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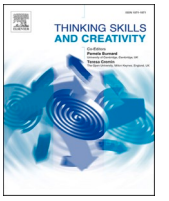

Age-related changes in creative thinking during late childhood: The contribution of cooperative learning

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ABSTRACT

Creative thinking has been considered a human skill that is necessary for facing challenging situations that require adaptive solutions. From an educational perspective, creative thinking plays an important role in learning processes and is an issue of central importance within classroom methodology. In this regard, Cooperative learning (CL) has been studied as a methodology that enhances creative processes. CL methodology refers to teaching procedures based on organizing the class into small mixed-abilities groups where students work cooperatively to complete academic tasks and consolidate their learning. However, the impact of CL on creative thinking seems to have been insufficiently explored in late childhood, which is known as a transitory stage between childhood and adolescence. Using two tests (at 5th and 6th grades of Primary School), we examined the trajectory of creative thinking in fifty-three students from two different schools. Students were assessed by a divergent thinking task (CREA Test; Corbalán et al., 2015) at two time points: Test-1 (T^1), with a mean age of 9.81 years (*Sd*= 0.48), and Test-2 (T^2), with a mean age of 11.35 years (*Sd*= 0.52). Given the differences in methodology delivered in each school (Cooperative and individualistic learning), we also analyzed the effects of this variable on student creative thinking performance. We found significant improvements between testing in the two schools, although CL appeared to have a more positive effect than IL on creative thinking performance. Our finding highlights the importance of studying classroom methodology as a mediating factor in creative thinking development, which could be important in the learning processes as well as the integral development of the child.

1. Introduction

In recent decades, educational institutions have highlighted the importance of preparing for a future landscape that will require students to have more complex problem solving and creative thinking skills (Richardson & Mishra, 2018). A creative and adaptive mind is necessary to learn and integrate new knowledge and develop original and novel ideas. Furthermore, creative thinking helps children develop coping and adaptive thinking strategies (Behnamnia et al., 2020). The study of creative thinking across childhood and

Abbreviations: CL, cooperative learning; IL, INDIVIDUAL Learning; T^1, Test 1; T^2, Test 2.

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adolescence has been linked to certain factors that are influential for development. Therefore, creative thinking is considered a construct that does not develop in isolation and requires support from the environment (Glăveanu, 2015).

Much research has been conducted on the effect of contextual factors that mediate creative thinking such as family characteristics or educational settings (Jankowska & Karwowski, 2019; Navarrete, 2013; Navarro & Chacón-López, 2021). However, although it is widely accepted that contextual factors contribute to creative thinking development, the mediating role of teaching practice (e.g., methodologies, learning resources, or classroom experiences) has received relatively less attention in empirical research. Despite this, previous studies focusing on the effect of teaching methodologies on creative thinking in the child school population have reported that creative thinking skills could be promoted through structured methodologies such as Cooperative Learning (CL; Marashi & Khtami, 2017; Segundo-Marcos et al. 2020).

The present study examined the longitudinal development of creative thinking in early adolescence over a period of two years. Moreover, we explored the effect of CL as an integrated methodology (Cooperative and individualistic learning) in day-to-day classroom practices across the last stage of primary school.

2. Creative thinking

Generally, creativity is defined as a set of abilities necessary to deal with challenging or unknown situations requiring novel and appropriate ideas (Torrance, 1972). Through creative thinking processes, individuals combine elements, perceive, understand, and generate new ideas, and share the results. Creative thinking skills are inherent in the generative and adaptive nature of human thought (Wang, 2012; Ward & Allport, 1997). Further, creative thinking has been linked to specific individual characteristics. For example, Corbalán et al. (2015), for the educational context, suggest that high performance in creative thinking is characterized by flexible and adaptive skills, along with a proactive and curious approach to learning. Consequently, creative thinking is considered a central skill for learning.

While divergent thinking tests such as the Torrance Test of Creative Thinking (Torrance, 1966) have been used to assess children's creativity, it is important to acknowledge the scope of these tests to achieve a more comprehensive understanding of the construct. Some researchers propose that creative thinking could consist of two components: the production of original ideas (through divergent thinking) and the assessment of novelty (through convergent thinking) (Cropley, 2006). Despite this proposal, divergent thinking tests have shown to be reliable indicators of creative thinking potential (Kim, 2008; Runco & Acar, 2012).

