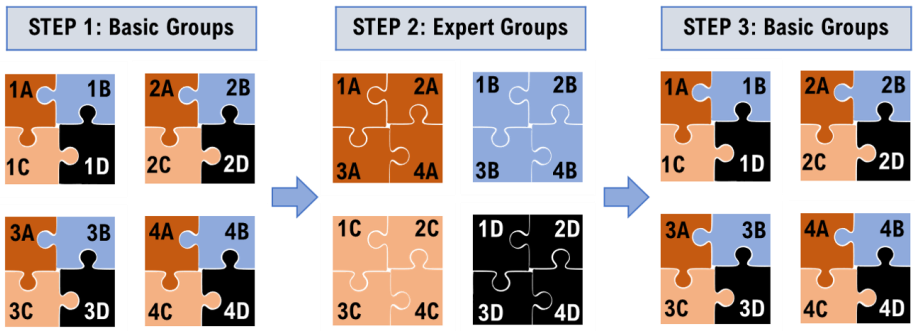

Figure 1
The Jigsaw learning method

In Group Investigation, students in the same group determine the sub-themes to be studied, organize the work plan and how they will present their findings to the rest of the class. The presentations receive feedback from classmates and the teacher. The teacher coordinates the work by giving feedback at different stages (Sharan et al., 2013). It has several advantages. Among others, it encourages students to take the initiative for their learning, to be creative and active, to learn to respect the opinions of others, to make decisions together and to take responsibility for their learning (Barkley et al., 2014). According to Slavin (2010), Jigsaw and Group Investigation are two of the cooperative methods that enable higher levels of group discussion and debate. By organizing, interpreting, and synthesizing information, they foster autonomous work and self-regulation (Listiana et al., 2020), which are significantly related with the improvement of critical and creative thinking skills and dispositions (Maison et al., 2021).

In Portugal, on the one hand, there are few studies that assess the development of critical and creative thinking during university education, particularly of future teachers and psychologists. On the other hand, although Cooperative learning is one of the methodologies that the literature refers to as one of the most effective in the development of critical and creative thinking (Loh & Ang, 2020), there are few studies at the higher education level which focus on the promotion of these skills, and fewer still, on cooperative learning and development of critical and creative thinking skills and dispositions, the latter being considered equally important (Dwyer et al., 2016).

METHOD

Design

The study employed a quasi-experimental design with three equivalent groups in a pretest and posttest (Cohen et al., 2018). The methodology followed in this study is shown in Figure 2.

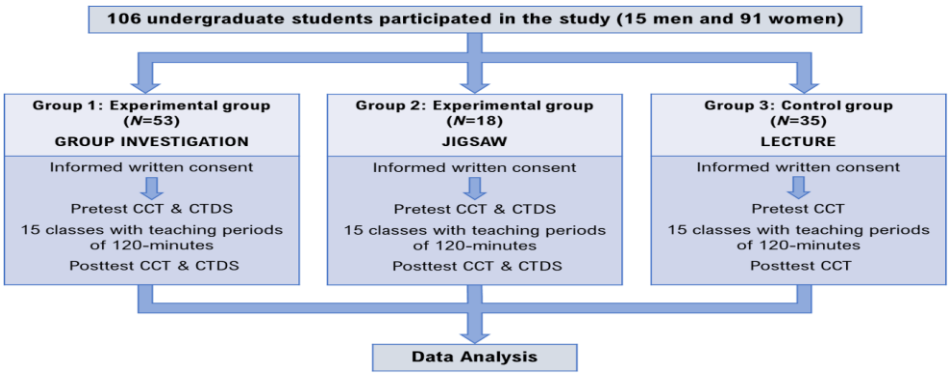

Figure 2
Methodology of the study

Participants

This study included 106 undergraduate students (15 men and 91 women) enrolled in three different classes of the 3rd year of a university in northern Portugal. One class was Pre-Service Teaching (Basic Education, 1st cycle degree) and the others of Psychology (1st cycle degree). The average age of participants was 21.4 years (SD = 4.61).

Pedagogical context / Procedures

Group 1 Experimental (Psychology, 1st cycle, 3rd year, 53 students, year 2019/20): Cooperative learning method- Group Investigation

At the beginning of the semester the following activities were done in the first class: 1) students answered the CCT test and CTDS (pretest) (presented below) ; 2) the teacher organized heterogeneous groups of four to five students; 3) different roles were assigned to each member of the group, on a rotating basis and adjusted to the objectives of the activities. Throughout the following 15 classes with teaching periods of 120-minutes long: 1) using Group Investigation (Slavin, 1995), the teacher provided one theme to each group to be studied along the semester and some supporting documents. Students in groups planned their work, selecting the sub-topics and conducting the investigation according to the objectives and planned tasks; they received oral feedback from the teacher while preparing the work and, at the end of the semester, they presented the work to the class. At the end of the presentation, the teacher and other classmates gave oral feedback. 2) students improved their work, incorporating feedback from colleagues (feedback from peers) and from the teacher; 3) each group periodically developed a reflection on the functioning of the group (group process), namely in relation to the strengths, weaknesses and possible improvement strategies. At the end of the semester, in the last class, the students answered the CCT test and CTDS (posttest).

Group 2 Experimental (Pre-Service Teaching, 18 students, 1st cycle, 3rd year, 2019/20): Cooperative learning method - Jigsaw

At the beginning of the semester the following activities were done in the first class: 1) the students answered the CCT test and CTDS (pretest) (presented below); 2) the

teacher organized heterogeneous groups of three to four students; 3) different roles were assigned to each member of the group, on a rotating basis and adjusted to the objectives of the activities. Throughout the following 15 classes with teaching periods of 120-minutes long, 5 problem-questions were worked sequentially along the semester: 1) using Jigsaw (Slavin, 1995) they read and analyzed articles delivered by the teacher on teaching-learning-methods on which they had to answer problem-solving questions (eg. which teaching-learning method is more adequate for the following learning objectives ? and why?); 2) works were exchanged between groups to give and receive written feedback between peers; 3) the teacher gave written feedback to the works of each group after feedback given by their colleagues; 4) students improved their work, incorporating feedback from colleagues (feedback from peers) and from the teacher; 5) each small group made a final oral presentation to the whole class; 6) each group periodically developed a reflection on the functioning of the group (group process), namely in relation to the strengths, weaknesses and possible improvement strategies At the end of the semester, in the last class, the students answered the CCT test and CTDS (posttest).

