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Elevating Science Education: Igniting Learning through Mindmapping and Collaborative Strategies

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ABSTRACT

This study aimed to enhance the learning outcomes of fifth-grade students in Science by implementing the Think Pair Share (TPS) model with a foundation in Mindmapping. The research was conducted at a particular elementary school and involved two cycles of instructional intervention. The study's objectives included assessing the impact of the TPS model on student learning outcomes, evaluating teacher and student engagement, and refining the instructional approach for improvement. The research employed mixed methods and quantitative and qualitative data collection techniques. Data was gathered through test scores, observation of teacher and student activities, and reflective discussions. The study found that students needed to improve their learning outcomes before implementing the TPS model due to less interactive teaching methods. However, following the introduction of the TPS model coupled with Mindmapping, there was a significant improvement in learning outcomes. The first cycle recorded an average score of 65, with 46.25% achieving the mastery standard. In contrast, the second cycle saw remarkable enhancement, with an average score of 84.42 and 88.46% of students meeting the mastery standard. Observations also indicated substantial improvements in both teacher and student engagement. The teacher's ability to foster motivation, clarify learning objectives, and deliver effective teaching improved significantly. Similarly, students displayed more active participation in learning, paying closer attention, engaging in discussions, and demonstrating better comprehension. In conclusion, implementing the TPS model integrated with Mindmapping techniques led to notable enhancements in student learning outcomes and engagement in Science education. This approach facilitated

collaborative learning, boosted critical thinking, and improved classroom experience. The study underscores the efficacy of interactive teaching methodologies in elevating student achievements and offers insights for educational practitioners seeking innovative strategies to foster effective learning environments.

Keywords
Collaborative Strategies
Mindmapping
Science Education
Think Pair Share

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Introduction

Education is an effort to humanise humans as much as possible by optimising the development of human potential through learning activities and teaching. Learning is an integral part of education, as it plays a crucial role in the educational process. The educator endeavours to assist learners in receiving the provided knowledge and facilitate the achievement of learning objectives [1]. At the Elementary School level, subjects such as Indonesian language, Mathematics, Civic Education, Social Studies, Natural Sciences, and others are categorised based on their fields of knowledge.

In elementary school, Natural Sciences (*Ilmu Pengetahuan Alam* or IPA) education provides knowledge and experiences to students, enabling them to systematically study the natural world and their environment through activities like observing, investigating, and conducting research. Additionally, within the framework of IPA learning, students are expected to engage in activities such as searching, discovering, drawing conclusions, and communicating findings. According to Ref. [2], IPA is the systematic knowledge of nature and its phenomena acquired through observation, simple investigations, or research. Students are expected to actively participate in IPA learning by searching, discovering, drawing conclusions, and communicating.

These activities aim to provide students with meaningful and enjoyable IPA learning experiences that lead to optimal learning outcomes. This aligns with Ref. [3] that IPA learning fundamentally involves discovering knowledge and offering genuine and meaningful learning experiences that positively impact students' learning outcomes. IPA involves systematically exploring the natural world, acquiring expertise comprising facts, concepts, and principles, and is a discovery process [4]. In IPA learning, students are expected to be engaged in discovering and mastering knowledge about the natural world.

The Elementary School IPA curriculum comprises several components. As conveyed by Ref. [3], the IPA curriculum in Elementary School should ideally encompass three parts:

teaching should stimulate intellectual growth and students' development; teaching should involve students in practical activities or experiments related to the essence; and education in Elementary School should encourage the formation of a scientific attitude, develop the ability to use scientific skills, grasp the fundamental patterns of knowledge, and stimulate the growth of critical and rational thinking.

However, there are challenges in IPA education at elementary school for fifth-grade students. Based on observations, some students seem to pay less attention during the teacher's explanation of IPA topics, exhibit limited active participation in learning, and engage in off-topic conversations with peers. Furthermore, a lack of interaction between teachers and students in the form of questions and answers is observed, and the teacher remains predominantly centred as the source of knowledge (teacher-centred approach).

