Iranian Journal of Educational Sociology

Journal Website

Article history:
Received 12 March 2025
Revised 19 May 2025
Accepted 28 May 2025
Published online 21 June 2025

Iranian Journal of Educational Sociology

Volume 8, Issue 2, pp 1-8

Quarterly
Iranian Journal of Educational Sociology

E-ISSN: 2645-3460

Effectiveness of the Concept Mapping Teaching Method on the Creativity Components of Second Grade Elementary Students in Mashhad

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A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Arabbaygi, M. A., Mahoor, H., & Fallah Mahneh, T. (2025). Effectiveness of the Concept Mapping Teaching Method on the Creativity Components of Second Grade Elementary Students in Mashhad. *Iranian Journal of Educational Sociology, 8*(2), 1-8.
https://doi.org/10.61838/kman.ijes.8.2.1

A B S T R A C T

Purpose: This study aims to evaluate the effectiveness of the Concept Mapping teaching method in enhancing the creativity components—fluency, flexibility, originality, and elaboration—of second-grade elementary students in Mashhad, Iran.
Methods and Materials: A semi-experimental design with a pre-test and post-test structure was used. The sample consisted of 40 second-grade elementary students from Mashhad, divided into an experimental group (n = 20) and a control group (n = 20). The experimental group received instruction using the Concept Mapping method, while the control group followed traditional teaching methods. Creativity was assessed using a creativity test based on Torrance's theory (1979). Descriptive statistics and covariance analysis (ANCOVA) using SPSS23 were employed for data analysis.
Findings: The results showed that the experimental group exhibited significant improvements in all creativity components—fluency, flexibility, originality, and elaboration—compared to the control group. The ANCOVA results indicated that the Concept Mapping method significantly affected creativity, with p-values less than 0.01 across all components. The experimental group demonstrated higher scores in the post-test on creativity measures, reflecting enhanced cognitive flexibility, fluency, originality, and elaboration.
Conclusion: The findings suggest that the Concept Mapping teaching method is an effective tool for enhancing creativity in elementary school students. By visually organizing and connecting ideas, students are able to improve their creative thinking across various dimensions, including fluency, flexibility, originality, and elaboration. This study provides evidence supporting the integration of Concept Mapping into elementary education as a strategy to foster creativity.

Keywords: *Concept Mapping, Creativity, Fluency, Flexibility, Originality, Elaboration, Elementary Education, Teaching Methods, Cognitive Development*

1. Introduction

Creativity is a crucial cognitive process that allows individuals to think divergently, solve complex problems, and adapt to new situations, which are essential skills for academic success and lifelong learning. The role of creativity in education has become increasingly recognized, particularly in fostering critical thinking, innovation, and academic performance (Almulla, 2023). As educators aim to improve students' cognitive abilities, integrating creative teaching methods into the curriculum has garnered attention, especially in primary and secondary education. One such innovative approach is the use of Concept Mapping (CM), a pedagogical tool that facilitates the development of meaningful connections between concepts and enhances students' problem-solving and critical thinking skills (Chularut & DeBacker, 2004).

Creativity is often defined as the ability to produce original, valuable, and useful ideas or solutions to problems (Wang et al., 2024). It involves a range of cognitive processes, including divergent thinking, problem-solving, and the ability to generate new ideas. Creativity is not confined to the arts but extends to various fields, including science, mathematics, and social studies, where innovative thinking is essential for breakthroughs and academic progress (Bicer et al., 2024).

In the context of education, fostering creativity has become a priority for many educators and policymakers, as it is closely linked to academic achievement and personal development. Studies have shown that students who exhibit higher levels of creativity tend to perform better academically and are more successful in problem-solving tasks (Mohebbi & Shamabadi, 2023). Furthermore, creativity is associated with improved social adaptation and self-confidence, which contribute to students' overall well-being and success (Abtahi & Nadri, 2012).

