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Application of the Quantum Teaching Learning Model to Improve Mathematics Learning Outcomes in Grade IV Students at SD Inpres 3 Tondo

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ABSTRACT

This research aims to improve the learning outcomes of mathematics students in grade IV of SD Inpres 3 Tondo through the application of the Quantum Teaching learning model. This research uses the Classroom Action Research (PTK) method which is carried out in two cycles. Each cycle consists of the stages of planning, implementation of actions, observation, and reflection. The research subjects amounted to 34 grade IV students of SD Inpres 3 Tondo. Data collection techniques are carried out through tests, observations, and documentation. Data were analyzed using quantitative and qualitative analysis. The results of the study showed that there was an increase in students' mathematics learning outcomes in each cycle. In the pre-action stage, the average score of students was 45.74 with classical learning completeness of 5.9%. After the application of the Quantum Teaching model in cycle I, the average score increased to 71.76 with classical learning completeness of 67.65%. In cycle II, the average score increased again to 79.12 with classical learning completeness reaching 91.18%. These results show that the application of the Quantum Teaching learning model is able to improve the mathematics learning outcomes of grade IV students of SD Inpres 3 Tondo. Thus, the Quantum Teaching model can be one of the effective learning alternatives to improve the understanding and learning outcomes of mathematics in elementary school.

1. Introduction

The success of the teaching and learning process can be seen from the learning outcomes achieved by students, these learning outcomes are achievements that are to be achieved in learning. The success of learning in schools will be realized from the success of learning for its students. Therefore, to improve the quality of education can be done by teachers by improving their ability to facilitate students in learning. Learning is defined as an activity that is specifically designed to create

a learning atmosphere that suits students to achieve the goals of learning itself (A. Lestari & Wati, 2025; Syaukani et al., 2024).

Mathematics is one of the subjects that has an important role in education because it functions to develop students' logical, critical, systematic, and creative thinking skills. Mathematics is a science that studies numbers, relationships between numbers, and operational procedures used to solve various problems (Susanto, 2016). Mathematics is also a science that is systematically arranged and obtained through the process of logical reasoning (P. Lestari et al., 2026; Muhaimin et al., 2025; Nursalam et al., 2021). Therefore, mathematics learning in elementary school has a strategic role as a foundation for mastering science at the next level of education. The success of mathematics learning is greatly influenced by the planning and implementation of learning carried out by teachers. Effective learning is expected to create an active, enjoyable, and meaningful learning environment so that students can understand mathematical concepts optimally. However, differences in students' learning outcomes indicate variations in learning characteristics and needs. The lack of active student involvement in the learning process also contributes to a low level of conceptual understanding, resulting in learning completeness that has not yet been achieved optimally. Therefore, it is necessary to implement a learning model that accommodates students' diverse characteristics and encourages active participation in mathematics learning (Ariana et al., 2020; Kurniawan et al., 2026).

Based on the results of the initial mathematics test conducted with Grade IV students, the level of learning completeness was still relatively low. Of all students, only two students, or approximately 5.9%, achieved the Minimum Completeness Criteria (KKM) of 70, while 32 students, or about 94.1%, had not yet met the required standard. In addition to the low percentage of learning completeness, the class average score also remained below the established KKM. These findings indicate that the low mathematics learning outcomes were influenced by several factors related to the learning process. The use of less varied instructional media and monotonous teaching methods reduced students' interest and engagement during classroom activities. As a result, students tended to be passive, participated less in discussions and question-and-answer sessions, and showed limited enthusiasm during learning. Furthermore, the lack of diverse instructional strategies and learning media affected students' conceptual understanding, causing them to forget previously learned concepts more easily. Consequently, many students experienced difficulties in understanding the material presented by the teacher. This condition indicates that the existing learning process has not yet provided meaningful and enjoyable learning experiences. Therefore, improvements are needed through the implementation of a more innovative learning model that can enhance students' participation and understanding in mathematics learning.