Guilford (1962, 1968) postulated that creativity involves divergent thinking abilities such as fluency, flexibility, elaboration, and originality. Fluency is defined as producing ideas and generating alternatives or solutions to a given problem. In the classroom context, this ability is relevant when the teacher asks the students to propose as many ideas as possible for introducing a new lesson or project (i.e., Brainstorming). Flexibility is the ability to use different categories of relevant responses, which means approaching problems from different angles. For instance, a teacher asks students to invent an alternative ending for a story or draw objects as a surrealist would. Elaboration is the capacity to add and build new elements upon a previous idea. For example, in a writing class, the teacher can ask students to incorporate new characters into a story or add components to a picture. Finally, originality refers to the capacity to generate uncommon responses. For instance, in an art activity, the teacher might ask students to make a collage to represent a song (Shively, 2011; Wechsler, 2006).

Kaufman and Beghetto (2009) describe the individual creative process (based on the Vygotskian learning approach) as constructing personal knowledge and understanding within a particular social and cultural context. Within this paradigm, creative thinking is as an extension of the thinking and problem-solving aspects of student learning. This means that creative thinking processes require learners to use all kinds of thinking abilities to solve problems and adapt to the context and not only focus on the result of learning (e.g., curricular contents), but also on processes that imply the generation of experiences and cognitive strategies useful for the future of learners (Shih et al., 2010).

3. Creative thinking development

The developmental trajectory of creative thinking during childhood has been studied for decades. Although the results are inconclusive, various studies suggest that creative thinking fluctuates ("slumps and jumps"). Studies conducted with preschoolers have found that an increase in creative thinking occurs from the early years. Bijvoet-van den Berg and Hoicka (2014) found a significant increase in performance on a divergent thinking test between the ages of 2 and 4 (Unusual Box Test). Similarly, Chae (2003) found a significant increase between the ages of 4 and 5 in the Test for Creative Thinking – Drawing Production (TCT- DP); however, no differences were found between the ages of 5 and 6. Torrance (1968) conducted the earliest study on the creative thinking trajectory in primary school children. This author assessed children in three different periods across third, fourth, and fifth grades of primary school and observed a greater decline in performance between third and fourth grade in all components of divergent thinking (Fluency, elaboration, flexibility, and originality); however, a subsequent increase was observed between fourth and fifth grade. This increase seems to be maintained, at least, between the ages of 10 and 11 (Smith & Carlsson, 1983). Gralewski et al. (2016), in an extensive study with a diverse sample ($n = 4898$) aged between 4 and 21 years, found that creative thinking measured through a divergent thinking test (TTCT-DP) increased progressively from the age of 4 to 14. During this period, decreased variations (although non-significant) were found at 7, 11, and 13 years. These results indicate that there are several "slumps and jumps" in the development of creative thinking across childhood.

The phenomenon of creative ''slumps and jumps'' has been observed in various domains and from different perspectives, such as artistic, scientific, and technological creativity (Hu et al., 2010). Torrance (1968) attributed these fluctuations to children's adaptation

to classroom expectations and emphasized the significant influence of social interaction pressure on the display of creative abilities. Yi et al. (2013) investigated the relationship between school climate and creativity development in children aged 10 to 16. These authors reported that a school's climate significantly impacted all dimensions of creativity measured. Additionally, Jastrzębska and Limont (2017) examined the developmental trajectory of creative thinking in 1522 Polish students aged 7 to 18 from lower and upper primary school, middle school, and high school. The authors observed not only jumps and slumps in these periods, but also short stable stages referred to as "Mini Plateaus." They concluded that school environments and programs, such as educational strategies, played a vital role in stimulating or inhibiting creative thinking development.

Creative thinking is a complex mental activity aimed at generating innovative and previously unknown solutions to problems. Al-Khatib (2012) defined this as a type of thinking that involves dismantling old ideas, forming new connections, expanding the boundaries of knowledge, and generating extraordinary ideas. From an educational perspective, Corbalán et al. (2015) stated that high creative performance could impact observable attitudes such as the use of abundant cognitive resources, flexibility in the face of change, broad interests, and a curious and proactive attitude towards learning (including remarkable academic performance). However, despite their importance, these abilities and skills are often undervalued by teachers as an integral and relevant component of effective learning (Jarwan, 2008). Gajda (2016) conducted a study that examined students across various educational levels. According to the author, in the early years of education, teachers emphasize skill and cognitive development while still allowing for spontaneous activity in the classroom. In contrast, later-stage students must meet academic demands that can constrain creativity (such as final exams and university admission requirements). Hence, the diverse learning contexts experienced during an individual's school years may exert a critical influence on the development of creative thinking. These contextual factors —specifically the school environment — include aspects such as methodological approaches, social interactions, and teacher characteristics, all of which have the potential to either facilitate or impede the development of creative thinking abilities (Bonawitz et al., 2011; Hoicka & Akhtar, 2011).