Group 3 Control (Psychology, 1st cycle 3rd year, 35 students, 2019/20): Lecture

At the beginning of the semester, students took only the CCT test in the first class (pretest). Over the next 15 classes with teaching periods of 120-minutes long, the course content was taught by the teacher. The syllabus contained topics involving notions of CCT. These were taught in a theoretical manner, and activities promoting CCT notions were not the main focus. The lesson content was supported by PowerPoints. Interaction was predominantly teacher-student, knowledge-based questions. Students asked questions to clarify doubts and performed individual exercises to check their learning. At the end of the semester, in the last class, students only took the CCT test again.

Instruments

Two instruments were used to measure the development of critical thinking skills and dispositions. The first one is the Critical and Creative Thinking (CCT) test validated for the Portuguese higher education population (Lopes et al., 2019a), which evaluates the CT skills. The CCT test gives an everyday problem situation (a scenario) that can be characterized as problematic and for which solutions must be provided, but it does not need specific knowledge of any subject. The respondent is asked to answer a set of six open-ended questions (e.g., "Identify the problem presented in the text"; "Identify the solutions for the problem presented in the text"; "Compare the solutions that you have identified"), which refer to different cognitive tasks and require their appreciation and resolution, using CT skills, taking in consideration the Bloom's taxonomy revised by Anderson and Krathwohl (2001) and Facione (1990) into the following CT skills classification: (i) interpretation, (ii) analysis, (iii) explanation, (iv) evaluation, (v) synthesis and (vi) production/creation. The test total score ranges from 0 to 25 points. The inter-judge reliability (Cohen kappa coefficient) ranged between 0.76 and 0.93 (Lopes et al., 2019a).

The second instrument is the Critical Thinking Dispositions Scale (CTDS). The CTDS is a self-report instrument consisting of 35 Likert scale questions designed to understand

college students' dispositions. This instrument presents 35 items (e.g., "I try to solve problems using reasoning"; "When I assess a topic, I do so impartially"; "People say that I make very thoughtful decisions") and consists of a model of dispositions with heptafactorial structure based on the Facione Delphi report: truth-seeking, open-mindedness, Analyticity, systematicity, CT self-confidence, Inquisitiveness, and Maturity of judgment. It is a likert type scale test validated for the Portuguese population (Lopes et al., 2019b). The CTDS reliability is very good (α = .94) and of the subscales ranges from 0.62 to 0.75.

Ethical considerations

This study followed the ethical requirements of the EFPA - European Federation of Psychologists' Associations (EFPA) as well as the OPP - Ordem dos Psicólogos Portugueses. All ethical principles were respected, ensuring that all participants knew and accepted the principles of informed consent, voluntary participation and confidentiality of their answers.

FINDINGS

Analysis was conducted with IBM SPSS Statistics 25.0 using independent and paired sample t tests, or the nonparametric alternatives (Wilcoxon signed-rank test, Kruskal-Wallis test and the Mann-Whitney test) depending on the validity of the tests' conditions. As a measure of the effect size, Cohen d was used.

The results of the participants' score in the CCT test are presented in Table 1. Both intervention groups had significantly higher average score in the CCT posttest than in the pretest, whereas the control group did not have a significant change. Therefore, one can infer that cooperative learning methods were more likely to promote the development of critical and creative thinking students' skills. However, no significant differences were found between the two intervention groups that used the Group Investigation method and the Jigsaw method ($t(110) = -0.343$, $p = .732$).

Table 1
Analysis of the total score in the CCT test

	Group Investigation (N = 53)	Jigsaw (N = 18)	Lecture (N = 35)
Pretest	12.7 ± 3.80	11.3 ± 2.66	13.4 ± 2.84
Posttest	16.3 ± 3.31	14.6 ± 2.95	12.3 ± 3.76
Gains	3.58 ± 3.95	3.28 ± 2.89	-1.03 ± 3.89
Mean differences	$t(52) = 6.60$. $p <. 001$ $d = 0.91$	$t(17) = 4.82$. $p < .001$ $d = 1.13$	$t(34) = -1.56$. $p = .127$ $d = -0.26$

From the analysis of student scores in each dimension of the CCT test presented in Table 2, results show that: the experimental group 1 (Group investigation) increased significantly the average score in evaluation, synthesis and creativity (fluency, flexibility and originality); the experimental group 2 (Jigsaw) had a significant increase in the scores of explanation and in creativity (flexibility); as for the control group, there was a significant increase in the CCT test score for the dimension Analysis_a (inference), and there was a significant decrease in creativity (flexibility and originality).

Table 2
Analysis of the total score in the CCT test for the groups for each skill