Through interviews with the fifth-grade teacher at a public elementary school, it is revealed that the students face difficulties in comprehending the IPA topic of heat conduction. The challenges arise due to the abundance of essential terms and content that students need to remember, such as conductors, insulators, classifying conductive and insulative objects, and their practical applications. These difficulties are exacerbated by the teacher's limited use of instructional models. The teacher has chosen a teaching model, but the phases of the selected model have yet to be effectively implemented.

Meanwhile, according to the fifth-grade teacher at the elementary school, it is known that the student's learning outcomes in IPA are still low. This indicates that the attained grades must still reach the Minimum Mastery Criteria (*Kriteria Ketuntasan Minimal* or KKM). Among 26 students, only seven have met the criteria, while 19 students still need to. The KKM score for the IPA subject is 76.

Given the challenges above, there's a need for a diverse instructional model to engage students in learning activities actively, ultimately achieving optimal learning outcomes. A well-prepared and tailored instructional model the teacher presents can lead to effective learning. An instructional model encompasses the sequence of activities from the beginning to the end, presented distinctively by the teacher [5]. Therefore, teachers must select the appropriate instructional model when delivering the subject matter.

An appropriate instructional model is vital to creating a meaningful, conducive, effective, and enjoyable learning environment, resulting in optimal learning outcomes. This aligns with the assertion by Ref. [6] that choosing a suitable instructional model can create a pleasant atmosphere and positively impact student engagement and learning outcomes. Learning becomes more meaningful when students can actively participate in the learning process.

Considering the problems mentioned above, an instructional model is required to improve the IPA learning outcomes for fifth-grade students. One such model is the TPS model based on Mindmapping. The TPS model emphasises collaboration among students, beginning with individual contemplation on the subject matter or questions, then discussions in pairs, and then sharing information about the questions or topics covered. The TPS model prioritises student cooperation through thinking, pairing, and sharing. The thinking activity involves students contemplating inquiries related to the subject matter. Pairing involves students partnering up to discuss their thoughts and answers to subject-related questions, which are mapped and recorded using mind-mapping techniques. Sharing entails students sharing the outcomes of their discussions, often in the form of mind maps, with their peers.

Mindmapping is a creative and effective way of organising thoughts, literally mapping out ideas [7]. Using Mindmapping, students creatively and effectively transform their thoughts or ideas into visual representations involving images, lines, symbols, and colours, enhancing their understanding of the material. The TPS model based on Mindmapping encourages students to think, collaborate, and partner up, creating mind maps and producing creative notes in images, lines, symbols, and colours. These notes are then shared with the entire class, contributing to achieving learning objectives.

Based on observations and interviews, the issues in IPA education at the particular elementary school for fifth-grade students include the teacher's inclination towards a teacher-centred approach, students' lack of attention during the teacher's explanation, low levels of student engagement, poor IPA learning outcomes; and the TPS model based on Mindmapping being unfamiliar to teachers. Therefore, the TPS model based on Mindmapping is expected to enhance the IPA learning outcomes regarding cognitive aspects of heat conduction for fifth-grade students. This research aims to determine the enhancement of IPA learning outcomes through the TPS model based on Mindmapping among fifth-grade students.

Material And Methods

A. Research Context

This study employs the Classroom Action Research (CAR) method, enhancing teaching and learning. CAR involves a teacher conducting research in their classroom to improve the educational process. Another perspective by Ref. [8] states that classroom action research consists of a series of actions conducted during teaching and learning situations to improve teaching performance. Based on these expert opinions, it can be concluded that classroom action research is undertaken to enhance and improve the learning process. The research design follows the action research model, which comprises three key phases: planning, action and observation, and reflection. The research was conducted at a particular elementary school in Kulon Progo Regency, Indonesia. This research takes place during the second semester of

the 2022/2023 academic year, from March to April 2023. The research participants consisted of fifth-grade students, totalling 26 students. This group is composed of 12 male and 14 female students.