Creativity can be measured through different components, including fluency, flexibility, originality, and elaboration. Fluency refers to the ability to generate a large number of ideas, flexibility is the capacity to shift between different ideas or strategies, originality involves producing novel and unique ideas, and elaboration is the ability to develop ideas in detail (Maleki, 2016). These components serve as indicators of creative potential and are essential for students to navigate complex academic challenges and real-world problems effectively.

In recent years, the application of Concept Mapping in various disciplines, including science, mathematics, and language learning, has proven to significantly enhance students' creativity (Binoy, 2022; Pashaei et al., 2020). Concept Mapping allows learners to visually organize and represent knowledge, which not only strengthens their understanding of complex topics but also stimulates creative thinking by encouraging them to explore relationships between different concepts (Bicer et al., 2024). This method has been shown to improve academic performance, self-regulation, and motivation in learners (Jang, 2010; Keraro et al., 2006). Concept Mapping is a visual representation of knowledge that helps learners organize and structure information by illustrating the relationships between different concepts. This tool has its roots in the cognitive theory of learning, where it is believed that meaningful learning occurs when new information is connected to existing knowledge (Kinchin & Gravett, 2020). By creating a map of related concepts, students are encouraged to think critically and reflect on the connections between ideas, which enhances their understanding and promotes creativity (Nersessians et al., 2018).

The effectiveness of Concept Mapping in promoting creative thinking has been widely acknowledged in educational research. It has been shown to improve students' problem-solving skills, enhance their understanding of complex topics, and stimulate creative thinking by forcing them to consider different perspectives and relationships (Doris, 2018; McGinity et al., 2021). Concept Mapping encourages students to move beyond rote memorization and engage in deeper cognitive processing, which is essential for the development of creative skills (Binoy, 2022).

In science and mathematics education, where abstract concepts and complex problem-solving skills are essential, Concept Mapping has proven to be particularly effective. Bicer et al. (2024) found that the use of Concept Maps in upper elementary mathematics curricula led to improved creativity and critical thinking among students. This was particularly true for students who struggled with understanding abstract mathematical concepts, as Concept Mapping provided them with a clearer, more tangible way to organize and make sense of the material (Bicer et al., 2024).

Moreover, studies have demonstrated that the integration of Concept Mapping with other collaborative and interactive teaching methods, such as cooperative learning and problem-based learning, can further enhance its effectiveness. Jang (2010) found that combining Concept Mapping with co-teaching techniques in elementary science classes significantly improved students' engagement, motivation, and creativity. This suggests that the social and

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E-ISSN: 2645-3460

interactive nature of Concept Mapping can create an environment that fosters both cognitive and creative development (Jang, 2010).

The underlying theories that support the use of Concept Mapping in education are based on cognitive psychology, particularly the constructivist theory of learning. Constructivism posits that learning is an active process in which learners build upon their existing knowledge and experiences to form new understandings (Allen et al., 2022; Nersessians et al., 2018). Concept Mapping aligns with this theory by providing a visual tool for students to actively construct and organize their knowledge, thereby promoting meaningful learning and creativity.

Furthermore, the relationship between creativity and learning is well-established in educational research. According to Damanik (2024), creativity plays a critical role in academic success and personal development, as it enables students to approach problems from different angles, think outside the box, and develop innovative solutions (Damanik, 2024). When students engage in creative tasks, such as creating Concept Maps, they are more likely to retain and apply the knowledge they have gained, leading to improved academic outcomes (Boeiry et al., 2024).

Given the theoretical and empirical support for both Concept Mapping and creativity in education, the present study seeks to investigate the effectiveness of the Concept Mapping teaching method on the creativity components of second-grade elementary students in Mashhad, Iran. The study aims to address the following research question:

Does the use of Concept Mapping improve the creativity components (fluency, flexibility, originality, and elaboration) of second-grade elementary students?