Dimension		Group Investigation (N = 53)	Jigsaw (N = 18)	Lecture (N = 35)
Interpretation	Pretest	1.47 ± 1.01	0.78 ± 0.81	1.06 ± 1.06
	Posttest	1.62 ± 0.92	1.00 ± 0.97	1.31 ± 1.02
	Wilcoxon Signed Ranks Test	Z = 0.90, p = .371	Z = 0.91, p = .366	Z = 1.33, p = .182
	Kruskal-Wallis Test	$\chi2(2) = 0.38$, $p = .828$		
Analysis a (inference)	Pretest	2.17 ± 0.38	2.00 ± 0.00	2.03 ± 0.30
	Posttest	2.17 ± 0.43	2.00 ± 0.00	2.17 ± 0.38
	Wilcoxon Signed Ranks Test	Z = 0.00, p = 1.00	Z = 0.00, p = 1.00	Z = 2.24, p = .025
	Kruskal-Wallis Test	$\chi2(2) = 3.36$, $p = .187$		
Analysis b (argumentation)	Pretest	1.19 ± 0.68	1.17 ± 0.51	0.97 ± 0.62
	Posttest	1.34 ± 0.55	1.22 ± 0.55	1.06 ± 0.77
	Wilcoxon Signed Ranks Test	Z = -1.30, p = .193	Z = 0.38, p = .705	Z = 0.69, p = .491
	Kruskal-Wallis Test	$\chi2(2) = 0.65$, $p = .724$		
Explanation	Pretest	1.42 ± 0.97	0.89 ± 0.47	1.57 ± 0.66
	Posttest	1.68 ± 1.00	2.00 ± 0.77	1.66 ± 0.94
	Wilcoxon Signed Ranks Test	Z = 1.46, p = .144	Z = 3.57, p < .001	Z = -0.44, p = .658
	Kruskal-Wallis Test	$\chi2(2) = 11.33$, $p = .003$		
Evaluation	Pretest	1.25 ± 1.04	1.17 ± 0.51	1.23 ± 0.69
	Posttest	1.58 ± 0.89	1.56 ± 0.78	1.03 ± 0.66
	Wilcoxon Signed Ranks Test	Z = 1.99, p = .047	Z = 1.66, p = .097	Z = -1.38, p = .166
	Kruskal-Wallis Test	$\chi2(2) = 7.30$, $p = .026$		
Synthesis	Pretest	1.32 ± 1.40	1.33 ± 1.41	1.03 ± 1.01
	Posttest	2.25 ± 1.11	2.06 ± 1.26	1.26 ± 1.22
	Wilcoxon Signed Ranks Test	Z = 3.57, p < .001	Z = 1.90, p = .058	Z = 1.04, p = .297
	Kruskal-Wallis Test	$\chi2(2) = 4.11$, $p = .128$		
Creativity - Fluency	Pretest	1.13 ± 0.71	1.00 ± 0.34	1.37 ± 0.60
	Posttest	1.66 ± 0.76	1.22 ± 0.43	1.09± 0.70
	Wilcoxon Signed Ranks Test	Z = 3.55, p < .001	Z = 1.63, p = .102	Z = -1.69, p = .092
	Kruskal-Wallis Test	$\chi2(2) = 15.36$, $p < .001$		
Creativity - Flexibility	Pretest	1.02 ± 0.54	1.06 ± 0.42	1.86 ± 0.36
	Posttest	1.72 ± 0.46	1.39 ± 0.50	1.14 ± 0.69
	Wilcoxon Signed Ranks Test	Z = 5.24, p < .001	Z = 2.12, p = .034	Z = -3.99, p < .001
	Kruskal-Wallis Test	$\chi2(2) = 50.01$, $p < .001$		
Creativity - Originality	Pretest	1.77 ± 0.93	1.94 ± 0.54	2.26 ± 0.51
	Posttest	2.30 ± 0.50	2.17 ± 0.38	1.71 ± 0.86
	Wilcoxon Signed Ranks Test	Z = 3.44, p = .001	Z = 1.34, p = .180	Z = -2.68, p = .007
	Kruskal-Wallis Test	$\chi2(2) = 18.09$, $p < .001$		

The statistical analysis of the scores in the CTDS are presented in Table 3. According to the validation of the CTDS (Lopes et al., 2019b), the average score in the CTDS and in each subscale, except in CT self-confidence, ranks both groups as having high dispositions for CT in the pre and in the posttest.

From the analysis of the results presented in Table 3, Psychology students (Group Investigation method) did not significantly improve their overall scores from the pretest to the posttest (Table 3) and these students only showed improvement in inquisitiveness (Table 4). In turn, Pre-Service Teaching students (Jigsaw method) posttest scores were significantly higher than the pretest scores, and for this group there was a significantly perceived increase of the following critical thinking dispositions (Table 4): truth-seeking, open-mindedness, systematicity, self-confidence, inquisitiveness and maturity of judgment.

Table 3
Analysis of the total score in the CTDS test

	Group Investigation (N = 53)	Jigsaw (N = 18)
Pretest	292.18 ± 25.10	289.23 ± 24.51
Posttest	292.79 ± 24.48	313.61 ± 21.38
Gains	0.61 ± 21.32	24.37 ± 29.93
Mean differences	$t(52) = 0.21$, p =.836	$t(17) = 3.46$, p = .003
Effect size	d = 0.03	d = 0.81

Table 4
Analysis of the total score in the CTDS test for the groups for each disposition

Disposition		Group Investigation (N = 53)	Jigsaw (N = 18)
Truth-seeking	Pretest	43.83 ± 7.36	44.17 ± 4.54
	Posttest	43.26 ± 6.92	47.50 ± 2.57
	Wilcoxon Signed Ranks Test	Z = -0.92, p = .357	Z = 2.62, p = .009
	Mann-Whitney U Test	U = 257.5, p = .003	
Open-mindedness	Pretest	43.49 ± 4.28	43.19 ± 4.60
	Posttest	42.74 ± 3.87	46.94 ± 3.98
	Wilcoxon Signed Ranks Test	Z = 1.62, p = .105	Z = 2.64, p = .008
	Mann-Whitney U Test	U = 245.5, p = .002	
Analyticity	Pretest	42.22 ± 4.69	40.83 ± 3.93
	Posttest	41.79 ± 4.79	43.33 ± 4.62
	Wilcoxon Signed Ranks Test	Z = -0.79, p = .431	Z = 1.64, p = .100
	Mann-Whitney U Test	U = 324, p = .041	
Systematicity	Pretest	42.13 ± 3.79	41.52 ± 4.64
	Posttest	42.24 ± 4.29	44.93 ± 4.05
	Wilcoxon Signed Ranks Test	Z = -0.13, p = .894	Z = 2.27, p = .023
	Mann-Whitney U Test	U = 298.5, p = .018	
CT self-confidence	Pretest	36.87 ± 5.39	36.44 ± 4.88
	Posttest	37.66 ± 5.05	40.22 ± 4.05
	Wilcoxon Signed Ranks Test	Z = 1.25, p = .210	Z = 2.16, p = .030
	Mann-Whitney U Test	U = 349, p = .088	
Inquisitiveness	Pretest	41.67 ± 4.58	41.28 ± 4.10
	Posttest	42.75 ± 3.88	44.84 ± 3.79
	Wilcoxon Signed Ranks Test	Z = 2.05, p = .040	Z = 2.96, p = .003
	Mann-Whitney U Test	U = 311.5, p = .028	
Maturity of judgment	Pretest	41.98 ± 4.74	41.81 ± 3.82
	Posttest	42.36 ± 4.61	45.83 ± 3.54
	Wilcoxon Signed Ranks Test	Z = 0.52, p = .602	Z = 3.03, p = .002
	Mann-Whitney U Test	U = 255.50, p = .003	

The correlations between the post-scores in the CCT test and in the CTDS are presented in tables 5 and 6. Considering the overall score in the CCT test and in the CTDS, there is a weak correlation for group 1 (Group Investigation) ($r(53) = 0.21$, $p = .130$) and for group 2 (Jigsaw) ($r(18) = 0.27$, $p = .272$).