On the other hand, the development of creative thinking cannot be fully comprehended without taking into account cognitive abilities, such as Executive Functions. Research on human development suggests that the processes involved in creative thinking are intertwined with the neurocognitive maturation of children (Ramírez et al., 2017). This suggests that creative thinking is a complex construct that could undergo critical phases that are related to the development of cognitive processes during childhood. Studies suggest that the development of creative thinking oscillates (declines and increases) when other aspects of cognition are developing (Lubart & Georgsdottir, 2004). Karmiloff-Smith's model (1994) also posits the existence of ''mismatches'' between these two constructs throughout childhood. This model maintains that a temporary regression in creative production would occur once the child acquires new skills. Once these skills have been consolidated, creative thinking processes are reestablished based on the new knowledge acquired.

We could conclude that children increase their creative thinking abilities as they get older due to their cognitive maturation and the enrichment of their educational and social experiences. However, due to the large number of factors that can contribute to the development of creative thinking, we cannot draw definitive conclusions. Nevertheless, the present study aimed to provide empirical evidence concerning the development of creative thinking during a critical stage (ages 9–12), as well as the potential impact of pedagogical approaches employed within the school context, as described below.

4. Creative thinking development and cooperative learning

Almost no studies have focused exclusively on the development of creative thinking across early adolescence. However, due to its very nature, this construct has been studied in terms of multiple determining factors including educational setting, family care, social status, or developmental cognition (Jankowska & Karwowski, 2019; Lucchiari et al. 2019; Zhou, 2021). Therefore, previous studies have focused mainly on the effect of these factors, as opposed to explicitly observing developmental changes over time.

The classroom environment is traditionally a space where strategies can be implemented to enhance the development of creative thinking (e.g., Moeller et al. 2013, Zhu 2010). In particular, the mediating effect of teaching methodologies has been widely studied among researchers within creative thinking development. According to studies conducted in school environments, creative thinking development arises from the interaction between contextual and individual factors (Zhang et al. 2020). In this regard, teachers (as well as teaching methodologies) play an important role as an environmental factor in developing students' creative thinking in early adolescence (Hong et al. 2009; Soh, 2017). Cropley (1995) has highlighted certain teaching practice characteristics (e.g., teaching methodology or creative environments for learning) that are necessary for favoring the development of creative thinking. These characteristics include promoting autonomy towards learning and the self-assessment of students; offering the opportunity to generate different actions for learning in a wide variety of conditions or scenarios; and encouraging a cooperative and socially integrative style of teaching.

CL is a methodology based on the social cognition principles of Vygostky (1978), who considered social interaction (parents, peers, teachers, etc.) to be a mediator of learning and cognitive development. The methodological approach of CL focuses on the pedagogical practice whereby students can work together in small heterogeneous and mixed ability groups and experience positive social interaction to accomplish a shared and common learning goal. Research has found that heterogeneous groups composed of students with diverse abilities, learning styles, genders, and/or ethnic backgrounds are more effective for successful teaching and learning (Lehman, 2007; Mandel, 2003; Webb, 1991). This approach — based on the principles of diversity, individual needs, and student learning patterns — has been the subject of numerous studies exploring its efficacy in promoting positive attitudes towards learning (Johnson & Johnson, 2002; Siegel, 2005) and fostering the development of creative and novel ideas among the students (Kim & Song, 2012; Nemeth & Kwan, 1985). Contrary to other group methodologies that do not necessarily imply cooperation (e.g., unstructured

collaborative group work), CL uses a wide range of routines or techniques for group management to ensure the development of the five elements that underpin this methodology (Johnson & Johnson, 2009a). These elements are (1) *Positive interdependence,* in which the classroom climate is based on cordial relationships and the constructive handling of conflicts; (2) *Individual accountability* which refers to the efforts made by the students toward achieving common objectives; (3) *Face-to-face promotive interaction*, which encourages students to place themselves face to face to interact verbally. Therefore, this is an appropriate group configuration for interacting with members of the group through dialog, debate, interviews and questioning; (4) *Social and interpersonal skills,* which includes promoting leadership attitudes, a climate of trust, communication, respect, and peer cooperation; and (5) *Group processing*. CL proposes a structure for evaluation, including self-evaluation, co-evaluation, and teacher evaluation of student attainment. In self-evaluation and co-evaluation, the members analyze each other's participation and accountability, assess the strategies most effective in the process of learning, and reach a consensus for modifying these strategies (Kyndt et al., 2013).