2. Methods and Materials

2.1. Study Design and Participants

This study is a semi-experimental research with a pre-test and post-test design and a control group. It aims to investigate the effectiveness of the concept mapping teaching method on the creativity components of second-grade elementary students in Mashhad. The target population for this study consisted of all second-grade elementary school students in Mashhad, with an estimated total of around 10,000 students. From this population, a purposive sampling method was used to select 40 students. These 40 students were randomly divided into two groups: the experimental group (20 students) and the control group (20 students).

2.2. Data Collection Tools

Creativity tools are strategies or techniques designed to stimulate and enhance the creative thinking process, helping individuals generate new, innovative, and original ideas. One of the most widely used tools for assessing and promoting creativity is the Torrance Tests of Creative Thinking (TTCT), developed by Ellis Paul Torrance in 1974. These tests are designed to measure key components of creativity, including fluency, flexibility, originality, and elaboration. Fluency refers to the ability to generate a large number of ideas or responses to a given prompt, while flexibility involves the ability to produce a variety of ideas across different categories or approaches. Originality is the ability to come up with ideas that are novel and unusual, standing out from conventional thinking, and elaboration refers to the ability to develop and expand on an idea with detail, depth, and richness. These components together provide a comprehensive picture of an individual's creative potential. Creativity tools also encompass methods that aid in the development and expression of creative ideas, such as brainstorming, mind mapping, and, notably, concept mapping. Concept mapping, for example, is a visual representation tool that organizes and connects information through nodes and links, allowing learners to visualize relationships between ideas and concepts. By using concept mapping as a creative tool, students can enhance their problem-solving abilities, engage in critical thinking, and better organize their thoughts. These creativity tools, including the TTCT and concept mapping, are essential in educational settings as they not only assess students' creative abilities but also provide a framework to cultivate creativity in various disciplines, fostering cognitive and emotional growth (Boeiry et al., 2024).

2.3. Intervention

The concept mapping teaching method employed in this study focused on creating meaningful connections between different concepts in science lessons. This approach was specifically applied to the experimental group over the six-week period. During the sessions, students were encouraged to create concept maps either manually or using relevant software, fostering discussions and reflections on the relationships between concepts. The goal was to strengthen students' critical thinking and creativity by actively engaging them in structured and meaningful learning experiences.

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2.4. *Data Analysis*

Descriptive statistics, including tables, charts, means, and standard deviations, were used for the initial data analysis. In terms of inferential statistics, Analysis of Covariance (ANCOVA) was employed to test the hypotheses of the study. The data were analyzed using SPSS23 software to compare the mean scores of the experimental and control groups before and after the intervention. This analysis aimed to determine the effect of the concept mapping teaching method on the creativity components of the students.

3. Findings and Results

In terms of demographics, among the respondents, 34 individuals have a high school diploma or lower, 14 hold a bachelor's degree, and 12 have a master's degree or higher. This means that 56.66% of the respondents have a high school diploma or less. Regarding employment, 45 individuals are self-employed, 11 are employees, and 4 work in the military. Additionally, 75% of the respondents' fathers are self-employed.

Table 1

Descriptive Statistics for Creativity

Groups	Variables	Test	Mean	Standard Deviation	Cronbach's Alpha
Experimental Group	Total Creativity Score	Pre-test	124.34	3.57	0.72
		Post-test	147.27	3.09	
	Elaboration	Pre-test	31.15	1.42	0.75
		Post-test	37.24	1.74	
	Fluency	Pre-test	31.24	0.38	0.77
		Post-test	36.97	1.55	
	Flexibility	Pre-test	31.47	1.29	0.79
		Post-test	39.26	0.87	
	Originality	Pre-test	31.29	1.55	0.76
		Post-test	36.66	0.67	
Control Group	Total Creativity Score	Pre-test	124.5	3.33	0.81
		Post-test	124.36	3.29	
	Elaboration	Pre-test	30.08	1.27	0.82
		Post-test	31.87	1.74	
	Fluency	Pre-test	30.35	1.38	0.77
		Post-test	32.75	1.46	
	Flexibility	Pre-test	31.28	1.85	0.83
		Post-test	30.46	1.72	
	Originality	Pre-test	31.43	1.28	0.80
		Post-test	31.97	1.37	