Table 5
Correlations for the group investigation ($N = 53$)

Dimension	Truth-seeking	Open-mindedness	Analyti-city	Systemati-city	CT self-confidence	Inquisiti-veness	Maturity judgment	CTDS
Interpretation	.163	.025	.015	-.040	.063	-.119	-.035	.034
Analysis a (inference)	-.172	-.141	-.246	-.075	-.169	-.004	.086	-.152
Analysis b (argument)	.069	-.038	-.216	-.106	-.151	-.124	-.019	-.102
Explanation	-.046	.120	.022	.102	-.007	.190	.105	.076
Evaluation	.100	.253	.213	.257	.217	.505**	.256	.328*
Synthesis	.074	.020	-.003	.057	-.005	.090	-.059	.035
Creativity - Fluency	.241	.241	.250	.094	-.161	.014	.247	.188
Creativity - Flexibility	.250	.257	.127	.089	-.076	.074	.279*	.201
Creativity - Originality	.250	.333*	.230	.115	.071	.296*	.226	.293*
CCT	.200	.234	.109	.131	-.012	.226	.208	.211

*significant correlation at level 0.05; ** significant correlation at level 0.01

Table 6
Correlations for the Jigsaw group ($N = 18$)

Dimension	Truth-seeking	Open-mindedness	Analyti-city	Systemati-city	CT self-confidence	Inquisiti-veness	Maturity judgment	CTDS
Interpretation	-.412	-.114	.230	.024	.120	.043	.129	.035
Analysis b (argument)	.000	-.277	.271	-.257	.029	-.228	-.253	-.117
Explanation	.224	-.144	.540*	-.244	.114	-.091	-.217	.041
Evaluation	.146	.387	.596**	.414	.403	.454	.407	.521*
Synthesis	.182	.124	.523*	.011	.228	.078	-.209	.183
Creativity - Fluency	.000	.163	.124	.203	.106	-.028	.162	.138
Creativity - Flexibility	.000	.041	-.021	.203	.129	.012	.055	.077
Creativity - Originality	.447	.161	.083	.088	.353	-.009	.000	.184
CCT	.097	.081	.672**	.087	.362	.099	-.009	.274

*significant correlation at level 0.05; ** significant correlation at level 0.01

DISCUSSION

The purpose of this study was to 1) analyze if cooperative learning using the methods Jigsaw and Group Investigating are more effective in promoting CCT skills than Lecture; 2) ascertain whether there are significant differences in the development of critical and creative thinking dispositions between Group Investigation and Jigsaw

cooperative learning methods; 3) analyze whether there are correlations between CCT skills and dispositions in both cooperative learning methods.

Results of this study showed that both cooperative methods (Jigsaw and/or Group Investigation) are significantly more effective in promoting CCT skills than lecture, confirming the evidence of the superiority of cooperative learning methods over lecturing or conventional learning (Asthiningsih et al., 2020; Silva et al., 2022; Subiyantari et al., 2019). The characteristics of the cooperative learning methods (Jonhson et al., 2013) play a significant role for these results, when compared with Lecture, a more individual learning dynamic. In cooperative groups different perspectives are discussed and socio-cognitive conflict occurs, leading students to higher order thinking (Johnson & Johnson, 2009; Alsaleh, 2020). The role played by teachers in the cooperative methods (scaffolding, constant feedback) is also a key aspect to take in account for the learning success (Cecchini et al., 2021; Sharan et al., 2013). Through Lecture, on the other hand, students are expected to gain knowledge of a myriad of content which has been presented in class in a setting where reciprocal exchange of knowledge is limited, and students' questioning and discussing of the content is minimal, restricting the pursuit of inquiry, the probing of the students' thinking and reasoning processes and disencouraging the exploration of differing or opposing points of view (Asyari et al., 2016); Fauzi et al., 2021).

The increase in the total scores between the pre and posttest using Jigsaw or Group Investigation confirm the results of several studies conducted on the effectiveness of those cooperative methods to promote CT skills (Disurya & Hamzah, 2022; Espey, 2018; Garcha & Kumar, 2015; Gokhale, 1995; Loes & Pascarella, 2017; Tamur et al., 2021).

Although the findings of the present study confirm the above ones on the effectiveness of these two methods in CCT development, when comparing both methods (Jigsaw and Group Investigation), we cannot conclude (contrarily to Parchment (2009) who found Group Investigation more effective) on the superiority of one method over the other regarding CCT skills development.

Despite that our results show no significant global differences in the total scores between both methods, it is possible to point out significant differences in the sub-scores skills. If creativity seems to increase significantly in both methods, confirming Nurmalia et al. (2020) in their study on Jigsaw, Jigsaw reinforces more the explanation skill, whereas Group Investigation showed a significant increase in the evaluation and synthesis skills. One hypothesis that can be made regarding the Jigsaw method is that the existence of three stances in which students have to communicate their ideas (Home groups, Expert groups and again Home groups) requires that they explain several times and to different students what they think, possibly being challenged to do it in a more and more clear way in order to be able to come to an agreement (in the expert group) on how to deliver what they learnt in an effective way (to the Base group in the final stance) and teach each other (Asyari et al., 2016; Ulrich & Glendon, 1995).