A. Variables

1. Learning Outcomes:

Learning outcomes encompass the competencies acquired by students after engaging in learning activities. These outcomes span cognitive, affective, and psychomotor domains. This study predominantly focuses on the mental part, assessing students' mastery of the "heat conduction" topic using the TPS model based on Mindmapping. Students' cognitive achievements will be gauged using multiple-choice test questions. Indicators for the "heat conduction" topic include:

- Defining the terms "conductor" and "insulator."
- Categorizing materials as conductors or insulators.
- Distinguishing everyday activities involving conductors and insulators.
- Analyzing the utilisation of conductors and insulators in various objects.

2. TPS Model Based on Mindmapping

The TPS model based on Mindmapping encourages collaborative thinking and creative note-taking using images, lines, symbols, and colours to achieve educational objectives. Students often encounter challenges comprehending the "heat conduction" topic due to its complex terminology and concepts. Thus, grounded in Mindmapping, the TPS model facilitates group learning, note-taking, and concept visualisation using images, lines, symbols, and colours. This approach will enhance students' understanding of the "heat conduction" concept. The TPS model sequence based on Mindmapping comprises the following steps, as shown in Fig. 1.

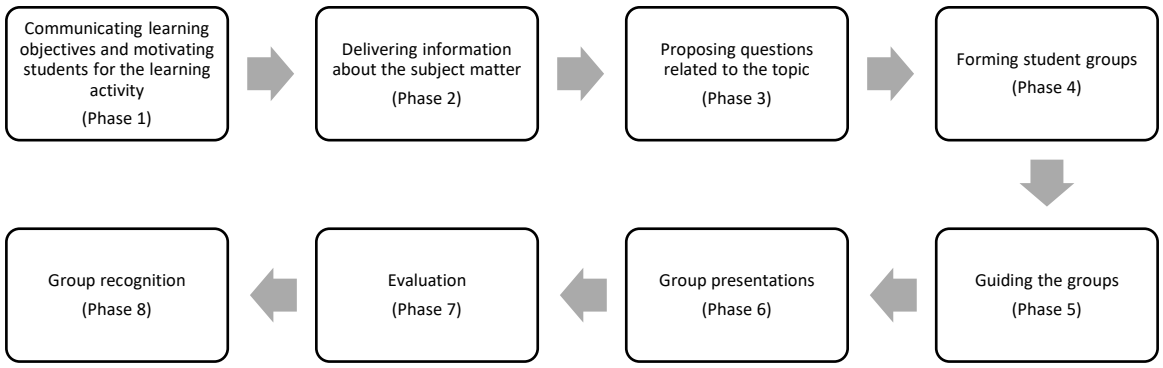


Fig. 1. Stages of Learning in Research

B. Research Instruments

1. Learning Outcomes Test

The test is a measurement tool to assess students' learning outcomes on "heat conduction" using the TPS model based on Mindmapping. The test comprises multiple-choice questions aligned with the core competencies, essential competencies, and specific indicators related to the "heat conduction" topic. The test items are structured to cover various cognitive levels, including knowledge (C1), comprehension (C2), and analysis (C4).

2. Observation Sheets

Observation sheets are employed to document the activities of students and the teacher (researcher) during the IPA learning sessions focused on the "heat conduction" topic, utilising the TPS model based on Mindmapping. The observation process involves three observers who complete the designated observation sheets. The observation sheets are designed to assess both the teacher's teaching activities and the student's engagement.

Results

A. Pre Cycle

Based on the finding data, which summarises the scores from the daily quizzes on the topic of heat conduction in the Science subject conducted by the 5th-grade teacher, it is evident that the range of scores obtained by the students varies between 25 and 80. Despite the variation in scores, it is noticeable that the lowest score achieved was 25, while the highest score reached 80. Among all the students in the class, only seven managed to attain passing scores or at least meet the KKM. However, as many as 19 other students still need to catch up to the passing grade or meet the KKM. Upon analysing the class's average scores, it was found that the average score is 54.61. Nevertheless, this result remains significantly below the KKM threshold 76 for the Science subject. See Fig 2.