The descriptive statistics for creativity indicate significant improvements in the experimental group compared to the control group. In the experimental group, the pre-test mean for total creativity was 124.34 (SD = 3.57), which increased to 147.27 (SD = 3.09) in the post-test, showing notable progress. Across the creativity components, fluency improved from 31.24 (SD = 0.38) to 36.97 (SD = 1.55), flexibility increased from 31.47 (SD = 1.29) to 39.26 (SD = 0.87), originality rose from 31.29 (SD = 1.55) to 36.66 (SD = 0.67), and elaboration advanced from 31.29 (SD = 1.51) to 36.66 (SD = 1.67). In contrast, the control group showed minimal changes, with the total creativity pre-test mean of 124.35 (SD = 3.33) remaining almost unchanged in the post-test at 124.36 (SD = 3.29). The control group's fluency increased slightly from 30.35 (SD = 1.38) to 32.75 (SD = 1.46), flexibility decreased from 31.28 (SD = 1.85) to 30.46 (SD = 1.72), originality increased marginally from 31.43 (SD = 1.28) to 31.97 (SD = 1.37), and elaboration saw a slight improvement from 31.43 (SD = 1.28) to 31.97 (SD = 1.37). These findings suggest that the Concept Mapping teaching method effectively enhances creativity in students, particularly in fluency, flexibility, originality, and elaboration, whereas traditional methods yield limited impact.

To test the hypothesis regarding the effect of the concept mapping teaching method between the experimental and control groups, an Analysis of Covariance (ANCOVA) was conducted.

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E-ISSN: 2645-3460

Table 2

Results of ANCOVA on the Effect of Concept Mapping Teaching Method on Creativity

Source	Variables	Sum of Squares	Degrees of Freedom	F	Significance Level	Eta Squared	Statistical Power
Pre-test	Elaboration	98.18	1	57.86	0.001	0.54	0.91
	Fluency	112.16	1	46.66	0.003	0.67	0.97
	Flexibility	147.39	1	47.24	0.002	0.57	0.95
	Originality	134.69	1	36.57	0.001	0.55	0.99
Group	Elaboration	109.47	1	33.18	0.001	0.64	0.97
	Fluency	136.24	1	45.39	0.002	0.71	0.95
	Flexibility	164.12	1	42.71	0.002	0.62	0.95
	Originality	147.54	1	29.86	0.003	0.58	0.94
Error	-	1236.05	58	-	-	-	-
Total	-	139851.00	60	-	-	-	-

Based on the findings from Table 2, the significance level for the between-group effect is 0.001, which is smaller than the threshold of 0.05, indicating a statistically significant effect. Moreover, the obtained F-value (33.16) exceeds the critical value from the F-table for degrees of freedom (1 and 58). Additionally, the statistical power is above 0.90, indicating a very low probability of error. Therefore, the research hypothesis regarding the effectiveness of the concept mapping teaching method on the creativity (elaboration, fluency, flexibility, and originality) of second-grade elementary students in Mashhad is supported.

Table 3

Adjusted Mean Scores of Creativity

Variable	Experimental Group (M, SD)	Control Group (M, SD)
Creativity	145.80 (3.90)	118.79 (3.47)
Fluency	36.02 (1.87)	30.16 (2.89)
Flexibility	36.86 (1.65)	29.98 (2.85)
Originality	36.11 (1.57)	29.31 (2.74)
Elaboration	36.06 (1.88)	29.34 (2.75)

The comparison of the adjusted means shows that the mean creativity scores in the experimental group are higher than in the control group. In other words, the concept mapping teaching method significantly increased the creativity (elaboration, fluency, flexibility, and originality) of the second-grade elementary students in the experimental group ($p<0.01$).