On the other hand, in Group Investigation, students do not have so many opportunities to explain again and again and to different students (as they do in Jigsaw) what they

have learnt (making sense together of the same topic as in Jigsaw experts' groups), and each member of the group is responsible finding material and deepening one part of the problem (or theme), which he/she must study and then share. This is coherent with the results showingthat students in group 2 (Jigsaw) had greater gains in the Explanation skill. There is more need for students (compared with Jigsaw in which), to choose what they learn for the final work, to evaluate if the chosen literature and findings are relevant and synthesize (make sense) all parts to a whole (Chairunnisa, 2016; Sharan et al., 2013), opportunities they have from the beginning of the six stages cycle of Group Investigation: choosing the topic, planning tasks, conducting investigations, analyzing and preparing the report, presenting the final report and evaluating (Rosiani et al., 2020; Sharan et al., 2013). As both groups are encouraged to take initiative, discuss between members, and be active, it is not surprising that students' perceptions of their creativity skill are higher at the end of the learning experience.

Regarding CCT dispositions, well known theorists in the CCT field like Ennis, Facione, Halpern, Paul and Elder (see literature review above), have repeatedly stated that attitudes and dispositions are essential for CCT skills development, and affect the motivation to think critically. Moreover, the lack of some dispositions like open-mindedness, fair-mindedness, and skepticism, would predict less likelihood from students to think critically even if they have CT skills (Halpern, 1998). However, to the date, there is no consensus on the relationship between CCT skills and dispositions. In his study, Facione (2000) concludes that the existence of a causal relationship between both dimensions of CCT is still to be demonstrated, even though he seemed to arrive at a more mitigated conclusion in his joint work (Facione & Facione, 1997) with a large sample of nursing students. If some rare studies among high school students (Giancarlo & Facione, 1994) and college nursing undergraduate (Colucciello, 1997; Profetto-McGrath, 2003) found significant positive correlations between both dimensions, others like Rimiene (2002) using cooperative learning methodologies, or Shin et al. (2005) or Summee and Park (2017), in the context of high education, do not report any significant correlation results between critical thinking dispositions and skills, except between few sub-dimensions in the sub-set of 4th grade students suggesting that grade should be considered in the process of constructing an educational program to develop dispositions and CT skills together Summee and Park (2017). Moreover, in these studies (with exceptions) the authors do not focus specifically on the effects of cooperative learning methods in CT skills and dispositions.

Furthermore, if some correlations seem to be present between dispositions at start and skills at exit (Facione & Facione, 1997), they do not seem to be very significant except for self-trust and analysis and between self-trust and evaluation (in nursing students).

Regarding the existence of significant differences in the development of critical and creative thinking dispositions between the Group Investigation and Jigsaw groups, our results show that both groups started with an overall similar score but only the Jigsaw group improved significantly after the learning experience. The only common improved disposition between both groups was inquisitiveness, whereas the Jigsaw group showed a significant perceived increase in truth-seeking, open-mindedness, systematicity, self-confidence, inquisitiveness and maturity of judgment. From our results, although both

learning methods are cooperative (Johnson & Johnson, 1999), it seems that Jigsaw is more propense to promote CT dispositions (Garcha & Kumar, 2015; Shakerian et al., 2020).

CONCLUSIONS, LIMITATIONS

Our results confirm the efficiency of Group Investigation and Jigsaw in the promotion of CT skills, compared to a more conventional way of teaching-learning, in line with the literature defending cooperative learning as an efficient method for CT skills development. However, our study aligns with the literature which evidences no clear superiority between both methods regarding the overall CT skills development. Exceptions in some sub-skills like explanation for Jigsaw, and synthesis and evaluation for Group Investigation, have been identified, certainly due to the nature of those two methods. In terms of dispositions, Jigsaw seems to demonstrate a high potential, like previous literature has evidenced, to be more effective for their development. Finally, our study nourishes the ongoing stand that correlation between the development of CT skills and CT dispositions have still to be demonstrated, or that at least more studies need to be carried out.

The results of this study have to be taken with caution since there were several limitations which can hinder the possibility of generalization. The students' academic performance in the groups under investigation as well as their socioeconomic characteristics at start were not measured and could represent influencing factors. We are also aware that the reviewed studies for this article present, in general, results related to a specific course. Although both cooperative methods under investigation here, Jigsaw and Group Investigation, are considered, in general, effective in CT skills development, it is difficult to state whether they are more effective in specific courses. Finally, the number of students participating in the investigation could be considered insufficient to test all possible correlations between dispositions and skills.

In future work, the authors intend to implement a longitudinal study comparing both methods among different courses over several academic years to compare them and evaluate the results, including some factors that may influence results as socioeconomic characteristics. Moreover, they believe that it would be fruitful to evaluate the results of a study which would combine both learning methods, since they believe that students would be more prepared using Jigsaw (to train the explanation CT skill and develop more CT dispositions) together with Group Investigation for the development of higher cognitive functions like evaluation and synthesis. While Jigsaw would strengthen the learning of the core basic concepts at start, students would then be more motivated to investigate the topic at hand and deepen their learning, seeking for more information, analyzing and evaluating it, followed by the creation of new knowledge and its communication, in Group Investigation.

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. https://doi.org/10.3102/0034654308326084

Ahuna, K.K., Tinnesz, C.G., & Kiener, M. (2014). A new era of critical thinking in professional programs. *Transformative Dialogues: Teaching & Learning Journal, 7*(3), 1-9. https://journals.kpu.ca/index.php/td/article/view/1197/655

Alsaleh, N. (2020). Teaching Critical Thinking Skills: Literature Review. *TOJET: The Turkish Online Journal of Educational Technology*, 19, 20-39. https://files.eric.ed.gov/fulltext/EJ1239945.pdf

Anderson, L., & Krathwohl, D. (2001). *A Taxonomy for Learning, Teaching and Assessing: a Revision of Bloom's Taxonomy*. Longman Publishing.