The Quantum Teaching learning model emphasizes the management of interactions among teachers, students, and the learning environment to create meaningful and enjoyable learning experiences. This model positions students as active participants in the learning process and encourages collaboration between teachers and students in achieving learning objectives. Quantum Teaching focuses on orchestrating

various elements of learning to maximize students' learning potential through positive and well-planned interactions (Arfiany, 2021; Fitri et al., 2020; Martua et al., 2019; Pahlevi et al., 2024). Furthermore, Quantum Teaching views learning as an integrated experience involving students' cognitive, affective, and psychomotor domains (Dewi et al., 2022; Martua et al., 2019; Tambunan, 2017). Therefore, learning is not merely oriented toward delivering instructional content but also toward creating a conducive learning environment in which students feel comfortable, motivated, and actively engaged throughout the learning process.

The Quantum Teaching learning model is implemented through the TANDUR framework, which consists of Grow, Experience, Name, Demonstrate, Repeat, and Celebrate. This framework provides teachers with systematic guidance for designing meaningful learning experiences, beginning with stimulating students' learning motivation and ending with reinforcing the knowledge and skills acquired during the learning process. Through these stages, students are encouraged to actively construct their understanding based on direct learning experiences, thereby promoting deeper conceptual understanding. Consequently, the implementation of the Quantum Teaching learning model is expected to create a more active, enjoyable, and meaningful mathematics learning environment that can improve students' learning outcomes. Therefore, this classroom action research was conducted to determine whether the implementation of the Quantum Teaching learning model through the TANDUR framework can improve the mathematics learning outcomes of Grade IV students at SD Inpres 3 Tondo.

2. Methodology

This study employed classroom action research as its research design. Classroom Action Research is specifically designed to improve the quality of teaching and learning practices in the classroom (Dewi et al., 2022). It is a form of reflective inquiry conducted by practitioners to enhance the rationality of their educational practices, deepen their understanding of the actions implemented, and improve the conditions under which these practices are carried out (Najah et al., 2022; Syaukani et al., 2024). This research was conducted to improve mathematics learning outcomes, particularly students' cognitive achievement, through the implementation of the Quantum Teaching learning model in Grade IV students of SD Inpres 3 Tondo. In this research, instructional actions were implemented to identify strengths and weaknesses in the learning process, followed by continuous improvements based on the reflection results (Fadhilah, 2026; Muhaimin et al., 2025). The study adopted the cyclical classroom action research model developed consisting of four stages: (1) planning, (2) action, (3) observation, and (4) reflection (Arfiany, 2021). Based on the research objectives and the required data, data were collected through tests, classroom observations, and documentation. Quantitative data analysis was used to measure improvements in students' learning outcomes based on the results of written tests, while qualitative data were analyzed through data reduction, data display, verification, and conclusion drawing following the

interactive analysis model proposed by (Pahlevi et al., 2024). The improvement in students' learning outcomes was calculated using the following formula.

$$\text{Classical Learning Completeness} = \frac{\text{Jumlah siswa yang tuntas}}{\text{jumlah siswa seluruhnya}} \times 100$$

Qualitative analysis is carried out to see the final results of students during the learning process through observation (observation). The results of data acquisition are recorded in the instruments that have been provided, the collected data is analyzed qualitatively and presented quantitatively in the form of percentages with the criteria of the stages, namely data reduction, data presentation, verification, and conclusion.