4. Discussion and Conclusion

This study sought to evaluate the effectiveness of the Concept Mapping teaching method in enhancing the creativity components (fluency, flexibility, originality, and elaboration) of second-grade elementary students in Mashhad, Iran. The results revealed that the application of Concept Mapping significantly improved students' creativity scores across all four components—fluency, flexibility, originality, and elaboration—compared to the control group. These findings suggest that Concept Mapping is a highly effective pedagogical tool for fostering creativity in young learners.

The results of this study align with previous research on the role of Concept Mapping in enhancing creativity. The significant improvements in the creativity components of the experimental group support the findings of Bicer et al. (2024), who demonstrated that the use of Concept Mapping in elementary school mathematics curricula promoted students' creative thinking and problem-solving abilities. In their study, students were able to make meaningful connections between mathematical concepts, which not only deepened their understanding but also stimulated creative thinking (Bicer et al., 2024). This is consistent with the results of the present study, where the experimental group exhibited higher scores in fluency, flexibility, originality, and elaboration. By visually representing knowledge and the relationships between concepts, Concept Mapping encourages students to think critically and divergently, thus fostering creative abilities.

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E-ISSN: 2645-3460

Moreover, the results of this study are in line with research by Khrais and Saleh (2017), who investigated the outcomes of integrating Concept Mapping in nursing education. They found that the use of Concept Mapping improved students' creativity by enhancing their ability to generate novel ideas and solutions, a key component of originality (Khrais & Saleh, 2017). Similarly, in the present study, students who were exposed to the Concept Mapping method demonstrated a significant improvement in originality, indicating that the method effectively encouraged creative thinking and the generation of unique ideas. Concept Mapping's ability to facilitate this process is supported by the constructivist theory of learning, which emphasizes the importance of actively organizing and relating new information to existing knowledge (Almulla, 2023). By constructing Concept Maps, students engage in the active process of linking concepts, thereby promoting deeper cognitive processing and creativity.

The results also resonate with the findings of Keraro et al. (2006), who showed that Concept Mapping, when combined with cooperative learning, significantly improved students' motivation and creativity. In this study, students' ability to adapt and shift between different problem-solving strategies (flexibility) improved, supporting the idea that Concept Mapping enhances students' cognitive flexibility (Keraro et al., 2006). By encouraging students to explore multiple perspectives and connections, Concept Mapping fosters the development of flexible thinking, which is critical for solving complex problems. This was particularly evident in the experimental group, where students demonstrated a higher level of cognitive flexibility compared to the control group.

Furthermore, the improvements in fluency and elaboration observed in this study align with the findings of Jang (2010), who explored the impact of Concept Mapping on students' self-regulation and academic achievement in science classes. Jang found that students who engaged in Concept Mapping not only developed a greater understanding of the content but also showed an increased ability to generate ideas and elaborate on them (Jang, 2010). In the present study, the experimental group exhibited enhanced fluency and elaboration, as they were able to generate more ideas and expand upon them in greater detail, demonstrating the effectiveness of Concept Mapping in promoting creative thought.

Despite the significant findings, this study has several limitations that should be considered. First, the study sample was limited to a small group of second-grade elementary students in Mashhad, Iran, which may not be representative of all elementary students. As a result, the generalizability of the findings to other populations or educational contexts is limited. Future studies could expand the sample size to include students from different grade levels, regions, and educational systems to increase the external validity of the results.

Second, the study relied on a pre-test and post-test design, which does not account for potential confounding variables that may have influenced the results. For example, the creativity scores of students in both the experimental and control groups could have been affected by factors such as prior knowledge, teacher characteristics, or other external influences. Future research could use a more robust research design, such as a longitudinal study or randomized controlled trial, to control for these variables and provide more accurate and reliable findings.