Asthiningsih, N., Fritiani, D., & Budiman, A. (2020). The Effectiveness of The Jigsaw Type Cooperative Learning Methods on Students` Critical Thinking Skills. *ICE 2019, September 28-30*, 709-718. https://doi.org/10.4108/eai.28-9-2019.2291083

Asyari, M., Al Muhdhar, M. H. I., Susilo, H., & Ibrohim. (2016). Improving critical thinking skills through the integration of problem-based learning and group investigation. *International Journal for Lesson and Learning Studies, 5*(1), 36–44. https://doi.org/10.1108/IJLLS-10-2014-0042

Bailin, S. (2002). Critical thinking and science education. *Science & Education, 11*, 361-375. http://dx.doi.org/10.1023/A:1016042608621

Bailin, S., & Siegel, H. (2002). Critical thinking. In N. Blake, P. Smeyers, R. Smith, & P. Standish (Eds.), *The Blackwell guide to the philosophy of education* (pp. 181–193). Blackwell

Barkley, E. F., Major, C. H., & Cross, P. K. (2014). *Collaborative Learning Techniques: A Handbook for College Faculty* (2nd ed.). Jossey-Bass.

Barry, M. (2012). *What skills will you need to succeed in the future? Phoenix Forward* (online). Tempe, AZ, University of Phoenix. www.phoenix.edu/forward/careers/2012/09/what-skills-willyou-need-to-succeed-in-the-future.html

Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity, 33*, 100584. https://doi.org/10.1016/j.tsc.2019.100584

Bonk, J, C., & Smith, G. (1998). Alternative instructional strategies for creative and critical thinking in the accounting curriculum. *Journal of Accounting Education, 16*(2), 261–293. https://doi.org/10.1016/s0748-5751(98)00012-8

Brookfield, S. (2012). *Teaching for critical thinking: tools and techniques to help students question their assumptions*. Jossey-Bass.

Camas Garrido, L., Valero Moya, A., & Vendrell Morancho, M. (2018). "Hackeando memes": Cultura democrática, redes sociales y educación | "Hacking memes": Democratic culture, social media and education. *ESPIRAL. CUADERNOS DEL PROFESORADO, 11*(23), 120–129. https://doi.org/10.25115/ecp.v12i23.2017

Candler, L. (2022, February 7). *How to Teach Social Skills, Step by Step*. Laura Candler. https://lauracandler.com/social-skills/

Cecchini, J. A., Carriedo, A., Méndez-Giménez, A., & Fernández-Río, J. (2021). Highly-structured cooperative learning versus individual learning in times of COVID-19 distance learning. *European Journal of Teacher Education*, 1–16. https://doi.org/10.1080/02619768.2021.1991305

Cecchini, J., Fernandez-Rio, J., Mendez-Gimenez, C. Gonzalez, B., Sanchez-Martínez, & Carriedo, A. (2020). High versus low-structured cooperative learning. Effects on prospective teachers' regulation dominance, motivation, content knowledge and responsibility. *European Journal of Teacher Education, 4*(4), 484-501 https://doi.org/10.1080/02619768.2020.1774548

Chairunnisa, C. (2016). The implementation of group investigation model (gim) to enhance students' critical thinking skill in educational program evaluation class. *Advanced Education*, *0*(0), 22–27. https://doi.org/10.20535/2410-8286.73823

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education* (8th edition). Routledge.

Colucciello, M. L. (1997). Critical thinking skills and dispositions of baccalaureate nursing students-a conceptual model for evaluation. *Journal of Professional Nursing, 13*(4), 236-245. https://doi.org/10.1016/s8755-7223(97)80094-4

Devi, A. P., Musthafa, B., & Gustine, G. G. G. (2016). Using Cooperative Learning In Teaching Critical Thinking In Reading. *English Review: Journal of English Education*, *4*(1), 1-14. https://doi.org/10.25134/erjee.v4i1.310

Disurya, R., & Hamzah, S. (2022). The Effect of Group Investigation Learning Model on Students' Critical Thinking Ability in Pancasila Education Courses. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, *7*(1), 283-300. https://doi.org/10.31851/jmksp.v7i1.7018

Dwyer, C. P., Hogan, M. J., Harney, O. M., & Kavanagh, C. (2016). Facilitating a student-educator conceptual model of dispositions towards critical thinking through interactive management. *Educational Technology Research and Development*, *65*(1), 47–73. https://doi.org/10.1007/s11423-016-9460-7

Ennis, R. (1985). A logical basis for measuring critical thinking skills. *Education Leadership*, 43 (2), 44-48.

Ennis, R. H. (2011). *The nature of critical thinking: An outline of critical thinking dispositions and abilities*.

http://faculty.education.illinois.edu/rhennis/documents/TheNatureofCriticalThinking_51711_000.pdf

Espey, M. (2017). Enhancing critical thinking using team-based learning. *Higher Education Research & Development*, *37*(1), 15–29. https://doi.org/10.1080/07294360.2017.1344196

European Commission (EC). (2016). *A new skills agenda for Europe*. https://doi.org/10.2863/708323

Facione, P. A. (1990). *Critical thinking*: *A statement of expert consensus for purposes of educational assessment and instruction (The Delphi Report)*. The California Academic Press.

Facione, P. A. (2000). The Disposition Toward Critical Thinking: Its Character, Measurement, and Relationship to Critical Thinking Skill. *Informal Logic*, *20*(1), 61-84. https://doi.org/10.22329/il.v20i1.2254

Facione, N. & Facione, P. (1997). *Critical thinking assessment in nursing education programs: An aggregate data analysis*. The California Academic Press.

Fauzi, F., Erna, M., & Linda, R. (2021). The Effectiveness of Collaborative Learning Through techniques on Group Investigation and Think Pair Share Students' Critical Thinking Ability on Chemical Equilibrium Material. *Journal of Educational Sciences*, *5*(1), 198-208. https://doi.org/10.31258/jes.5.1.p.198-208

Freire, P. (2019). *Pedagogia do oprimido*. Paz e Terra.

Garcha, P., & Kumar, K. (2015). Effectiveness of Cooperative Learning on Critical Thinking Dispositions of Secondary School Students. *Issues and Ideas in education*, *3*(1), 55-62. https://doi.org/10.15415/iie.2015.31005

Giancarlo, C. & Facione, N. (1994). *A study of the critical thinking disposition and skill of Spanish and English speaking students at Camelback High School*. The California Academic

Gillies, R. M., & Boyle, M. (2008). Teachers' discourse during cooperative learning and their perceptions of this pedagogical practice. *Teaching and Teacher Education, 24*(5), 1333–1348. https://doi.org/10.1016/j.tate.2007.10.003

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education, 7*(1), 22-29. https://doi.org/10.21061/jte.v7i1.a.2

Halpern, D. F. (2002). *Thought and Knowledge: An Introduction to Critical Thinking, 4th Edition (Volume 2)* (4th ed.). Psychology Press.