3. Results and Discussion

This research will be carried out in February 2026 in grade IV of SD Inpres 3 Tondo. The results of this study are divided into two stages, namely: 1) Pre-action results, 2) Action implementation results. The details of the results of this study are as follows:

Implementation of the Quantum Teaching Learning Model

The implementation of the Quantum Teaching learning model in this classroom action research was carried out through the TANDUR framework, consisting of Grow, Experience (Natural), Name, Demonstrate, Repeat, and Celebrate. Each stage was systematically designed to encourage active student participation, strengthen conceptual understanding, and create a meaningful learning atmosphere. The implementation was continuously improved from Cycle I to Cycle II based on the results of reflection and classroom observation. At the Grow stage, the teacher initiated learning by greeting students, checking attendance, and conducting apperception using questions related to objects found in students' daily lives. Concrete objects and posters were also used to stimulate students' curiosity and connect prior knowledge with the new mathematical concepts. Observation results indicated that most students showed enthusiasm during this stage by responding actively to the teacher's questions and demonstrating increased readiness to participate in learning activities.

During the Experience (Natural) stage, students were encouraged to observe concrete objects representing squares and rectangles before discussing their characteristics in small groups. Students actively exchanged ideas, identified similarities and differences among the objects, and related the learning material to their everyday experiences. Classroom observation showed that collaborative learning increased students' engagement and encouraged peer interaction throughout the learning process. The Name stage focused on introducing mathematical concepts and terminology. The teacher guided students to identify the properties of squares and rectangles using posters and classroom discussions. Students recorded important concepts in their notebooks and asked questions

whenever they encountered difficulties. Compared with the initial condition, students demonstrated better conceptual understanding because the concepts were introduced after they had experienced the learning activities directly.

At the Demonstrate stage, students presented the results of their group discussions and explained their reasoning before the class. Other groups were encouraged to provide feedback, ask questions, and compare their answers. Observation results revealed that students became more confident in expressing their opinions and explaining mathematical concepts. Teacher guidance during presentations also helped students correct misconceptions and strengthen conceptual understanding. The Repeat stage was conducted through oral questioning and individual exercises to reinforce students' understanding. Students answered review questions, solved mathematical problems independently, and discussed the solutions together with the teacher. Observation data indicated that repeated practice enabled students to recall mathematical concepts more accurately and reduced mistakes found during the previous learning activities.

Finally, at the Celebrate stage, the teacher provided verbal praise, applause, and simple rewards for students and groups who actively participated during the lesson. This appreciation created a positive classroom atmosphere and increased students' motivation to engage actively in subsequent learning activities. Students appeared more confident, enthusiastic, and willing to participate throughout the learning process. Overall, classroom observations demonstrated that the implementation of Quantum Teaching successfully transformed the learning process into a more interactive, student centered, and enjoyable experience. Students not only showed higher participation during classroom activities but also demonstrated improved confidence, collaboration, and conceptual understanding, which contributed to the improvement of mathematics learning outcomes across both research cycles.

Pre-Action Results

In the pre-action implementation stage, to analyze the initial ability of grade IV students of SD Inpres 3 to the mathematics lessons that have been taught. The researcher provides an initial/pre-action test, which is a multiple-choice of 20 mathematics subject question numbers. The implementation of this pre-action activity was carried out on Wednesday, February 18, 2026 in grade IV of SD Inpres 3 Tondo. The results of the analysis of the activities are displayed in the form of a table, as seen in table 1.

Table 1. Results of Pre-Action Initial Test Analysis

Procurement Aspects	Results
Highest Score	80
Lowest Score	15
Number of Students	34
The Number of Students Who Have Completed	2
Average Score	45,74
Classical Learning Completeness Percentage	5,9%

Based on table 1, it can be concluded that the average score of the student with the number of students who completed 2 people with the highest score of 80, this is because some students who got the highest score at the beginning of the test did like the mathematics subject and some of these students were class champions so they got the highest score at the beginning of the test. Meanwhile, there were 32 students who did not complete with the lowest score of 15 because the student was not focused on working on the question and it is possible that the student does not seem to understand the material in the question and it is possible that the student does not understand the material in the question very well. Based on the results of the analysis of the percentage of student completeness in the pre-action, which is 5.9%, it has not reached the set percentage of classical learning completeness, which is $>75\%$. This shows that in the pre-action there are still many students who do not understand the material delivered by the teacher, this is because the teacher still uses the lecture method and does not use creative learning media in delivering the learning material. Seeing the above, therefore, the researcher will carry out learning actions according to the learning implementation plan that has been prepared beforehand, which will be applied to grade IV students by applying the Quantum Teaching learning model.

