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Effects of Coordinated Techniques on Science Education Learning: Six Hats and Jigsaw Techniques[1]

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Abstract

The objective of this study was to investigate the impact of the coordinated application of the Six Thinking Hats and Jigsaw (separation-assembly) techniques in a Science and Technology lesson on the learning outcomes related to air, water, and soil pollution among 5th-grade students. The study employed a quantitative approach and followed a pretest-posttest control group research design, aligning with the experimental research method. The sample consisted of 56 middle school students recruited using purposive convenience sampling The experimental group in this study received instruction on the topics of air, water, and soil pollution through the coordinated application of the Six Thinking Hats and Jigsaw techniques, whereas the control group was taught in accordance with the existing curriculum. The research findings revealed a significant difference between the experimental and control groups, with the experimental group demonstrating superior outcomes.

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Introduction

In recent years, educational research has catalyzed positive transformations in curricular frameworks, shifting from traditional teacher-centered paradigms to student-centered educational systems. The overarching objective is to cultivate students as proactive individuals, fostering autonomous information retrieval and critical evaluation skills. Environments characterized by student-centered education, wherein teachers assume guiding roles, facilitate learning through active participation, leading to a more enduring acquisition of knowledge. This pedagogical approach aligns with constructivist learning principles, conceptualizing learning as the cognitive process of interpreting external stimuli, objects, or concepts, leveraging sensory perception and prior experiences (Atasoy et al., 2007). In the constructivist approach to primary education programs in 2005, students are tasked with constructing their own conceptual frameworks and devising solutions to life's challenges. Consequently, the implementation of a constructivist teaching environment becomes imperative to facilitate active student engagement in the learning process (Larison, 2022). Atasoy et al. (2007) delineate three distinct learning environments. In the "individual learning" environment, students engage in solitary work, isolating themselves from peer interactions and assuming a limited role in the learning experiences of their counterparts. The competitive learning environment perceives learning as a form of competition, potentially leading unsuccessful students to progressively disengage from the learning milieu. This disengagement may stem from perceptions of inadequate effort and a lack of peer support (Chen et al., 2020).

In a collaborative learning milieu, students collectively strive towards predetermined learning objectives, fostering an environment where knowledge is co-constructed through shared insights. This cooperative engagement promotes interactive learning, as students exchange acquired knowledge, contributing to an enriched understanding of the subject matter. The constructivist approach finds its most conducive manifestation in environments that afford equal learning opportunities to all students, rather than isolating individuals or subjecting them to continual comparisons (Serrano Amarilla et al., 2022). Cooperative learning, with its emphasis on shared learning goals and interactive processes, aligns seamlessly with the principles of constructivist pedagogy. Numerous studies in the literature attest to the efficacy of cooperative learning in elevating students' levels of comprehension. Given the conceptual similarities between cooperative learning and the techniques harmonized with six-hat thinking and jigsaw methodologies, there is a reasonable presumption that these techniques also wield a positive influence on enhancing students' comprehension levels. The science curriculum, extending beyond theoretical realms, encapsulates our immediate environment, encompassing both living and non-living entities—an intricate tapestry of nature with which humans intricately interact. Despite this inherent connection with the natural world, comprehending scientific principles remains a formidable challenge, necessitating a tangible and concrete approach to learning.

Teachers play a pivotal role in rendering lessons palpable, requiring the creation of collaborative learning environments wherein students actively engage with and materialize abstract concepts. The integration of the Six Thinking Hats technique, jigsaw technique, and coordinated methodologies emerges as a facilitative strategy in enhancing students' original thinking and empathy skills. Moreover, these approaches contribute to the cultivation of positive peer relationships and foster an acute awareness of environmental issues (Culha, 2019; Ertürkler & Bagci, 2019).

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The main research question was "How do the Six Thinking Hats and Jigsaw techniques, when applied in coordination, affect science learning in the second level of primary school?"