Developmental research suggests that CL is a teaching methodology that enhances creative thinking. The methodological characteristics of CL could help students to use more varied reasoning strategies (problem-solving strategies and divergent thinking) to find novel solutions and to generate original ideas (Hattie, 2009). In this sense, studies have been conducted at different educational stages. For example, Segundo-Marcos et al. (2020) used a pre-test/post-test design in Primary School to compare performance on a verbal creative thinking test (CREA Test) between two groups: CL vs. Standard Learning (individualistic group). The results revealed that children involved in CL methodology significantly improved their performance in creative thinking across time, while the control group did not show such improved performance between tests. On the other hand, in a quasi-experimental pre-test and post-test control group design conducted with preschoolers, Siew et al. (2017) reported that, compared to other non-structured collaborative group methodologies, CL had a significant positive impact on creative thinking skills. The authors argued that the children were involved in thinking and discussion processes through CL strategies that promote many uncommon or original responses. Moreover, Marashi and Khatami (2017) found that systematic use of cooperative techniques (e.g., think-pair-share, three-stay one-stray, roundtable, and three-step-interview) significantly improved the creative thinking of students (in middle childhood and adolescence) compared to unstructured group learning approaches. The authors noted that providing students with curricular contents supported by an unstructured group learning environment is insufficient for effectively promoting creativity in a primary school classroom. In comparison to other learning methods, CL could lead to an increase in the capacity to generate novel solutions to problems, a greater use of a variety of reasoning strategies, more original ideas, and more creative solutions to problems (Hattie, 2009; Johnson, 2003; Johnson & Johnson, 1989, 2005, 2009b). A CL environment facilitates active exploration of problems through students' own ideas and strategies. This type of setting fosters a supportive environment in which students feel comfortable taking risks in decision-making, questioning, and putting forward their own ideas (Bray, 2011; Sharma, 2015).

While some studies have reported positive effects of cooperative learning (CL) in different areas and dimensions, other research has yielded different results in this regard. For instance, Slavin et al. (1984) tested two instructional methodologies (Cooperative team and Individualized instruction) against a control group. These authors found that both cooperative and individualized instruction had positive effects on prosocial behavior and a positive attitude toward math. However, there were no significant differences in academic achievement between the three groups. In a study conducted by Okebukola (1986), the author hypothesized that the effects of cooperative versus competitive learning depend on students' preference for one style over the other. The study involved two groups of students, one taught through cooperative learning and the other through competitive learning. The groups were composed of students who preferred and those who did not prefer the method used. The overall comparison between the two methods did not reveal a significant difference in science achievement, but students who learned by their preferred method (either cooperative or competitive), outperformed those who did not by a large margin (effect size 1.8). Moreover, in a previous study, Okebukola (1985) compared different cooperation conditions (including mixed cooperative and competitive styles) against a control group. The author observed that those classes that used a combination of cooperation and competition outperformed both the "pure" cooperative classes and the "pure" individual competition classes.

These findings highlight the possibility that the efficacy of CL is contingent upon motivational factors and its integration with complementary pedagogical approaches. Although these results are not conclusive, recent research has revealed the potential of CL to elicit favorable outcomes when synergistically combined with other instructional strategies (e.g. flipped classroom: Erbil & Kocabaş, 2020; Lee et al., 2021).

Given this backdrop, conducting further studies is essential to provide a more in-depth analysis of Collaborative Learning (CL) in the school context. Such studies are necessary for gaining a broader perspective on the potential impact of this methodology on the development of creative thinking among students.

5. The present study

The present study aimed to longitudinally examine the trajectory of creative thinking in late childhood (between childhood and early adolescence), specifically between 9 and 12 years. We expected to find a significant age-related improvement in the potential to show creative thinking, as measured by a divergent thinking test. In addition, since participants belonged to two different schools that delivered different methodologies (cooperative learning -CL-, and individualistic learning -IL-), we could explore the effect of this variable on creative thinking performance. Therefore, we predicted that the CL students would show significantly greater improvement than the IL group between Test 1 (T^1) and Test 2 (T^2).

6. Methods

6.1. Participants

Fifty-three students (23 boys and 30 girls) from two different elementary schools in the urban area of the province of Almería (Spain) were recruited. The participants were assessed twice: T^1, at the beginning of the 5th grade (November) of Primary School ($m =$ 9.81 years; $Sd = 0.48$); T^2, and at the end of 6th grade (June) ($m = 11.35$ years; $Sd = 0.52$). The participants were students from Spanish ($n = 20$) or migrant families (Morocco, Romania, Portugal, and Sub-Saharan countries) who were born in Spain or schooled at early ages in the Spanish educational system ($n = 33$; 60.38%). All participants showed acceptable competence in the Spanish language according to the school curriculum demands.