Results of Cycle I Actions

In the planning stage here, the researcher prepares all the needs that will be needed during the research process. At this stage, the researcher prepares several things, namely:

1. Compile teaching modules by applying the Quantum Teaching learning model to square, square and rectangular building materials.
2. Prepare learning media in the form of concrete objects, posters on the properties of flat buildings, and animated videos that are relevant to the learning material.
3. Compile Student Worksheets (LKPD) which are used to support student learning activities in groups.
4. Prepare instruments for observing teacher activities and student activities during the learning process.

Prepare student learning outcome assessment sheets and determine learning completeness criteria in accordance with the Minimum Completeness Criteria (KKM) set by the school. The implementation stage (action) in Cycle I was carried out on Tuesday, June 2, 2026 at 07:00 WITA, which was carried out for 2 hours of lessons (2 x 35 minutes) consisting of initial activities, core activities and final/closing activities. In this first meeting students learn about the properties of squares and squares and rectangles. The steps for implementing the learning are described as follows:

Early Activities

The stage of implementing the initial activities in Quantum Teaching learning is included in the initial phase or phase 1, namely Grow which includes: (1) The teacher opens the learning by saying a greeting then the student answers the

greeting, asking one of the students to lead the prayer together, (2) The teacher checks the attendance and readiness of the students by asking "Children, who is not present today?" the students in unison answer no ma'am, (3) The teacher makes an appreciation by asking "Children, who sees square or rectangular objects around us? Try to give an example!". What makes the object called a square? What makes the object called a rectangle? (4) The Master proceeded with the sparker question: Do you think a square is always the same as a rectangle? What is the difference between the two?" (5) teachers foster students' motivation and interest in learning by inviting students to observe posters and concrete objects that have been prepared and pasted on the board. "Kids, let's take a look at these posters and concrete objects". We will learn what are the properties of the properties of the flat building today to make it easier for us to recognize and distinguish them, (6) The teacher conveyed the purpose of today's learning, namely: "Today we will learn about the properties of squares and rectangles and how to distinguish them so that we can recognize the flat buildings around us".

Core Activities

In the core activity, learning is carried out by applying the stages of Quantum Teaching which consist of Natural, Name, Demonstrate, Repeat, and Celebrate. In the Natural stage, the teacher pastes square and rectangular pictures on the whiteboard as a learning medium. Next, the teacher asks students questions about square and rectangular objects that are often encountered in daily life. Students then mention various examples, such as floor tiles, windows, notebooks, whiteboards, and drawing paper. After that, the teacher divides the students into five groups consisting of six to seven people each. Each group obtained an LKPD and several images of rectangular and rectangular objects to observe and discuss in order to identify the characteristics of the two flat buildings. In the Namai stage, the teacher explains the meaning of square and rectangle using poster media. The teacher then guides the students to identify the characteristics possessed by the two flat buildings through question and answer activities. The results of student identification are written on the board by the teacher, then students record the properties of squares and rectangles in their respective notebooks as learning materials.

The Demonstrate stage is done by asking each group to group an image of an object based on its shape, i.e. a square or rectangle. After the group discussion is over, the group representative presents the results of his work in front of the class. Other groups were given the opportunity to provide responses, inputs, and questions related to the results of the presentation. The teacher then provides reinforcement and clarification of the correct answers so that students' understanding of the material increases. In the Repeat stage, the teacher gives some oral questions related to the properties of squares and rectangles. Students answer questions in turn as a form of strengthening the concepts that have been learned. In addition, the teacher also provides short exercises in the form of activities to determine the name of a flat building and mention its properties. The exercises were done independently by students to measure their level of understanding of the learning material.