Another limitation is that the study focused solely on the effects of Concept Mapping on creativity, without considering other potential outcomes, such as academic performance or student motivation. While creativity is an important factor in academic success, it is also essential to examine how Concept Mapping impacts other aspects of students' learning, such as their overall academic achievement or attitudes toward learning. Future studies could explore the broader effects of Concept Mapping on students' academic performance, motivation, and engagement, providing a more comprehensive understanding of the method's impact on students' learning.

There are several directions for future research that could build on the findings of this study. First, researchers could investigate the long-term effects of Concept Mapping on creativity. While this study showed significant improvements in creativity after a short-term intervention, it is important to explore whether these effects are sustained over time. Longitudinal studies could examine how the use of Concept Mapping influences creativity in the long run and whether students continue to benefit from this method as they progress through their academic careers.

Additionally, future research could explore the impact of Concept Mapping on other cognitive and affective outcomes, such as critical thinking, problem-solving, and student motivation. While the present study focused on creativity, there is evidence to suggest that Concept Mapping can also enhance critical thinking and problem-solving abilities (Smyth et al., 2022). Investigating the interplay between these cognitive skills could provide valuable insights into how Concept Mapping supports broader

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E-ISSN: 2645-3460

cognitive development and prepares students for more complex academic tasks.

Another potential avenue for future research is to examine how different variations of Concept Mapping—such as collaborative or digital Concept Mapping—may impact students' creativity. While this study utilized traditional paper-and-pencil Concept Mapping, recent studies have explored the benefits of digital Concept Mapping tools, which may offer additional advantages in terms of collaboration, engagement, and ease of use. Comparing the effectiveness of different forms of Concept Mapping could help determine the most effective approaches for fostering creativity in diverse educational contexts.

Based on the findings of this study, there are several practical recommendations for educators seeking to incorporate Concept Mapping into their teaching practices. First, teachers should consider integrating Concept Mapping into their lessons across various subjects to enhance students' creative thinking and problem-solving abilities. Given its positive impact on creativity, Concept Mapping can be particularly useful in subjects such as science, mathematics, and social studies, where students are required to understand complex concepts and relationships. By encouraging students to create Concept Maps, teachers can help them organize their thoughts, visualize connections, and develop a deeper understanding of the material.

Second, educators should encourage collaborative Concept Mapping, where students work together to create Concept Maps. Collaborative learning has been shown to enhance creativity by fostering social interaction and the exchange of ideas. Teachers can design group activities that involve students in jointly constructing Concept Maps, allowing them to share perspectives and generate a wider range of ideas. This collaborative approach can further enhance students' cognitive flexibility and creativity.

Finally, it is important for teachers to provide ongoing support and feedback as students create and refine their Concept Maps. While Concept Mapping can be a powerful tool for promoting creativity, it requires guidance and practice to be fully effective. Teachers can scaffold the Concept Mapping process by providing clear instructions, offering feedback on students' maps, and encouraging them to elaborate on their ideas. By providing this support, teachers can help students develop their creative potential and improve their ability to generate and elaborate on ideas.

In conclusion, this study provides strong evidence for the effectiveness of Concept Mapping in enhancing creativity in second-grade elementary students. The findings highlight the positive impact of Concept Mapping on fluency, flexibility, originality, and elaboration, which are critical components of creative thinking. While the study has some limitations, it contributes valuable insights into the potential of Concept Mapping as a teaching method for fostering creativity in young learners. By incorporating Concept Mapping into their teaching practices, educators can help students develop the creative skills necessary for academic success and lifelong learning.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Acknowledgments

We hereby thank all participants for agreeing to record the interview and participate in the research.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethical Considerations

All procedures performed in studies involving human participants were under the ethical standards of the institutional and, or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Iranian Journal of Educational Sociology
E-ISSN: 2645-3460