Method

Research Design

In this study, a quantitative method was employed to investigate the effects of integrating the six thinking hats and jigsaw techniques into the Ministry of National Education's 5th-grade science course unit on air, water, and soil pollution. The research adopted a quasi-experimental design with a pretest-posttest control group. The quasi-experimental design involves the random assignment of subjects to experimental and control groups, and measurements are taken before and after the experimental study (Büyüköztürk, 2002). The utilization of a quasi-experimental design is justified by the impracticality of randomly assigning the control and experimental groups using a random technique (Şevkin, 2008). Based on the pretest data, two groups were formed in the study: a control group and an experimental group where the Six Thinking Hats and Jigsaw techniques were implemented in coordination (Six Hats Jigsaw).

Study Group

Participants were recruited using purposive convenience sampling, which is a non-probability sampling method. The sample consisted of 56 middle school students divided into experimental and control groups.

Data Collection Tools

The data for this study were collected using a pretest and a postest designed to assess the effects of integrating the six hats and jigsaw techniques into the Ministry of National Education's 5th-grade science course unit on air, water, and soil pollution. These tests aimed to measure students' learning outcomes, comprehension levels, and engagement in the subject matter. To establish a baseline measure of students' initial understanding of the air, water, and soil pollution unit, a pretest was administered before the implementation of both the current program and experimental techniques. A posttest was administered after the completion of the study to evaluate the impact of integrated teaching methods on students' learning outcomes. The homogeneity test, pre-test, and post-test questions to be applied in the study were prepared by two science teachers working in schools affiliated with the Ministry of National Education. The questions in the tests were designed to be clear, concise, and aligned with the learning objectives of the study. The test instrument underwent a validation process to ensure its reliability and relevance to the study's objectives. The pretest and posttest sections included questions that evaluated the students' understanding of key concepts related to air, water, and soil pollution. In collecting this dataset, the impact of the teaching method, coordinated with the Six Thinking Hats and Jigsaw techniques, on the academic learning of the participants was assessed.

Data Analysis

Since the study could not be conducted in a school with more than one 5th-grade class, it was carried out in two schools, each with a single class and located close to each other. A homogeneity test was applied to determine the experimental and control groups among three nearby village schools that were identified in advance and easily accessible by transportation (Dugard & Todman, 1995).

Procedure

In this study, the effects of Six Hats and Jigsaw techniques on science learning in the second grade of primary school were investigated. That work study specifically determined whether these techniques could improve students' academic achievements and attitudes toward science (Akkuş & Çetin, 2017; Avcı, 2022). The research question addressed in this study is:

> *"How do the Six Thinking Hats and Jigsaw techniques, when applied in coordination, affect science learning in the second level of primary school?"*

To answer this research question, a quasi-experimental design was used, comprising an experimental group and a control group. The experimental group received instruction on air, water, and soil pollution using the Six Thinking Hats and Jigsaw techniques, while the control group received instruction using traditional methods. Pre- and post-tests were administered to both groups to measure their academic achievement. The findings of this study have important implications for science education. The Six Thinking Hats and Jigsaw techniques have the potential to enhance science learning by promoting collaboration, communication, and critical thinking skills among students. By investigating the effects of these techniques on science learning, this study contributes to the literature on innovative teaching methods and science education.

Finding

The 5th-grade students from Güzeltepe Secondary School, whose homogeneity test results were similar, were selected as the control group, and the 5th-grade students from Suvaran Secondary School were selected as the experimental group as shown in Table 1. The 23-question 5th-grade homogeneity test averages of Güzeltepe, Harman, and Suvaran middle schools were 9.6, 11.7, and 9.4, respectively. Based on these data, Suvaran Middle School's 5th-grade students were designated as the experimental group, while Güzeltepe Middle School's 5th-grade students were assigned as the control group. The implementation phase of the study involved administering a pre-achievement test consisting of 20 questions about air, water, and soil pollution to both the experimental and control groups. The control group was taught using the traditional teaching method, where the teacher explained the subject of air, water, and soil pollution using the 5th-grade science textbook provided by the Ministry of National Education.

Table 1

Means of Homogeneity Test

	Güzeltepe	Harman	Suvaran
N	22	27	30
Arithmetic Mean	9.5455	11.6667	9.4333
Median	9.5000	11.0000	8.5000
Mod	8.00[a]	16.00	8.00
Ss	3,03515	3.73136	3.79367
Min.	3.00	6.00	1.00
Max.	16.00	20.00	18.00

On the other hand, the experimental group received information about the jigsaw technique and six thinking hats techniques to be applied in coordination after the pre-test was conducted. The group was divided into five groups of six people each, and it was determined which hats each member would wear. The classroom environment was organized accordingly to facilitate the activity (Alexandersson, 1986).