From this analysis, it can be concluded that the student's learning outcomes in the Science subject, particularly regarding heat conduction, still need to be revised. The average score falling below the KKM indicates an urgent need for corrective actions in teaching methods to substantially improve the student's learning outcomes.

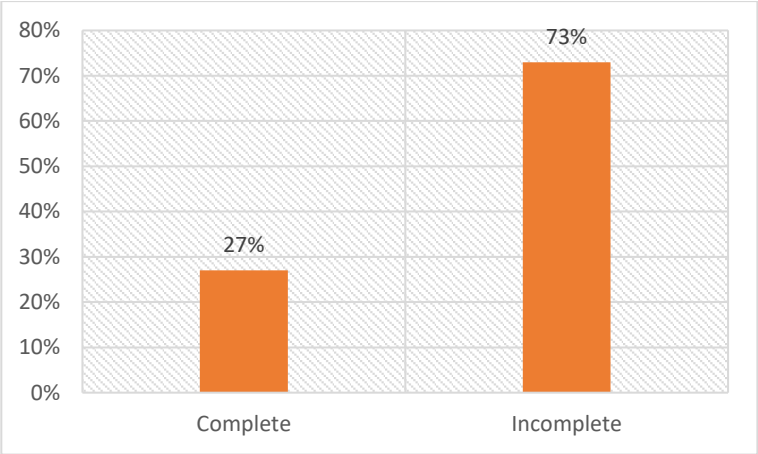


Fig. 2. Completion rate on the Pre Cycle

B. 1st Cycle

The results show that 12 students met the KKM, and 14 still needed to. Furthermore, the highest score was 95, while the lowest was 30. See Fig. 3. The average score for the 5th-grade students after participating in the Science learning session on heat conduction using the TPS model based on Mindmapping in 1st Cycle was 65. The percentage of learning mastery reached was 46.15%. These results indicate that the learning outcomes in 1st Cycle have yet to achieve the desired level.

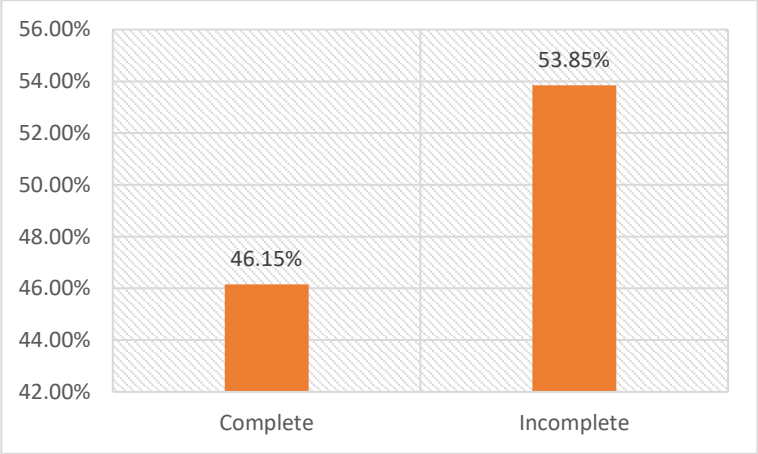


Fig. 3. Completion rate on the 1st Cycle

The observation conducted in this study focused on both the teacher's activities and the student's activities. Three observers, including the 5th-grade teacher, a 4th-grade teacher, and a 2nd-grade teacher, observed the teacher's and student's actions during the Science lesson on heat conduction, using the TPS model based on Mindmapping. Fig. 4 describes the observation activities during the Science lesson on heat conduction using the TPS model based on Mindmapping in 1st Cycle.