Hanna, D., David, I., & Francisco, B. (Eds.). (2010). *Educational research and innovation the nature of learning using research to inspire practice: Using research to inspire practice*. OECD publishing.

Jacobs, G. M., & Kimura, H. (2013). *Cooperative learning and teaching*. In the series, English language teacher development. TESOL.

Johnson, D. W., & Johnson, R. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning* (5th Ed.). Allyn & Bacon.

Johnson, D. W., & Johnson, R. (2016). Cooperative learning and teaching citizenship in democracies. *International Journal of Educational Research*, *76*, 162-177. http://dx.doi.org/10.1016/j.ijer.2015.11.009

Johnson, D. W., & Johnson, R. T. (2009). Energizing Learning: The Instructional Power of Conflict. *Educational Researcher*, *38*(1), 37–51. https://doi.org/10.3102/0013189x08330540

Johnson, D. W., & Johnson, R. T. (2014). Cooperative Learning in 21st Century. [Aprendizaje cooperativo en el siglo XXI]. *Anales de Psicología*, *30*(3), 841–851. https://doi.org/10.6018/analesps.30.3.201241

Johnson, D. W., Johnson, R., & Holubec, E. (2013). *Cooperation in the classroom* (9th ed.). Interaction Book Company

Kuhn, D. (2016). A Role for Reasoning in a Dialogic Approach to Critical Thinking. *Topoi*, *37*(1), 121–128. https://doi.org/10.1007/s11245-016-9373-4

Lai, E. R. (2011). *Critical Thinking: A Literature Review Research Report*. Parsons Publishing.

Lau, J. (2015). Metacognitive Education: Going beyond Critical Thinking. In Davies, M., & Barnett, R. (Eds.), *The Palgrave handbook of critical thinking in higher education* (pp. 373-389). Palgrave Macmillan.

Ling, M., & Loh, S. (2020). Relationship of creativity and critical thinking to pattern recognition among Singapore private school students, *The Journal of Educational Research*, *113*(1), 59-76, https://doi.org/10.1080/00220671.2020.1716203

Lipman, M. (1991). *Thinking in education.* Cambridge University Press.

Listiana, L., Raharjo, & Hamdani, A. S. (2020). Enhancing Self-Regulation Skills through Group Investigation Integrated with Think Talk Write. *International Journal of Instruction, 13*(1), 915-930. https://doi.org/10.29333/iji.2020.13159a

Loes, C., Pascarella, E. (2017) Collaborative Learning and Critical Thinking: Testing the Link. *The Journal of Higher Education, 88*(5), 726-753. https://doi.org/10.1080/00221546.2017.1291257

Loh, R.C.Y., & Ang, C. S. (2020). Unravelling cooperative learning in higher education: A review of research. *Research in Social Sciences and Technology, 5*(2), 22-39. https://doi.org/10.46303/ressat.05.02.2

Lopes, J., & Silva, H. (2009). *A aprendizagem cooperativa na sala de aula- um guia prático para o professor (Portuguese Edition).* LIDEL.

Lopes, J., Silva, H., & Morais, E. (2019a). Teste do Pensamento Crítico e Criativo para estudantes do ensino superior [Critical and Creative Thinking Test for Higher Education Students]. *Revista Lusófona de Educação, 44*(44), 173-189. https://doi.org/10.24140/issn.1645-7250.rle44.11

Lopes, J., Silva, H., & Morais, E. (2019b). Escala de disposições do pensamento crítico [Critical Thinking Dispositions Scale]. In J. Lopes, H. Silva, C. Dominguez, & M. Nascimento, *Educar para o pensamento crítico na sala de aula* [Educating for critical thinking in the classroom] (pp. 283-288). PACTOR

Magrabi, S., Pasha, M., & Pasha, M. (2018). Classroom Teaching to Enhance Critical Thinking and Problem-Solving Skills for developing IOT Applications. *Journal of Engineering Education Transformations, 31*(3), 152-157. http://dx.doi.org/10.16920/jeet/2018/v31i3/120785

Maison., T., Kurniawan, D. A., Sukarni, W., Erika., & Hoyi, R. (2021). Assessing students' attitudes towards physics through the application of inquiry and jigsaw cooperative learning models in high schools. *International Journal of Instruction, 14*(4), 439-450. https://doi.org/10.29333/iji.2021.14426a

Meepian, A., Wannapiroon, P. (2013). Design of Social Learning Environment as Inquiry-Based on Cloud Technology for Enhancing the Critical Thinking Skill and Collaborative Learning. *International Journal of E-Education, e-Business, e-Management and e-Learning, 3(3), 253-257*. https://doi.org/10.7763/ijeeee.2013.v3.234

Mok, F. K., & Yuen, T. W. (2016). A critical evaluation of the understanding of critical thinking by school teachers: The case of Hong Kong. *Citizenship, Social and Economics Education*, *15*(1), 28–44. https://doi.org/10.1177/2047173416652146

Morancho, M., & Mantilla, J. (2020). Pensamiento Crítico: conceptualización y relevancia en el seno de la educación superior. *Revista De La Educación Superior*, *49*(194), 9-25. https://doi.org/10.36857/resu.2020.194.1121

Nieto, A. M., & Saiz, C. (2010). Critical Thinking. *Inquiry: Critical Thinking Across the Disciplines*, *25*(2), 19–26. https://doi.org/10.5840/inquiryctnews20102524

Nurmalia, Halim, A., & Syahrun, N. (2020). Application of jigsaw type cooperative learning to improve student creative thinking skills. *Journal of Physics: Conference Series*, *1460*, 012142. https://doi.org/10.1088/1742-6596/1460/1/012142

OECD (2018). Pisa - *Preparing our youth for an inclusive and sustainable world*. https://www.oecd.org/education/Global-competency-for-an-inclusive-world.pdf

Parchment, G. L. (2009). A study comparing cooperative learning methods: Jigsaw & Group Investigation (Master's thesis). School of Arts and Sciences St. John Fisher College. https://fisherpub.sjfc.edu/mathcs_etd_masters/25/

Paul, R. & Elder, L. (2006). *Critical thinking: Tools for taking charge of your learning and your life*. Pearson Prentice Hall.