The last stage, namely Celebrate, is carried out by giving appreciation to groups who actively discuss and dare to express opinions during the learning process. The teacher and the students then applaud or applaud mathematics as a form of appreciation for the participation that has been shown. The teacher also praised all students for their cooperation and involvement in learning activities. In closing, the teacher invites students to conclude the material that has been learned about the properties of squares and rectangles, so that students' understanding of the concepts learned becomes stronger and meaningful.

Closing Activities

In the final activity of learning the material on the properties of square and rectangle, students with the guidance of the teacher draw conclusions about the material that has been studied. Students concluded that a square has four sides of equal length and four right angles, while a rectangle has two pairs of sides facing each other of equal length as well as four right angles. The teacher gives students the opportunity to ask questions that are not understood about the properties of squares and rectangles. Furthermore, the teacher provides reinforcement to the important material that has been learned so that students' understanding is better. In addition, teachers provide reflection by asking about students' learning experiences during learning, such as the difficulties faced and the interesting things they learned that day.

Observation of Teacher and Student Activities

To provide a clearer description of the learning process, classroom observations were conducted during each implementation stage of the Quantum Teaching model. The observations focused on teacher performance and students' learning activities throughout the TANDUR stages of table 2.

Table 2. Observation Results of Teacher and Student Activities During Quantum Teaching Implementation

TANDUR Stage	Teacher Activities	Student Activities	Observation Results
Grow	Motivated students through apperception and questioning	Responded to questions enthusiastically	Students showed increased readiness and learning motivation
Experience	Guided observation using concrete media and LKPD	Observed, discussed, and identified concepts collaboratively	Students actively interacted and exchanged ideas
Name	Explained concepts and guided discussions	Asked questions and recorded important concepts	Students demonstrated better conceptual understanding
Demonstrate	Facilitated presentations and discussions	Presented group work and responded to peers	Students became more confident in communicating ideas
Repeat	Conducted review and exercises	Solved problems independently	Students reinforced mathematical concepts and reduced misconceptions

Celebrate	Provided appreciation and positive reinforcement	Participated enthusiastically and appreciated peers	Students' motivation and classroom participation increased
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The observation results indicate that both teacher and student activities improved throughout the implementation of the Quantum Teaching model. Students gradually became more active in asking questions, discussing mathematical problems, presenting their ideas, and responding to their peers. Likewise, the teacher consistently functioned as a facilitator who guided learning through meaningful interactions rather than relying solely on direct instruction.

Learning Outcomes of Cycle I

The next stage after completing the implementation of the first cycle of action learning, the researcher gave the final test in the form of multiple-choice questions of 7 numbers and essays of 3 numbers, followed by 34 students. Students who answered all questions correctly will get a score of 100, in summary the results of the analysis can be seen through the following table 3.

Table 3. Results of Analysis of Learning Outcomes Cycle I

Procurement Aspects	Results
Highest Score	100
Lowest Score	50
Number of Students	34
The Number of Students Who Have Completed	23
Average Score	71,76
Classical Learning Completeness Percentage	67,65%

Based on the results of data analysis, the highest score was obtained of 100 and the lowest score of 50 out of 34 students who participated in the learning. The average score obtained by students was 71.76, which shows that in general student learning outcomes are in the category of being quite good. Of the total students, there are 23 students who have achieved learning completeness, while the other 11 students have not reached the completion criteria that have been set. The percentage of classical learning completeness reached 67.65%. These results show that the completeness of classroom learning has not reached the classical completeness standard which is generally set at 75% or more. Thus, student learning outcomes in this learning still need to be improved through improving the learning process so that more students can achieve the completeness and learning goals that have been set.

Reflection and Challenges in Cycle I

Although the implementation of Quantum Teaching in Cycle I produced better learning outcomes than the pre-action stage, several challenges were still identified through classroom observation. Some students were initially reluctant to express their opinions during group discussions, while others depended heavily on more capable classmates when completing the worksheets. In addition, several students still experienced difficulties distinguishing the characteristics of squares and rectangles and tended to memorize concepts without fully understanding them.