Fig. 4. Student situation when learning with the TPS model

Based on the observation results during 1st Cycle regarding the activities of the researcher acting as the teacher during the Science lesson on heat conduction using the TPS model based on Mindmapping, it is evident that the teacher followed the phases of the TPS model based on Mindmapping. However, during the teaching process, the teacher exhibited limitations, such as inadequacies in fostering motivation, clearly conveying learning objectives, and providing proper preface and quizzes.

In the reflection phase, the researcher and the teacher reflect on the activities conducted at the end of each cycle. This is done to discuss aspects that need improvement from 1st Cycle to implement the action plan in the subsequent process. Based on the overall observation results of the Science learning session on heat conduction using the TPS model based on Mindmapping, the outcomes have yet to demonstrate optimal results. The student's learning outcomes, the teacher's and the student's activities must be enhanced. Therefore, the researcher and the teacher engaged in reflection for improvements in 2nd Cycle due to several reasons as follows:

- The students were not adequately prepared to receive the lesson from the teacher. This was because the students were still confused about the activities involving the TPS model based on Mindmapping, as the teacher had not used this model before.
- The teacher struggled to foster motivation and provide clear learning objectives. Additionally, a proper preface was not given to the lesson.
- Many students showed a lack of attention to the teacher, insufficient engagement with the teacher's explanations, inadequate focus on the material about heat conduction, and a tendency to engage in individual conversations with their peers.
- The students' learning outcomes in 1st Cycle were not yet optimal. The student's learning outcomes in 1st Cycle only reached a percentage of 46.15% from the classical success criteria, which is set at 75%.

C. 2nd Cycle

The average score of the fifth-grade students after participating in the Science learning session on heat conduction using the TPS model based on Mindmapping in 2nd Cycle was 84.42, with a percentage of learning mastery reaching 88.46%. See Fig. 5. This indicates that the learning outcomes in the 2nd Cycle have shown improvement compared to the 1st Cycle, and the success criteria have been achieved. Therefore, the research was concluded after 2nd Cycle.

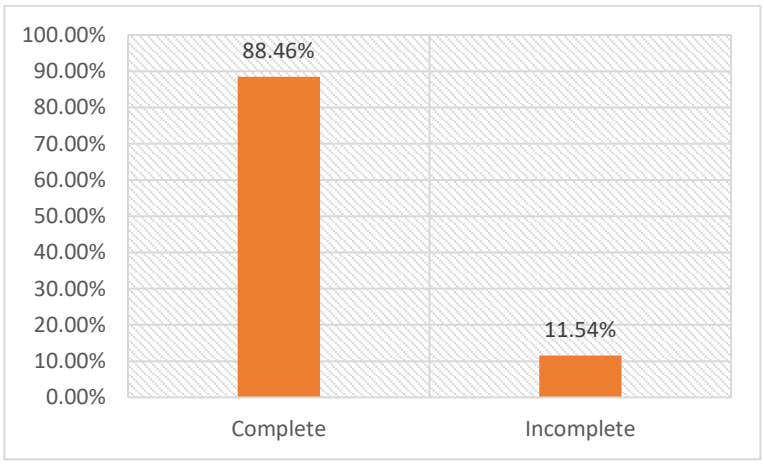


Fig. 5. Completeness rate on the 2nd Cycle

Based on the observation results in 2nd Cycle regarding the activities of the researcher acting as the teacher during the Science learning session on the topic of heat conduction using the TPS model based on Mindmapping, the teacher successfully executed the teaching process following the phases of the TPS model based on Mindmapping. Throughout the lesson, the teacher improved in fostering motivation, delivering clear learning objectives, and providing prefatory information and quizzes. See Fig. 6.



Fig. 6. Students show the results of Mindmapping.

From the results, it can be concluded that the teacher, in general, effectively carried out the Science lesson on heat conduction by the phases of the TPS model based on Mindmapping, with

an average final score of 4.51, categorised as good. Thus, it can be inferred that the teacher's activities during the Science lesson using the TPS model based on Mindmapping demonstrated enhancement.

