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Increasing Interest in Learning Mathematics Through the Technological Pedagogical and Content Knowledge (TPACK) Approach in Grade II Elementary School Students

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Abstract

The problem addressed in this research is the low interest in mathematics learning among second-grade students at SDN Demangan, which is attributed to conventional teaching methods and the minimal use of technology in the learning process. The purpose of this study is to enhance students' interest in mathematics by implementing the *Technological, Pedagogical, and Content Knowledge* (TPACK) approach. This study employed Classroom Action Research (CAR) using the spiral model developed by Kemmis and McTaggart, which includes planning, action, observation, and reflection stages. The research was conducted in two cycles during the even semester of the 2024/2025 academic year. Data were collected using observation and a learning interest questionnaire and analyzed using the Guttman Scale in percentage form. The results indicated a significant improvement in students' learning interest: in the pre-cycle stage, student interest was at 45% (categorized as sufficient), increased to 70% in the first cycle (high category), and reached 87% in the second cycle (very high category). The application of the TPACK approach successfully created a more engaging and enjoyable learning environment, encouraging student participation. This study concludes that the TPACK approach is effective in increasing the interest of second-grade students in mathematics learning at Demangan Elementary School, Kudus.

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INTRODUCTION

Education is a learning process that aims to form individuals who are knowledgeable, intelligent, and educated (Akbar et al., 2024). According to Nasution et al. (2022), education is an effort made by humans to grow and develop knowledge,

skills, values, attitudes, and behavior that are useful in social life. Mathematics is a fundamental subject that is included at every level of education, including elementary school (Ermawati & Zuliana, 2020). This is because mathematics is an applied science that plays a vital role in everyday life. Through mathematics instruction, students are expected to develop the ability to solve various real-life problems they may encounter (Ermawati & Riswari, 2020). Therefore, mathematics plays a crucial role in the intellectual development of students at the elementary level.

In learning mathematics, students learn basic concepts that are abstract through symbols that are arranged hierarchically with deductive reasoning patterns. This condition often causes students to consider math as a difficult, boring, and even scary subject (Ermawati et al., 2023). As a result, students' interest in learning mathematics at the elementary level remains relatively low. The majority of students tend to lack interest in math because they perceive it as a difficult subject. This assumption makes students less confident and not eager to learn math (Ermawati et al., 2024). Meanwhile, learning will be more meaningful if students are actively involved in every learning activity and are ultimately able to determine what they want to learn and how to learn it (Ermawati et al., 2024).

One way to boost students' motivation to learn is by introducing innovations in the learning process. According to Slameto (2003), learning interest refers to an individual's willingness and active involvement in an activity without any external pressure. Essentially, learning interest arises from the perceived connection between the learner and the subject matter. The stronger the emotional bond or sense of attachment a person feels toward an activity or topic, the greater their interest, even without external encouragement. In essence, learning interest reflects the degree to which an individual accepts and connects with something beyond themselves—the closer or more meaningful this relationship, the higher the level of interest in learning.

Based on initial observations conducted in Grade II at SDN Demangan Kudus on February 5, 2025, many students demonstrated a lack of interest in participating in mathematics learning. This was evident during the learning process, as students tended to be passive, showed low levels of participation, and lacked enthusiasm when working on mathematical problems. Such student conditions are influenced by several factors such as conventional learning approaches, lack of use of technology in learning, and the limited ability of teachers to integrate mathematics content with learning technology so that learning activities feel less interesting and less relevant to the development of today's times, so that students' interest in learning mathematics is low.

Therefore, engaging and meaningful learning activities are essential to enhance the interest of Grade II students at SDN Demangan Kudus in learning mathematics. To To achieve this, it is important to implement appropriate approaches, strategies, models, and methods that align with students' needs (Ermawati & Riswari, 2020). The efforts made are using the TPACK (Technological, Pedagogical, and Content Knowledge) approach. In line with current developments, teachers are required to innovate their teaching methods, one of which is by utilizing the TPACK approach. According to Farikhah and Malik (2020), the TPACK approach is a teaching method that integrates

technology into learning to facilitate students in acquiring new knowledge, enabling them to master the material effectively. Amrina et al. (2022) argued that the TPACK approach combines three aspects, namely technology, pedagogics, and content/material knowledge. So that the development of technology, pedagogics, and content is needed to provide learning that suits the needs of students. According to Rafi & Sabrina (2019), the use of TPACK can help students understand abstract material, particularly from a pedagogical perspective. Through the TPACK approach in learning, a more active, creative, innovative, and fun learning atmosphere will be created.