Based on these findings, several improvements were implemented in Cycle II. The teacher provided more intensive guidance during group discussions, reorganized group interactions to encourage equal participation, used additional concrete learning media, and increased opportunities for students to explain their answers before receiving teacher feedback. These improvements were expected to strengthen students' conceptual understanding and increase active participation during learning activities.

Results of Cycle II Actions

In the planning stage here, the researcher prepares all the needs that will be needed during the research process. At this stage, the researcher prepares several things, namely:

1. Compile teaching modules by applying the *Quantum Teaching* learning model to square, square and rectangular building materials.
2. Prepare learning media in the form of concrete objects, posters of circumference and square and rectangular areas, as well as animated videos relevant to the learning material.
3. Compile Student Worksheets (LKPD) which are used to support student learning activities in groups.
4. Prepare instruments for observing teacher activities and student activities during the learning process.
5. Prepare student learning outcome assessment sheets and determine learning completeness criteria in accordance with the Minimum Completeness Criteria (KKM) set by the school.

The implementation stage (Action) in Cycle II will be held on Wednesday, June 3, 2026 at 07:00 WITA, which will be carried out for 2 hours of lessons (2 x 35 minutes) of lessons consisting of initial activities, core activities and final/closing activities. At this first meeting, students learn about the circumference and area of the square and the square and the rectangle. The steps for implementing the learning are described as follows:

Early Activities

The initial activities in *Quantum Teaching learning* are included in phase 1 or the growth stage which includes: (1) The teacher opens the lesson by saying a greeting, then the student answers the greeting (2) The teacher asks one of the students to lead a prayer together (3) The teacher checks the attendance and readiness of the students to participate in the learning (4) The teacher conducts perception by showing a photo frame and floor tiles in the shape of a square and rectangle, The teacher asked: "If we want to put a ribbon around the perimeter of the photo frame, what do we need to know?" and "If we want to cover the entire surface of the tile with paper, what should we count?" (6) The teacher relates the students' answers to the material of circumference and area of the square and rectangle that has been studied previously (7) The teacher motivates the students by explaining the benefits of learning the circumference and area in daily life (8) The teacher conveys the

learning objectives, namely that students can correctly determine and calculate the circumference and area of the square and rectangle.

Core Activities

In the core activity, learning is carried out by applying the stages of Quantum Teaching which include Natural, Name, Demonstrate, Repeat, and Celebrate. In the Natural stage, the teacher displays a poster containing the material of the circumference and area of the square and rectangle in front of the class. Next, the teacher shows some concrete objects around the students, such as notebooks, small whiteboards, food boxes, and floor tiles. Students observe the posters and objects to gain a learning experience related to the concept of travel and vastness. After that, the teacher divides the students into groups of five to six people. Each group obtained an LKPD and a measuring instrument in the form of a ruler to measure the length of the sides or the length and width of the concrete object that had been provided.

In the Namai stage, the teacher guides the students to recall the formulas of circumference and area of the square and rectangle that have been studied before. The teacher then explained the difference between the concept of traveling and wide by using posters as a learning medium. Students record the formulas explained along with the example calculations given by the teacher. During the learning process, teachers provide opportunities for students to ask questions related to material that they have not yet understood so that their understanding of concepts can be strengthened.

The Demonstration stage is carried out by asking each group to work on the LKPD which contains questions about determining the circumference and area of several concrete objects that have been measured beforehand. Students discuss with group members to solve the problems given. After the discussion was over, the group representative presented the results of the group's work in front of the class. Other groups were given the opportunity to provide feedback, input, and questions on the results of the presentation. The teacher then provides reinforcement and clarification to the students' answers so that the concepts learned can be better understood. At the Repeat level, the teacher provides individual exercises related to the calculation of circumference and area of squares and rectangles. Students work on the questions independently as a form of reinforcement of the material that has been studied. After all students have completed the exercise, the teacher and students discuss the answers together. The teacher also gives some oral questions to ensure that the students have understood the correct calculation concepts and procedures.