Based on the observation results in the 2nd Cycle concerning the activities of the students during the Science learning session on the topic of heat conduction using the TPS model based on Mindmapping (Fig. 7), the students actively engaged in the learning process following the phases of the model. Throughout the learning session, the students demonstrated a severe attitude towards learning. They paid attention to the teacher, engaged with the material on heat conduction, thoughtfully responded to the questions posed by the teacher, and effectively answered quizzes.

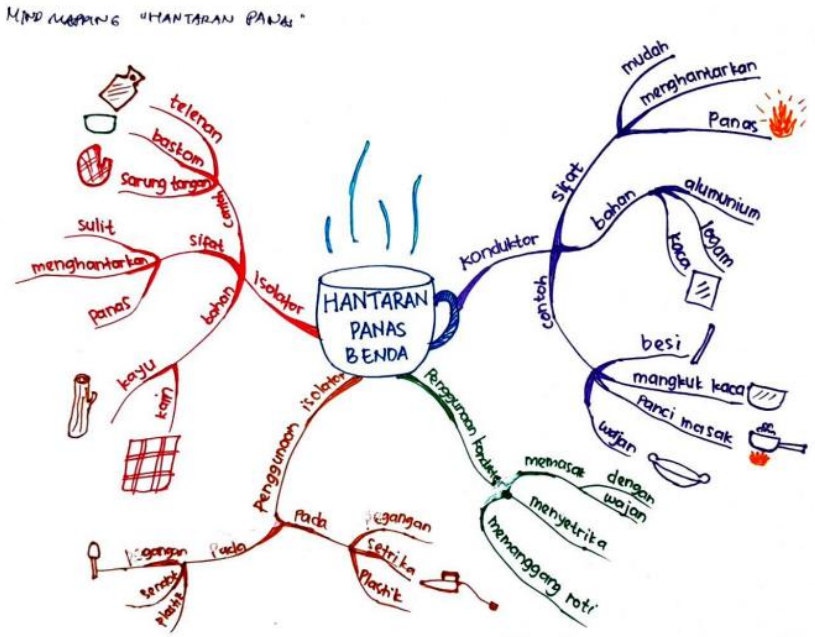


Fig. 7. Examples of Mindmapping used in learning

Based on the data, the students effectively participated in the Science learning session on heat conduction following the TPS model phases based on Mindmapping, achieving an average final score of 4.39, categorised as good. Therefore, it can be concluded that the student's activities during the Science learning session using the TPS model based on Mindmapping showed improvement.

Discussion

The results have been successfully achieved and proven based on the research on improving the learning outcomes in Science through using the TPS model based on Mindmapping for fifth-grade students. Before implementing the Science learning sessions

using the TPS model based on Mindmapping, the teacher's instructional approach needed to be revised, and students were required to pay more attention to the teacher's explanations, resulting in low Science learning outcomes. However, after conducting the Science lessons using the TPS model based on Mindmapping, the learning outcomes, teacher's and student's activities demonstrated improvement. The result shows an increase in the average class scores from the 1st Cycle (65) to the 2nd Cycle (84.42) and a corresponding increase in the learning mastery percentage from 46.25% to 88.46%. The improvement in student learning outcomes is aligned with the enhanced activities of the teacher and the students during the Science lessons using the TPS model based on Mindmapping. The teacher's activity scores increased from 3.18 to 4.51, moving from the "Fair" category to the "Good" category. In contrast, the student's activity scores increased from 3.10 to 4.39, shifting from the "Fair" to the "Good" class.