The students of this study were included as a part of a broader developmental investigation to examine the changes in cognitive processes across late childhood over two school years (Segundo-Marcos et al., 2022). The two participating schools were selected due to their similarities in demographic characteristics and the different teaching methodologies experienced, that is, Cooperative Learning in one school, and Individualistic learning in the other. Therefore, two separate groups were distinguished according to these schools (Table 1). The study involved voluntary participation of experienced teachers with more than ten years of teaching experience who were interviewed to gather information on both methodologies (Table 2). Moreover, teachers reported information regarding their training. CL teachers (two teachers) participated in both face-to-face and online training sessions, provided by the ''Teacher Training Center of the Consejería de Educación y Deporte of Andalucía (Spain)''. These training sessions included supervision sessions, where the teachers shared activities with other CL specialists and received feedback and support to improve their pedagogical proposals. This training was focused on theoretical foundations, Cooperative Learning management (implementation sequence), cooperative techniques and lessons, and planning and evaluation through Cooperative Learning. As a result, teachers obtained a certificate of attendance and attainment. No information about the training was reported by the Individualistic learning teachers (two teachers). No information about any specific training was reported by the Individualistic learning teachers (two teachers).

It should be noted that CL was implemented in the classroom in specific subjects, such as Language, Math, and Arts. The teachers' objective was to cultivate sociable relationships, positive interdependence, and individual accountability among the students with the aim of working toward common goals through a diverse range of cooperative techniques and routines (see Torrego, 2012). The students were divided into mixed-ability groups of 3–4 participants. Promoting face-to-face interaction facilitated the development of social and interpersonal skills, as well as the evaluation of CL processes and curricular content (including self-evaluation, co-evaluation, and student achievements). The teacher in charge of CL provided the resources necessary for academic success and collaborated with the students on setting objectives, designing contents, and planning activities. The students perceived the teacher's role as that of a guide and mentor. Student achievement was assessed through final work, portfolios, and the various materials generated in class, rather than exclusively through exams (For further details on the classroom methodology used in this study, refer to Segundo-Marcos et al. (2022)).

Note. In the cooperative learning group, the cooperative methodology was conducted in subjects such as Spanish language and literature, Mathematics and Arts by the same teacher; while the rest of the subjects (Natural and social sciences, Physical Education and second language) were delivered by different teachers using an individualistic methodology. For example, in the Spanish educational system, a principal teacher delivers basic subjects (Spanish language and literature, mathematics, and arts). In contrast, specific teachers deliver other subjects such as natural and social sciences, Physical Education, and Second languages. Moreover, the individualistic group followed the same teacher allocation concerning the subjects, although all were delivered using the same methodological structure: individualistic learning.

6.2. Procedure

At both T^1 and T^2, students from each group (CL and IL) completed the CREA Test in their usual classroom. All participants received the instructions at the same time. These specific instructions were given as indicated by the authors of the test manual (Corbalán et al., 2015). In addition, each participant was given an individual answer sheet and the corresponding slide image. For impartiality reasons, the study used the same evaluator for each group. Therefore, the two groups (CL and IL) were evaluated with a 24 h time difference due to their locations. Finally, two external and impartial (Double-blind) assistants participated in correcting the test.

The procedure of this study followed the Spanish personal data protection law of the 5th of December 3/2018, with the Ethical

Table 1
Socio-demographic characteristics of Cooperative and Individualistic Learning groups.

		CL ($n = 25$)	IL ($n = 28$)	*Statistic*	*p*
Age	T^1	9.84 ($Sd = 0.47$)	9.78 ($Sd = 0.49$)	$t = 1.48$	.148
	T^2	11.44 ($Sd = 0.51$)	11.28 ($Sd = 0.53$)	$t = 1.58$	.123
Gender	*Girls*	14	16	$X^2 = 0.007$	.933
	Boys	11	12		
Ethnic Background				$X^2 = 1.91$	.136
Spanish		8	12		
Migrant families		17	16		

Note: CL= Cooperative Learning; IL= Individual Learning.

Table 2
The main characteristics of CL and IL methodology.

Methodology	Cooperative	Individualistic
Interaction	Mix-ability groups of 3–4 members. Face-to-face interaction. Individual effort depends on group commitment and social motivation.	Students are seated individually. The student did not share any materials and activities with a classmate. Individual effort depends on one's own motivation and external rewards.
Goals	Established by consensus between the members of the cooperative groups. Dependent on workgroups. The group should work together until all group members have understood and completed the activities successfully.	Achieved individually and not agreed upon. Dependent on one's own abilities and skills.
Teacher role	Students see the teacher's role as a guide and adviser. Use of specific cooperative routines (e.g., jigsaw)	The teacher is the principal evaluator. Teachers reported no specific strategies. Teaching based on an expository approach. They explain and share a reading, and then, students are involved in various individual activities.
Evaluation	The achievements are assessed by final group projects, portfolio (individual and group), investigative activities and both closed and open-ended activities. Achievements are measured through personal skills and knowledge, including the students' social, emotional, and affective competencies. Various ways of evaluation are applied, including the teacher and the students themselves (Self- and co-evaluation*).	The achievements are assessed by exams, final tests, and closed-answer activities. The achievements are measured through the knowledge acquired.