In response to the issues mentioned above, the researchers will carry out Classroom Action Research (CAR) aimed at enhancing second-grade students' interest in learning mathematics at SDN Demangan Kudus through the implementation of the Technological, Pedagogical, and Content Knowledge (TPACK) approach. The researcher selected the TPACK approach due to the necessity of three elements in mathematics learning: technology, pedagogy, and content/knowledge material. Therefore, the TPACK approach is appropriate to use in this class action research. According to research conducted by Nurul Hikmah Masda (2024) over two cycles, student mastery in the first cycle was only 53.84%, but it significantly increased to 80.76% in the second cycle. These findings indicate that the TPACK approach is effective in improving the learning outcomes of fourth-grade IPAS students at SDN Labuang Baji II. The results of Nurul Hidayah's research (2024), conducted over two cycles, revealed that the student completeness rate was low during the pre-cycle phase at 30%. In Cycle I, this rate increased to 67% and further improved to 86% in Cycle II. These findings indicate that the implementation of the TPACK approach in the mathematics learning process can significantly enhance the learning outcomes of Class X students at SMA N 2 Semarang, consisting of 36 students. By using TPACK, teachers are able to deliver creative and innovative lessons.

The application of the TPACK approach has been proven effective in increasing students' interest in learning mathematics, as demonstrated by the research conducted by Bunga et al. (2024). Their study showed a significant increase in mathematics learning interest among students who participated in lessons using the TPACK approach compared to those who experienced conventional teaching methods. This finding reinforces that the TPACK approach can be used as an effective learning strategy to increase interest in learning mathematics at the elementary school level.

METHOD

This research is a descriptive quantitative study conducted using the Classroom Action Research (CAR) method. The purpose of CAR is to address problems encountered in the learning process and to enhance the quality of education. Through CAR, teachers have the opportunity to recognize and implement more effective learning strategies or activities, continue to innovate, and strive to achieve optimal learning goals. This research focuses on how the implementation of a learning approach can enhance the quality of education. As stated by Saputra (2021), Classroom Action Research (CAR) is conducted to improve and develop the quality of learning. This study

adopts the Classroom Action Research (CAR) model developed by Kemmis and McTaggart, which follows a reflective spiral process consisting of planning, action implementation, observation, reflection, and revision.

Figure 1: CAR design of Kemmis and MC. Tagart

This classroom action research took place over two cycles at SDN Demangan, Kudus City, in the 2024/2025 school year. The research was conducted from February to March 2025, involving all Grade II students at SDN Demangan. A peer assisted the researcher during the research, acting as an observer to monitor the process.

The data collection instruments used include observation and questionnaire filling. Researchers observed the learning process of the research subjects, who were grade II students at SDN Demangan Kudus. As for filling out the questionnaire of interest in learning mathematics, it was carried out by grade II students with the help of researchers to read the filling instructions and statement items because there were several grade II students who were not fluent in reading.

In analyzing students' interest in learning, researchers use the Guttman Scale as a measurement tool. According to Sugiyono (2020: 150), the Guttman Scale is obtained from firm answers, namely "yes and no," "true and false," "ever and never," or "positive and negative."

The Guttman scale used in this study was in the form of a checklist, where a score of 1 represents the highest response and 0 represents the lowest. The Guttman Scale was chosen as a technique for analyzing students' interest in learning because its systematic approach is easy to understand, especially for low-grade elementary school student respondents. The formula used to calculate the results of the student learning interest questionnaire is as follows:

Sudjono (in Maulidta, 2018)

$$P = \frac{f}{N} x\ 100\%$$

Description:

P = percentage of student interest in learning

f = the total score obtained from data collection

N = maximum score

Table 1. Scoring Questionnaire Based on Guttman Scale

Statement		**Statement**	
Positive	Value	Negative	Value
True	1	True	1
False	0	False	0

Source: (Sugiyono, 2009: 147)

The resulting percentages are then interpreted based on the following research criteria:

Table 2. Criteria for Analyzing Student Learning Interest

Percentage	Criteria
0-20	Very Low
21-40	Low
41-60	Medium
61-80	High
81-100	Very High

Source: (Ridwan, 2011)

The rise in student learning interest, expressed in percentages, is classified into the following categories.

Table 3. Percentage Increase Criteria

Range of Improvement (%)	Criteria for Improvement
≥31%	Very High
21%-30%	High
11%-20%	Medium
1%-10%	Low
≤0%	No Improvement

RESULTS AND DISCUSSION

This study was carried out at SDN Demangan, involving six second-grade students. It employed the Technological, Pedagogical, and Content Knowledge (TPACK) approach to enhance students' interest in learning mathematics. The research was conducted over two cycles, each comprising the stages of planning, implementation, observation, reflection, and revision. The results of the classroom action research are presented as follows.