In the first stage of the application, each student generated ideas about the subject according to the characteristics of the hat they wore and shared their ideas with the group. After each student in the group shared their ideas, the second stage of the application started. At this stage of the study, students who were separated from their first groups came together with their like-minded friends and shared their ideas with each other according to the characteristics of the hat of the same color they were wearing. They chose the good ideas that reflected the characteristics of the hat they were wearing and noted down the ideas they had chosen (Astuti et. al., 2021). At this stage, the students who specialized and came back to their old groups shared the ideas they had determined in the groups they had specialized in with their old groups, and the whole class participated in the general evaluation with ideas from different perspectives on the subject, and the application was terminated. After the end of the application, the experimental group, in which the application was made, and the control group, in which the subject was taught with traditional methods, were subjected to a post-test in which academic achievement was measured, and the results were recorded (Herranen & Aksela, 2019). The study involved two groups, Güzeltepe and Suvaran, with each group consisting of 27 and 31 students, respectively. The data were analyzed for each group separately, considering various statistical measures as shown in Table 2 and Table 3. In terms of the arithmetic mean, Güzeltepe had a higher average (9.55) compared to Suvaran (8.78). The median for Güzeltepe was 9.50, while for Suvaran, it was 8.00. The mode for both groups was 8.00. Standard deviations (Ss) reflected a slightly higher variability in scores for Suvaran (3.12) compared to Güzeltepe (3.04).

Table 2

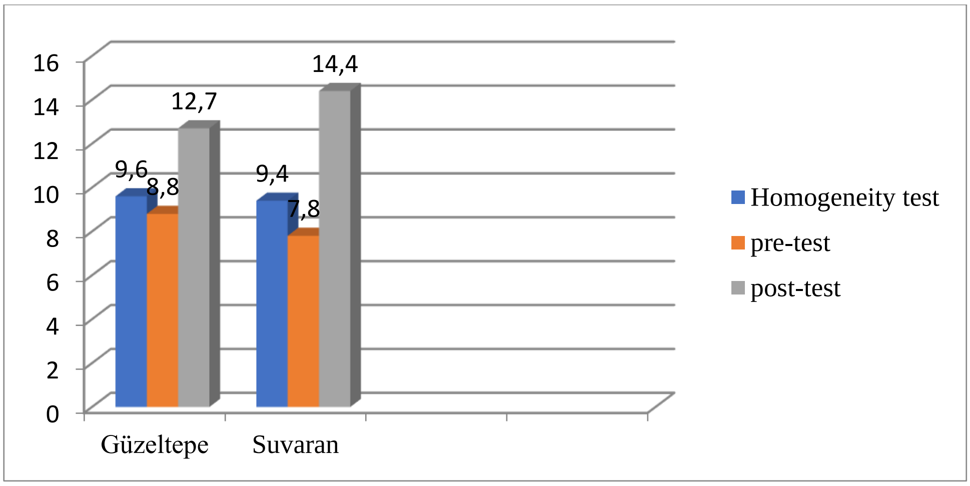
Pre-test and Post-test Results of The Study

	Pre-test averages		Post-test averages	
	Güzeltepe	Suvaran	Güzeltepe	Suvaran
N	27	31	26	31
Arithmetic Mean	9.5455	8.7778	9.5455	12.6538
Median	9.5000	8.0000	9.5000	12.000
Mod	8.00[a]	7.00[a]	8,00[a]	8.00
Ss	3.03515	3.11736	3.03515	5.69169
Min.	3.00	3.00	3.00	4.00
Max.	16.00	14.00	16.00	22.00

The minimum and maximum scores for Güzeltepe were 3.00 and 16.00, respectively, while Suvaran had a range of 3.00 to 22.00. These findings suggest variations in academic achievement between the two groups, with Güzeltepe generally exhibiting higher central tendency measures. The mode for both groups being 8.00 indicates that this score occurred most frequently. The standard deviations imply that scores in Suvaran were more dispersed than those in Güzeltepe. The minimum and maximum scores demonstrate the range of academic performance within each group. According to the results of the achievement test consisting of 20 questions, the average of the experimental group was 14.4 and the average of the control group was 12.7 in Table 3.