* Cooperative group evaluation.

Principles for Medical Research Involving Humans of the World Medical Association's Declaration of Helsinki. Furthermore, the study was approved by the research ethics board of the University of Almería and by the Provincial Authority of Education of the Autonomous Community of Andalucía government.

6.3. Measures

CREA Test. Divergent thinking tests allow us to obtain a cognitive measure of creative thinking (Corbalán et al., 2015). This test allows for completing the greatest possible number of questions in 4 min. These questions are based on a slide image (given at the beginning of the test) in paper format and an answer sheet. The image is black, which is presented on a yellow background. We used two different slide images suitable for children between the 5th and 6th grades of Primary School for T^1 (Image 'A') and T^2 (Image 'C'). Image 'A' shows an older telephone, while Image 'C' shows a waiter and a customer in a confusing scene in a restaurant. All the questions are accounted for except decontextualized and repeated questions and "repertory" questions without justification such as ''What? ''When?'' or similar. One point is given for an appropriate response and an extra point is awarded when the participant combines syntactically independent schemes (which are considered by the author as a cognitive scheme) such as the use of compound questions (e.g., "Is the handle used to charge the phone, or as a prize machine?"). A single score is obtained from the total number of valid responses (questions). Inter-rater reliability was assessed for the CREA test results in both T^1 and T^2 using Cronbach's alpha coefficient ($T^1 = 0.984$; $T^2 = 0.973$) indicating high consistency between evaluators. The CREA test shows strong reliability, convergent validity with Guilford's divergent thinking tasks, which measures fluency, originality, flexibility, and divergent production, and discriminant validity with aptitude and intelligence measures (OTIS Sencillo, Test Elemental de Inteligencia -TEI- and Test de Aptitudes Escolares -TEA-2-) in children and adults (Corbalán et al., 2015).

7. Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) v. 23.0 (IBM Corporation, Armonk, NY, USA). Kolmogorov-Smirnov test (with Lilliefors correction) was conducted to determine whether the study variables showed a normal distribution. To detect possible differences by gender or ethnic background in creative thinking, we used student's t-tests for each testing. To identify the possible effect of time and teaching methodology on creative thinking, we conducted a 2 (CL, IL group) x 2 (T^1, T^2) repeated-measures analysis of variance (ANOVA) of the CREA test scores. Post hoc comparisons were made using Sidak's test. Statistical significance was set at $p \leq 0.05$. *Partial Eta-Square* (η_p^2) and *Cohen's d* were reported as measures of effect size. Conventional level for *Partial Eta-Squared* was $\eta_p^2 > 0.01$ as a small effect, $\eta_p^2 > 0.06$ as a medium effect, and $\eta_p^2 > 0.14$ as a large effect (Cohen, 1973). About *Cohen's d* the level was: trivial (<0.2), small (0.2–0.49), medium (0.5–0.79), and large (≥0.8) (Cohen, 1988).

8. Results

First, we tested possible differences by gender or ethnic background in CREA scores. No statistically significant differences by gender were found at T^1 ($t = -0.23$; $p = .82$) or T^2 ($t = 0.08$; $p = .93$), as well as by ethnic background at T^1 ($t = 0.35$; $p = .73$) or T^2 ($t =$

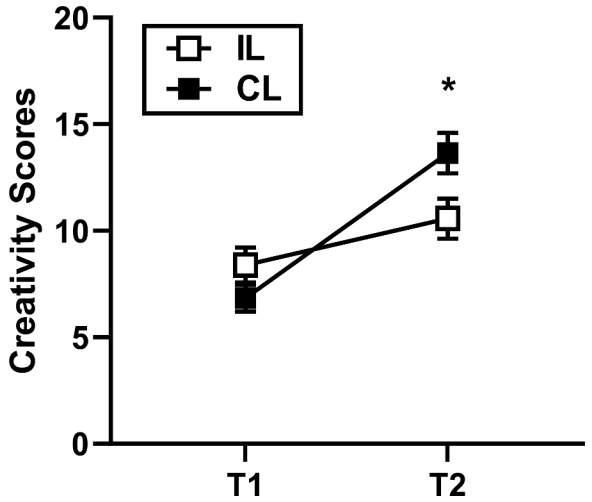

Fig. 1. Differences in creative thinking between T^1 and T^2 and teaching methodology groups.
Note. CL=Cooperative Learning; IL= Individualistic Learning. * Statistically significant differences between CL and IL in T^2 (* $p < .05$).