Paul, R. W. (1995). *Critical thinking: How to prepare students for a rapidly changing world*. Library of Congress.

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. https://doi.org/10.1046/j.1365-2648.2003.02755.x

Rimiene, V. (2002). Assessing and Developing Students' Critical Thinking. *Psychology Learning & Teaching*, *2*(1), 17–22. https://doi.org/10.2304/plat.2002.2.1.17

Rosiani, E., Parmin, P., & Taufiq, M. (2020). Cooperative Learning Model of Group Investigation Type on Students' Critical Thinking Skill and Scientific Communication Skills. *Unnes Science Education Journal*, *9*(1), 48-58. https://journal.unnes.ac.id/sju/index.php/usej/article/view/36880v

Sadeghi, M. R. (2012). The effects of cooperative learning on critical thinking in an academic context. *Journal of Psychological and Educational Research, 20*(2), 15-30. http://www.marianjournals.com/files/JPER_articles/JPER_20_2_2012/Sadeghi_20_2_2012.pdf

Scriven, M., & Paul, R. (1987) *Defining Critical Thinking*. 8th Annual International Conference on Critical Thinking and Education Reform. http://www.criticalthinking.org/pages/defining-critical-thinking/766

Shakerian, S., Khoshgoftar, Z., Rezayof, E., & Amadi, M. (2020). The Use of the Jigsaw Cooperative Learning Technique for the Health Science Students in Iran: A Meta-Analysis. *Educational Research in Medical Sciences*, *9*(1). https://doi.org/10.5812/erms.102043

Sharan, S., Sharan, Y., & Tan, G. C. I. (2013). The Group Investigation approach to Cooperative Learning. In C. Hmelo-Silver, C. Chinn, C., A. O'Donnell, C. Chan, C. (Eds.), *International Handbook of Collaborative Learning* (pp. 351-369). New York: Routledge

Shin, K. R., Ha, J. Y., & Kim, K. H. (2005). A Longitudinal Study of Critical Thinking Dispositions & Critical Thinking Skills in Baccalaureate Nursing Students. *Journal of Korean Academy of Nursing*, *35*(2), 382. https://doi.org/10.4040/jkan.2005.35.2.382

Sills, J., Rowse, G., & Emerson, L.-M. (2016). The role of collaboration in the cognitive development of young children: A systematic review. *Child: Care, Health and Development*, *42*(3), 313–324. https://doi.org/10.1111/cch.12330

Silva, H., Lopes, J., Dominguez, C., & Morais, E. (2022). Lecture, Cooperative Learning and Concept Mapping: Any Differences on Critical and Creative Thinking Development? *International Journal of Instruction*, *15*(1), 765–780. https://doi.org/10.29333/iji.2022.15144a

Slavin, R. (2010). Co-operative learning: what makes group-work work? In Dumont, H., D. Istance, & F. Benavides (eds.), *The Nature of Learning: Using Research to Inspire Practice*, OECD Publishing, Paris. https://doi.org/10.1787/9789264086487-9-en

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice* (2nd ed.). Prentice Hall.

Soo-mi, P., & Ji-hoe, P. (2017). A Study on the Relationship between College students' Critical Thinking Skills and Dispositions and the Generalizability by students' characteristics. *Journal of Educational Innovation Research, 27*(3), 137–158. https://doi.org/10.21024/pnuedi.27.3.201709.137

Standish, R., & Thoilliez, B. (2018). Critical thinking in Crisis. A pedagogical reconsideration in three movements. *Teoría e Historia de la Educación, 30*(2), 7-22. http://dx.doi.org/10.14201/teoredu302722

Sternberg, R. (1989). *The Triarchic Mind: A New Theory of Human Intelligence*. Penguin Books.

Subiyantari, A. R., Muslim, S., & Rahmadyanti, E. (2019). Effectiveness of Jigsaw Cooperative Learning Models In Lessons of the Basics of Building Construction on Students Learning 'Outcomes Viewed From Critical Thinking Skills. *International Journal for Educational and Vocational Studies*, *1*(7). https://doi.org/10.29103/ijevs.v1i7.1653

Sumee Park, & Park Ji Hoe (2017). A Study on the Relationship between College students' Critical Thinking Skills and Dispositions and the Generalizability by students characteristics. *Journal of Educational Innovation Research, 27*(3), 137–158. https://doi.org/10.21024/pnuedi.27.3.201709.137

Tamur, M., Subaryo, S., Ramda, A. H., Nurjaman, A., Fedi, S., & Hamu, A. (2021). The effect of jigsaw type of cooperative learning on critical thinking ability of junior high school students. *Journal of Honai Math, 4*(2), 173–182. https://doi.org/10.30862/jhm.v4i2.201

Thayer-Bacon, B. J. (1993). Caring and its relationship to critical thinking. *Educational Theory, 43*(3), 323–340. https://doi.org/10.1111/j.1741-5446.1993.00323.x

Ulrich, D., & Glendon, K., 1995). Jigsaw: A Critical-Thinking Experience. *Nurse Educator, 20*(3), 6–7. https://doi.org/10.1097/00006223-199505000-00003).

Wechsler, S. M., Saiz, C., Rivas, S. F., Vendramini, C. M. M., Almeida, L. S., Mundim, M. C., & Franco, A. (2018). Creative and critical thinking: Independent or overlapping components? *Thinking Skills and Creativity, 27*, 114–122. https://dx.doi.org/10.1016/j.tsc.2017.12.003

WEF - World Economic Forum. (2020). *Forecasts for Labour Market Evolution in 2020-2025. In The future of job Report 2020. World Economic Forum*. https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

Wu, Y., & Liu, Y. (2020, February). *Study on Class Teaching Equity in Cooperative Group Learning*. In the 6th International Conference on Education, Language, Art and Intercultural Communication (ICELAIC 2019) (pp. 50-54). Atlantis Press. https://doi.org/10.2991/assehr.k.191217.077