The Celebration Stage was carried out by giving appreciation to the group who were active in discussing and were able to work well together during the learning process. The teacher also praised the students who dared to ask questions or answer the questions given. As a form of appreciation for student participation, the teacher invited all students to applaud together. In addition, teachers give simple awards to

the group that obtains the best discussion results as a form of motivation so that students are more active and enthusiastic in participating in learning.

Closing Activities

The teacher guides the students to return to their original seats, the students with the teacher's guidance conclude the material that has been learned, the learning activities end by working on the evaluation questions that have been given by the teacher, the teacher closes the learning by saying greetings and praying.

Cycle II Learning Outcomes

After the implementation of the second cycle is completed, the final test is continued which aims to find out the learning outcomes of students which amount to 7 multiple-choice questions and 3 essay questions, students who answer all questions correctly get a score of 100 as in the following table 4.

Table 4. Results of Cycle II Learning Outcome Analysis

Procurement Aspects	Results
Highest Score	100
Lowest Score	60
Number of Students	34
The Number of Students Who Have Completed	31
Average Score	79,12
Classical Learning Completeness Percentage	91,18%

Based on the results of data analysis, the highest score of 100 and the lowest score of 60 out of 34 students who participated in the learning were obtained. The average grade of the class reached 79.12, which shows that the students' learning outcomes are in the good category and have exceeded the minimum completeness criteria set. The high average score indicates that most students have understood the material being taught well. Of the total students, as many as 31 students have achieved completeness of learning, while only 3 students have not completed their studies. The percentage of classical learning completeness reaches 91.18%, which means that it has exceeded the classical completeness standard which is generally set at 75% or 80%. These results show that the learning carried out has taken place effectively and is able to increase students' understanding of the material studied. Thus, the learning objectives can be said to have been achieved because most students managed to obtain learning outcomes that meet the criteria of completeness.

The improvements implemented in Cycle II resulted in a more effective learning process. Classroom observation revealed that students participated more confidently during discussions, demonstrated better collaboration, and showed greater independence when solving mathematical problems. Students who were previously passive became more willing to ask questions and share ideas, indicating that the learning environment had become more supportive and student-centered. Consequently,

these improvements contributed to the higher level of classical learning completeness achieved in Cycle II.

Discussion

The findings of this study indicate that the implementation of the Quantum Teaching learning model successfully improved students' mathematics learning outcomes from the pre-action stage to Cycle II. The improvement was not only reflected in the increase in average scores and classical learning completeness but also in the quality of the learning process observed during classroom activities. Throughout the implementation of the TANDUR framework, students gradually became more engaged in discussions, demonstrated greater confidence in expressing their ideas, and participated more actively in collaborative learning activities. These findings suggest that meaningful learning experiences created through Quantum Teaching contributed to better conceptual understanding and higher student achievement.

The improvement in students' learning outcomes can be explained by the characteristics of Quantum Teaching, which emphasizes meaningful interaction between teachers, students, and the learning environment. During the Grow and Experience stages, students connected prior knowledge with real-life experiences through concrete objects and guided questioning. This approach helped students construct mathematical concepts more effectively before receiving formal explanations, as meaningful learning occurs when students actively experience concepts before learning theoretical explanations (Putri & Wati, 2025). Likewise, meaningful learning environments enhance students' motivation and facilitate deeper conceptual understanding, enabling students to engage more actively throughout the learning process (Nursalam et al., 2021; Tambunan, 2017).