−0.97; p= .34) (data not shown).

We carried out a 2 (CL group, IL group) x 2 (T^1, T^2) repeated-measures ANOVA of the CREA scores, which revealed that this interaction was significant ($F_{1, 51}$= 9.27; p= .004; η_p^2= 0.15; Fig. 1). *Post-hoc* analysis indicated that both the CL (p< .001) and IL (p< .05) groups showed significant improvement in creative thinking between T^1 and T^2. At T^1, the CL (m = 6.84; Sd= 0.768) and IL groups (m = 8.39; p= .726) were statistically similar in creative thinking (p= .148). However, at T^2, the differences on creative thinking perform between CL group (m = 13.64; p= .975) and the IL group (m = 10.571; Sd= 0.922) were statistically significant (p= .026). The improvement index (obtained by subtracting T^1 from T^2) showed that 92% of students in the CL group improved their performance (the remaining 8% corresponded to 2 students). In comparison, 64% of students from the IL group showed an improvement (the remaining 36% corresponded to 10 students).

In addition, the ANOVA yielded a significant main effect of time ($F_{1, 51}$= 34.98; p< .001; η_p^2= 0.41) on creative thinking performance. *Post-hoc* analysis showed a significant general increase between T^1 (m = 7.62; Sd= 0.528) and T^2 (m = 12.11; Sd= 0.671) (p< .001). The main effect of methodology group was not statistically significant ($F_{1, 51}$= 0.651; p= .424.; η_p^2= 0.01).

9. Discussion

This study set out to analyze the trajectory of creative thinking across late childhood, a transitory stage between childhood and early adolescence (9 to 12 years old) measured by the CREA Test (Corbalán et al., 2015). The CREA test provides an integrated measure of creative thinking and has shown to be strongly correlated with scores on other creativity tests such as the Guilford Test, which measures fluency, originality, flexibility, and divergent production. For this purpose, two tests (T^1 and T^2) were administered to children between the fifth (T^1) and sixth (T^2) grade of Primary School. Our findings confirmed our hypothesis, which predicted a significant age-related improvement in creative thinking between the two tests, thus indicating a general improvement in creative thinking across time. These results agree with those of previous studies, suggesting that creative thinking performance increases from 9 to 11 years old (Gralewski et al., 2016; Smith & Carlsson, 1983; Torrance, 1968). The latter authors suggested that a learning experience is a creative act of constructing knowledge and adaptation that could undergo critical changes throughout creative thinking development. Creative thinking changes due to interacting with the environment and others along with objects in a particular setting. Therefore, the school environment is an important socio-cultural context that could mediate between individual and social dimensions and is thus a space where creativity is expected to emerge (to a greater or lesser degree) and be supported (Maksic & Smiljana, 2021).

Moreover, creative thinking is a skill that allows children to generate original and novel ideas (Lara, 2013). In this sense, creative thinking is a cognitive process whose development could be linked to neuropsychological changes in this stage of life. Studies in this field have concluded that a direct positive correlation exists between creative thinking and neuropsychological maturity (Ramírez et al., 2017).

Moreover, these findings suggest that the teaching methodology may play a mediating role in the development of creative thinking, highlighting the importance of further exploring this relationship. We recruited participants from two schools that adopted different methodologies: cooperative learning (CL) and individualistic learning (IL). We observed that the scores of the CL students increased significantly more than those of the IL group between Test 1 (T^1) and Test 2 (T^2). These findings are supported by previous studies, which suggest that creative thinking is developed across late childhood, particularly in those students who have received specific methodology or training (Doron, 2017; Gu, Dijksterhuis, & Ritter, 2019). In our study, no specific intervention programs were implemented in either group, which means that all activities were designed by the teacher and students according to the contents and objectives of the curricula framework and were adapted to the methodology (Cooperative or individualistic) applied for each group.

According to the teachers involved in our study, these organizational differences between groups were based on the student interactions and the teacher.

On the one hand, CL — unlike IL — encourages students to work together in small heterogeneous and mixed ability groups. CL strategies consider the students' interactions from a position of respect for each individual's abilities, needs, and learning styles. In IL, each student works individually towards achieving the proposed goals, which can lead to competitive attitudes. On the other hand, the CL teacher acts as a facilitator of interactions, promoting and supervising group self-management strategies and providing the students with the basic resources and tools required to achieve their objectives. In contrast, the IL teacher unilaterally guides the learning and, usually, directs the specific planning needed to achieve the objectives (e.g., activities, exams, extra activities). At the same time, CL students agree on all the steps and plans required to achieve the objectives. According to Hertz-Lazarowitz and Shachar (1990), the CL teacher's attitude tends to be more caring, positive, and effective, and the language more spontaneous, varied, and creative. However, some authors argue that there are differences in teaching style between CL and IL instructors, with the latter often described as more authoritarian, rigid, and less friendly. Previous studies suggest that these distinguishing characteristics of the two methodologies (CL and IL) may have a significant impact on student performance (Gillies, 2014). For instance, Johnson and Johnson (2002) conducted a meta-analysis of 111 studies and found that CL (compared to IL) had the strongest effects on a wide range of skills involved in the learning process as well as achievement, socialization, motivation, and personal self-development.