Pre-Cycle

Based on the observations made, information was obtained that there were several problems experienced by students, especially in mathematics subjects, which showed that students' interest in learning was still relatively low. This can be seen from the lack of student activity and participation, a focus that is easily distracted, and a lack of enthusiasm when learning takes place. This condition is influenced by several factors, such as the implementation of learning that seems monotonous, the lack of variety of activities during learning, and not involving students so they are able to actively participate in learning.

Based on the analysis of the questionnaire of interest in learning mathematics that has been filled out by grade II students, it appears that students' interest in learning is still relatively low. The data obtained from the mathematics learning interest questionnaire revealed that three students demonstrated a low level of interest in learning mathematics, while the remaining three students showed a moderate level of interest.

The mathematics learning interest questionnaire results from the pre-cycle stage are presented as follows.

Table 4. Results of Questionnaire of Learning Interest of Class II Students at Pre-cycle

Indicator	Very High
Feelings of pleasure or like	42%
Interest in learning material	33%
Pay attention when the teacher presents the material	58%
Participation in learning activities	50%
Average	45%

Based on the percentage results, students' interest in learning mathematics during the pre-cycle stage was 45%, which falls into the 'sufficient' category.

Therefore, there is a need for innovation in the application of learning approaches that are fun and involve more student participation, one of which is Technological, Pedagogical, and Content Knowledge (TPACK). The goal of this approach is to enhance students' interest in learning mathematics. Observational data also indicated that many students displayed enthusiasm and excitement during lessons that incorporated the TPACK approach.

Cycle I

Classroom Action Research (CAR) in Cycle I was conducted over three meetings, held on Wednesday, February 19, 2025; Thursday, February 20, 2025; and Wednesday, February 25, 2025. The following are the stages implemented during Cycle I.

1. Planning Stage

At this stage, the researcher engaged in planning by preparing the necessary instructional materials and learning tools for the research. This stage plays a crucial role in the success of classroom action research, especially when it is well-structured and carried out efficiently. The planning carried out includes the time of implementation, the resources needed, and the indicators of success (Salmah et al., 2025). The planning activities carried out include a) determining the object of research, namely grade II students of SDN Demangan Kudus consisting of 6 students, namely 4 boys and 2 girls; b) determining the subject matter of the material, namely measurement, including units of weight and units of time; c) preparing learning tools in the form of teaching modules that contain learning objectives, assessments, and steps of learning activities in which the Technological, Pedagogical, and Content Knowledge (TPACK) approach is applied; d) preparing learning resources both from books, the internet, and objects that are often encountered in everyday life; e) preparing learning media such as concrete objects related to the measurement of units of weight in the form of scales, ladders of units of weight that can be played interactively by students, interactive powerpoint slides, to quizzes through wordwall, matific, and online stopwatch platforms, as well as devices such as laptops and projectors; f) preparing assessments used to measure the achievement of learning objectives; and g) making a questionnaire of interest in learning mathematics in the form of 10 statements with 2 answer options in the form of "yes" and "no".

2. Action Stage

At this stage, the learning process was conducted over three sessions using the Technological, Pedagogical, and Content Knowledge (TPACK) approach, incorporating various instructional models and media.

a) First meeting

The first meeting was held on Wednesday, February 19, 2025. Learning activities are carried out using the Problem-Based Learning (PBL) learning model, while the methods used are discussion, question and answer, demonstration, lecture, presentation, and ice breaking. The material taught is about measurement using units of weight. The activity begins with the teacher saying greetings and praying together to start learning. The teacher checks student attendance, ensures student learning readiness, and conducts social-emotional learning. The teacher conveys learning objectives and makes apperceptions related to the material to be delivered.

In the core activities, learning is carried out according to the syntax of Problem-Based Learning (PBL), namely: problem orientation, learning organization, exploration, presentation of results, and analysis and evaluation. Researchers used learning media in the form of PowerPoint slides, the song "Unit of Weight," the weight unit ladder "Smart Ladder" that students can play to change the unit of weight, and Wordwall to display evaluation questions.