Table 3

Homogeneity Test, Pretest and Posttest Averages



Discussion and Conclusion

The combination of coordinated techniques, such as the jigsaw technique and six-hat thinking, has been recognized in the literature for its potential positive impact on academic achievement in education. The work of Martins et al. (2022) emphasizes that these techniques, when applied together, can empower students to play a more active role in their learning process, promoting meaningful engagement with the subject matter. The jigsaw technique, as highlighted by Hu et al. (2021), involves breaking students into smaller groups to collaboratively work on different aspects of a broader task or topic. This not only fosters cooperation and collaboration but also instills a sense of responsibility among students. Simultaneously, the six thinking hats technique, as described by Dolapçıoğlu and Gürkan (2020), encourages students to think critically and creatively by adopting various thinking styles or perspectives. When these techniques are integrated, students may benefit from the synergistic development of both cooperative and critical thinking skills. The collaborative nature of working in smaller groups and sharing ideas can contribute to a deeper understanding of the subject matter. This approach, as suggested by the literature, can lead to enhanced academic achievement as students become more actively engaged in the material and develop a stronger sense of ownership over their learning process. Furthermore, the coordinated use of these techniques contributes to creating a dynamic and interactive classroom environment, fostering excitement and curiosity about the subject matter. Drawing on the insights of these studies, the present research aligns with the broader scholarly conversation on the efficacy of coordinated techniques in enhancing the learning experience and academic outcomes for students.

In light of the information presented, it is evident that the coordinated application of the jigsaw technique and six thinking hats holds great promise for enriching the educational landscape. The collaborative and cooperative nature of these techniques aligns with contemporary educational theories emphasizing student-centered learning and active participation. The findings of this study contribute to the growing body of literature that underscores the potential of coordinated teaching methodologies to enhance both cooperative skills and critical thinking abilities among students.

In this study, the experimental group consisted of 30 students in which six thinking hats technique and jigsaw techniques were applied in coordination, while the control group consisted of 26 students and the subject was taught with traditional methods. The application was completed in four lesson hours. The study found that the mean achievement of the control group increased from 8.8 to 12.7, while the mean achievement of the experimental group increased from 7.8 to 14.4. In conclusion, the outcomes of this study illuminate the substantial impact of integrating coordinated techniques such as the jigsaw and six thinking hats into science education at the second level of primary school. The significant increase in mean achievement scores, coupled with the pronounced percentage improvements, underscores the efficacy of these coordinated teaching methods. The observed 84.6% enhancement in the experimental group, as compared to the 44.3% increase in the control group, substantiates the assertion that the coordinated application of jigsaw and six-hat thinking techniques contributes significantly to students' learning outcomes in the context of air, water, and soil pollution. These findings extend beyond the immediate context of the study, suggesting that the benefits of coordinated techniques could be extrapolated to various science subjects in the second level of primary education. As educators and curriculum developers contemplate strategies to enhance teaching methodologies, the insights gleaned from this research provide compelling evidence for the adoption of coordinated techniques. The greater effectiveness demonstrated by these methods implies a transformative potential for science education, fostering a more engaging and impactful learning environment for both teachers and students alike. Moreover, the positive impact on academic achievement observed in this research resonates with the broader discourse on pedagogical innovation. The notion that students who actively engage with subject matter, facilitated by collaborative techniques, exhibit improved academic performance is consistent with the principles of learner-centric education (Sadi & Gülcü, 2020). These insights support the argument that educational strategies combining cooperative learning and critical thinking methodologies can serve as effective tools for educators striving to cultivate a dynamic and engaging classroom environment. As we contemplate the broader implications of these findings, it becomes apparent that the integration of these techniques not only positively influences academic outcomes but also nurtures essential life skills. The development of collaborative problem-solving skills and the ability to approach challenges from diverse perspectives are valuable assets that extend beyond the academic realm. Thus, educators and curriculum developers may find inspiration in this study's outcomes when considering innovative approaches to foster holistic student development.