The present study extends previous research analyzing how the CL approach can enhance creative thinking in different educational stages by comparing the CL and IL approaches (Catarino et al., 2019; Marashi & Khatami, 2017; Siew et al., 2017). Moreover, our results are aligned with previous studies in which CL and IL groups were compared. In a study conducted with Sixty fifth-grade students, Segundo-Marcos et al. (2020) found a significant increase in creativity scores in the CL group compared with the IL group across time. Furthermore, the CL group showed a significant increase in creative thinking (measured by CREA Test) in two months, while IL students did not show improvements in the same period. In contrast to these previous findings, the elapsed time in the current study was greater (18 months), which has allowed us to observe longer-term changes. Therefore, an increase in divergent thinking test performance was observed across time in both CL and IL groups. However, the CL group showed significantly greater performance gains than the IL group between the tests (and the CL group showed a higher score than the IL group on T^2). Thus, our hypothesis is confirmed, meaning that creative thinking can be significantly improved by applying CL methodology in school-age children.

10. Limitations

Our study highlights the potential improvements in performance on a creative thinking task across late childhood, while also showing how classroom methodologies could affect such development. However, our study may have some limitations.

Specifically, we used a divergent thinking verbal test (CREA) for creative thinking assessment. This test is based on the principle that creative thinking comes from the individual capacity to develop questions considered the product of a cognitive system related to problem finding (Corbalán et al., 2015). Although this test has demonstrated strong reliability and validity with respect to Guilford's divergent thinking tasks and is considered a good predictor of creative thinking potential, the CREA test only focuses on the verbal domain, which could limit our understanding of individual creative thinking processes. Therefore, it would be useful to employ a measure of creative thinking that allows for testing other domains such as visual and figural tasks.

No differences according to gender or ethnicity were found for the measures of interest in this study. However, greater control of language competence could be an important issue for this study since 60% of our participants belong to migrant families. Although the students from migrant families showed adequate competence in the Spanish language (under curricula standards), we did not control for factors such as varying degrees of bilingualism or exposure to the mother tongue. This is clearly a limitation of our study, and it would thus be beneficial to address this issue in future research, given that earlier studies have identified a correlation between creative thinking and levels of linguistic competence (Sampedro & Peña, 2019; Sur & Ateş, 2022). Therefore, an exhaustive analysis of the linguistic characteristics of the participants could help to obtain a more in-depth understanding of our findings.

Finally, several possibilities are worth considering for future studies. In particular, our study accurately represents the integral nature of groups within the school environment, meaning that in no case were the students chosen from different classrooms (e.g., randomly). Therefore, the classroom ecologies were strictly respected. We emphasize the importance of respecting these aspects, which are intrinsically linked to the processes of learning and development. Nonetheless, the fifty-three students involved in this study may not represent the entire population of Spanish primary school children. Thus, a larger sample would provide a more representative view of the trajectory of creative thinking and the impact of classroom methodologies on such development.

Moreover, other factors such as language development, abstract reasoning, and/or academic achievement should be more rigorously assessed in future studies. Studying these variables could help to better understand the nature of creative thinking and their involvement in the learning processes and, consequently, in the development of creative thinking.

11. Conclusions

In conclusion, the present findings indicate the importance of teaching methodologies — particularly CI — in developing creative thinking. These results suggest that cooperative learning could be a powerful mediating factor in the development of creative thinking, which has a significant impact on both the learning process and the integral development of the child. Our study helps to understand, at least in part, the nature of creative thinking development and provides new evidence to inform educational strategies that could be used to promote creative thinking processes in the school environment. In short, this study brings to light the important role played by the classroom in the learning experiences by which students build and develop their socio-emotional and cognitive abilities and

creative thinking skills.

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Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The private data are not publicly available due to privacy or ethical restrictions.

Authors' contributions

All authors have been involved in the design of the study and drafting of the manuscript. All authors have approved the final version.

Consent for publication

All participants gave permission for the publication of their data.

Ethics approval and consent to participate

All procedures were approved by the research ethics board of the University of Almería and by the Provincial authority of Education of the Autonomous Community of Andalucía government. All participants provided informed consent to take part in the experiments.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Data availability

The data that has been used is confidential.

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