Initially, only seven students had achieved the KKM in the Science daily quizzes, while 19 students still needed to meet the KKM. After implementing the Science lessons using the TPS model based on Mindmapping through two cycles, there was a consecutive improvement in the Science learning outcomes from 1st Cycle to 2nd Cycle. This finding indicates a continuous enhancement in the Science learning outcomes for fifth-grade students, progressing from the pre-cycle to 1st Cycle and finally to 2nd Cycle. The learning mastery increased from 27% in the pre-cycle to 46.15% in 1st Cycle and 88.46% in 2nd Cycle, with 23 students achieving KKM.

Based on the discussion above, it can be concluded that the TPS model based on Mindmapping has effectively improved the Science learning outcomes for the fifth-grade students in the academic year 2022/2023. This is supported by the student’s ability to achieve the required KKM of 76 in the Science assessment. The research indicates that using the think-pair-share model enhances student engagement, participation, and understanding in the Science learning process, leading to better learning outcomes.

The improvement in Science learning outcomes using the TPS model aligns with the findings of various other research studies such as Ref. [9]-[12]. These studies demonstrate that the think-pair-share model can effectively enhance Science learning outcomes for elementary school students. The model's group-based approach fosters active participation and more profound understanding among students, leading to improved learning outcomes. The other research also confirmed the effectiveness of using Mindmapping in learning [13]-[16].

Implementing the TPS model is particularly suitable for elementary school students, specifically those in higher grades with the cognitive abilities to optimise their thinking. The

model's emphasis on group discussions, pairing, and sharing encourages students to actively engage with the material, discuss concepts with peers, and present their thoughts, promoting varied learning activities and improved learning outcomes [12].

In the context of elementary school students at the stage of concrete operational thinking, visual aids like Mindmapping help accelerate their understanding of learning material, contributing to improved learning outcomes in Science [13]. The application of Mindmapping helps students absorb and retain information more effectively. Moreover, the creative freedom provided by Mindmapping, where students can create visual representations using images, lines, symbols, and colours, supports their creativity, knowledge retention, and comprehension [15]. The TPS model based on Mindmapping has proven to enhance the Science learning outcomes for fifth-grade students. This improvement is evidenced by the student's ability to achieve the Science learning objectives and attain a passing grade. The combination of group interactions, visual aids, and creative engagement fostered by this model contributes to improved learning outcomes in Science.

Conclusion

The research on enhancing Science learning outcomes through implementing the TPS model based on Mindmapping for fifth-grade students has yielded successful and significant results. The study demonstrated the effectiveness of this pedagogical approach in improving student engagement, participation, and understanding in Science education. The research showcased a clear and notable improvement in the Science learning outcomes of the fifth-grade students. The learning outcomes needed to be more optimal before implementing the TPS model based on Mindmapping. However, after the model was integrated into the teaching process, there was a consistent increase in both average scores and learning mastery percentages. This positive trend was observed from 1st Cycle to 2nd Cycle, indicating that the innovative instructional approach significantly enhanced students' comprehension and knowledge retention. The research highlighted the evolution of teacher activities throughout implementing the TPS model based on Mindmapping. During 1st Cycle, teachers demonstrated moderate effectiveness in motivating students, clearly conveying lesson objectives, and providing effective introductions. However, by the 2nd Cycle, there was a substantial improvement in these areas. This shift indicates that the model's structured approach encouraged teachers to refine their instructional techniques, leading to more engaging and effective teaching practices. The study also revealed positive changes in student activities. While in the 1st Cycle, students showed moderate participation and attentiveness, by the 2nd Cycle, their engagement had significantly improved. The TPS model based on Mindmapping facilitated peer interaction, cooperative learning, and creative expression. As a result, students

were more involved in the learning process, actively sharing their thoughts and collaboratively constructing knowledge, ultimately contributing to their enhanced learning outcomes. Implementing the TPS model based on Mindmapping successfully achieved the learning objectives. Students completed the required KKM in Science and displayed increased interest and understanding of the subject matter. The model's emphasis on collaboration, discussion, and creative visualisation proved effective in helping students achieve their educational goals.

Conflict of Interest

The authors declare that there is no conflict of interest.

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