Building upon the results of this study, several suggestions for future research and educational practices emerge. Future studies can explore the extended application of coordinated techniques, such as the jigsaw and six-hat thinking, across various science subjects at the second level of primary education, investigating their transferability and effectiveness in different contexts to provide a comprehensive understanding of their potential impact on diverse science topics. Conducting longitudinal studies is recommended to offer insights into the sustainability and long-term effects of coordinated teaching methods, tracking the academic progress and retention of knowledge among students over an extended period to contribute valuable information regarding the lasting impact of these techniques on learning outcomes. Integrating teacher training programs focusing on the effective implementation of coordinated techniques in science education can enhance the pedagogical skills of educators, contributing to broader educational improvements. Exploring student perspectives and attitudes toward coordinated techniques through qualitative research can provide a more holistic understanding of the learning experience, delving into students' perceptions, motivation, and engagement. Comparative studies can be undertaken to evaluate the effectiveness of coordinated techniques against other innovative teaching approaches, informing educators and policymakers in selecting the most impactful methodologies for science education. Given the increasing prevalence of online education, future research could investigate the applicability of coordinated techniques in virtual learning environments, addressing their translation to online platforms in the evolving landscape of education.

Recommendations

Future research in the field of education can focus on several key areas to enhance teaching methodologies and improve learning outcomes. Firstly, exploring the application of coordinated techniques such as the jigsaw and six-hat thinking across various science subjects at the second level of primary education will provide valuable insights into their transferability and effectiveness in different educational contexts. This exploration can help educators tailor their teaching strategies to better engage students and foster deeper understanding. Additionally, conducting longitudinal studies will be crucial in tracking the sustainability and long-term effects of coordinated teaching methods on students' academic progress and knowledge retention. Understanding how these methods contribute to students' learning over an extended period can inform educators about the most effective approaches to support continuous academic growth. Integrating teacher training programs that focus on the effective implementation of coordinated techniques in science education is another important aspect. By enhancing educators' pedagogical skills and knowledge of these techniques, we can contribute to broader educational improvements and create more engaging learning environments for students. Qualitative research is also essential in gaining a deeper understanding of students' perspectives, attitudes, motivation, and engagement regarding coordinated techniques. This holistic approach to research can provide valuable insights into the learning experience from the students' point of view, helping educators refine their teaching practices to better meet students' needs. Furthermore, comparative studies that evaluate the effectiveness of coordinated techniques against other innovative teaching approaches will be beneficial. These studies can guide educators and policymakers in selecting the most impactful methodologies for science education, ultimately enhancing learning outcomes for students. Finally, with the increasing prevalence of online education, investigating the applicability of coordinated techniques in virtual learning environments is crucial. Understanding how these techniques can be translated to online platforms and their effectiveness in the evolving landscape of education will be essential for designing effective online learning experiences that promote student engagement and academic success.

Limitations

The study has several limitations that should be considered when interpreting its findings. Firstly, the sample size, especially in the experimental group with only 30 students, is relatively small. This limited sample size may restrict the generalizability of the study's findings to larger student populations, as the characteristics and outcomes observed in a small group may not reflect those of a broader and more diverse student body. Secondly, the application of coordinated techniques was completed within just four lesson hours. This short duration might not fully capture the long-term effects or sustained impact of these methods on students' learning outcomes. Longer-term assessments could provide a more comprehensive understanding of how these techniques influence students' academic progress and retention of knowledge over time. Lastly, the study primarily relied on mean achievement scores as the primary outcome measure. While quantitative measures are valuable, they may not capture the full spectrum of students' learning experiences, including qualitative aspects such as critical thinking skills, creativity, and engagement. Incorporating qualitative assessments alongside quantitative measures could offer a more holistic evaluation of the effectiveness of coordinated teaching techniques. Addressing these limitations in future research can contribute to a more nuanced understanding of the benefits and challenges associated with coordinated teaching methodologies, ultimately leading to more informed educational practices and policies.

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investigator under the guidance and supervision of the second author.

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Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of interest

None

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