Furthermore, the Demonstrate, Repeat, and Celebrate stages encouraged students to communicate mathematical ideas, receive immediate feedback, and reinforce their understanding through repeated practice. Classroom observations showed that students who initially hesitated to participate became increasingly confident in presenting their work and responding to their peers during Cycle II. Positive reinforcement provided during the Celebrate stage also increased students' enthusiasm and classroom participation. These findings suggest that the implementation of Quantum Teaching creates enjoyable, student-centered learning experiences that improve students' motivation and learning achievement (Arfiany, 2021; Fitri et al., 2020). Likewise, active interaction and a positive classroom environment contribute significantly to improving elementary students' mathematics learning outcomes (Nursalam et al., 2021).

The collaborative learning activities implemented during group discussions also played an important role in improving students' understanding. Through peer interaction, students exchanged ideas, discussed different problem-solving strategies, and corrected misconceptions with teacher guidance. These collaborative learning experiences encouraged active participation and ultimately improved mathematics achievement among elementary school students through the

implementation of the TANDUR framework (Alhakiki & Taufina, 2020). Similar findings indicate that Quantum Teaching facilitates meaningful learning by promoting communication, cooperation, and active student engagement throughout the learning process (Dewi et al., 2022).

The reflection conducted after Cycle I identified several challenges during the implementation of the learning process. Some students were still reluctant to express their opinions, while others relied on more capable classmates during group discussions. In addition, several students experienced difficulties distinguishing mathematical concepts because they were not yet accustomed to active learning strategies. These challenges were addressed in Cycle II by providing more intensive teacher guidance, reorganizing group interactions, increasing opportunities for student presentations, and utilizing additional concrete learning media. As a result, students became more independent, confident, and actively involved in classroom discussions. These findings indicate that continuous reflection and systematic improvements are essential components of classroom action research for enhancing the effectiveness of teaching and learning practices (Dewi et al., 2022).

This study also identified several strengths of the Quantum Teaching learning model. First, the model created an enjoyable and supportive classroom atmosphere that increased students' motivation and confidence during mathematics learning. Second, collaborative learning activities promoted communication, critical thinking, and teamwork among students. Third, the use of concrete learning media enabled students to understand abstract mathematical concepts more easily, resulting in better conceptual understanding and improved learning outcomes. These findings are consistent with previous studies showing that Quantum Teaching effectively enhances students' learning motivation, conceptual understanding, and academic achievement through meaningful and interactive learning experiences (Ariana et al., 2020; Syaukani et al., 2024).

Despite these strengths, several limitations were observed during the implementation of the model. Quantum Teaching requires careful lesson planning, adequate instructional media, and effective classroom management to ensure that each learning stage can be implemented successfully. In addition, collaborative learning activities require more instructional time, and some students initially need intensive guidance before actively participating in discussions. However, these limitations gradually diminished after improvements were implemented in Cycle II. Therefore, teachers intending to apply Quantum Teaching should prepare appropriate instructional materials and classroom management strategies to maximize the effectiveness of the learning process.

Overall, the findings demonstrate that the successful improvement in mathematics learning outcomes was not merely the result of repeated testing but was strongly associated with the systematic implementation of the Quantum Teaching model through the TANDUR framework. Meaningful learning experiences, active student participation, collaborative interaction, and continuous reflection throughout the classroom action research cycles collectively contributed to the improvement of students' conceptual understanding and mathematics achievement.

4. Conclusion

This classroom action research demonstrates that the implementation of the Quantum Teaching learning model successfully improved mathematics learning outcomes among Grade IV students at SD Inpres 3 Tondo. The systematic application of the TANDUR framework created a more meaningful, interactive, and student-centered learning environment that encouraged active participation, collaboration, and deeper conceptual understanding. Continuous reflection and improvement across the research cycles enabled teachers to address learning difficulties and optimize instructional practices, leading to the successful achievement of the learning objectives. These findings suggest that Quantum Teaching can serve as an effective instructional alternative for elementary mathematics learning, particularly in promoting student engagement and improving conceptual understanding. Future studies are recommended to examine the implementation of this model in different grade levels, learning topics, and educational contexts to further evaluate its effectiveness and broader applicability.

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