The closing activity of the teacher and students reflected on the material and the implementation of learning; the teacher motivated students to be enthusiastic about learning, prayed together to close the learning, and ended with a closing greeting by the teacher.

b) Second meeting

The implementation of the second meeting is almost the same as the first meeting but different in the use of learning models. The learning model at the second meeting used Contextual Teaching and Learning (CTL). The flow of core activities includes constructivism, asking, finding, learning community, and modeling. Researchers used learning media in the form of a video, "Getting to Know the Types of Scales," a weight unit ladder, "Smart Ladder," that students can play to change weight units, as well as body scales and cake scales that students can use to practice measuring the weight of objects.

c) Third meeting

The implementation of learning in the third meeting used the role-playing learning model. The flow of core activities includes preparation, selecting players, decorating the stage, appointing observers, arranging role stages, playing roles, evaluating, and sharing experiences and conclusions. Researchers use learning media in the form of interactive PowerPoint slides, "Dandangan" theme role-playing equipment in the form of grocery items in the form of pictures equipped with questions, shopping baskets, shopping vouchers, and evaluation questions.

3. Observation

Based on the observation, there are still students who feel bored and do not focus on learning. This can be seen when there are students who choose to stick their heads

on the table rather than sit upright, besides that when students are still talking to friends when the teacher explains the material. Students began to be interested and enthusiastic in participating in learning when they were given interactive quizzes using the wordwall platform and online stopwatch, along with LKPD in the form of direct practice such as weighing body weight or the weight of objects using scales. Following the distribution of a questionnaire on students' interest in learning mathematics at the end of the cycle, the results were as follows.

Table 5. Results of Class II Students' Learning Interest Questionnaire in Cycle I

Indicator	Cycle I
Feeling happy or like	83%
Interest in learning material	50%
Attention when the teacher presents the material	75%
Participation in learning activities	78%
Average	70%

Based on the percentage results, the level of interest in learning mathematics during the first cycle reached 70%, which falls into the high category.

4. Reflection and Redesign

The fourth stage is reflection and redesign, which is useful for reviewing the successes and shortcomings during the implementation of cycle I (Rahmi & Farida, 2025). The implementation of learning in Cycle I demonstrated that the use of the TPACK (Technological, Pedagogical, and Content Knowledge) approach in teaching mathematics effectively increased the learning interest of Grade II students. Furthermore, the percentage of interest in learning can be increased by making improvements in cycle II. The results of the reflection on the implementation of cycle I showed an increase in learning interest indicators, namely a) feelings of pleasure or liking; b) interest in learning material; c) attention when the teacher conveys the material; and d) participating in learning activities. However, in indicators b) and c), the percentage increase is still minimal. There were some students who still had difficulty understanding the material, were less motivated to learn about math, and often lost concentration during the learning process. Therefore, in cycle II, the researcher must Design the application of the TPACK approach in learning that focuses more on student activities.

Cycle II

Classroom action research (CAR) in cycle II was conducted in three meetings on Wednesday, March 12, 2025, Thursday, March 13, 2025, and Wednesday, March 19, 2025. Cycle II has the same stages as cycle I. The following is an explanation of each stage.

1. Planning Stage

At this stage, researchers started planning again based on the results of the first cycle reflection. The planning stage carried out by researchers includes a) preparation of mathematics teaching modules on measurement material about units of time; b) preparing learning media in accordance with learning activities using the TPACK

approach; c) preparing a learning interest questionnaire that will be distributed to students at the end of cycle II.

2. Action Stage

At this stage, the learning process was conducted over three sessions using the Technological, Pedagogical, and Content Knowledge (TPACK) approach, incorporating a range of instructional models and media.

a) First meeting

During the first meeting, the learning activities were conducted using the problem-based learning (PBL) model. The methods employed included discussion, question and answer sessions, demonstrations, lectures, presentations, and icebreakers. The material taught was about measurement using units of time. The activity begins with the teacher saying greetings and praying together to start learning. The teacher checks student attendance, ensures student learning readiness, and conducts social-emotional learning. The teacher conveys learning objectives and makes apperceptions related to the material to be presented.

In the core activities, learning is carried out according to the syntax of Problem-Based Learning (PBL), namely: problem orientation, learning organization, exploration, presentation of results, and analysis and evaluation. Researchers used learning media in the form of analog clock presentation slides, as well as quizzes through the 'online stopwatch' platform.

During the closing activity, both the teacher and students reflected on the material and the learning process; the teacher motivated the students to be enthusiastic about their learning, prayed together with them to conclude the session, and ended with a farewell greeting.

b) Second meeting

The second meeting was similar to the first, but the learning models were different. The learning model in the second meeting used Project- Based Learning (PjBL). The flow of core activities includes determining questions, developing project plans, making schedules, monitoring the implementation of PjBL, testing and providing project assessments, and evaluating learning. Researchers used learning media in the form of analog clock presentation slides, as well as project equipment to make analog clock creations.

c) Third meeting

The implementation of learning at the third meeting used the problem-based learning (PBL) learning model. The flow of core activities includes problem orientation, learning organization, exploration, presentation of results, and analysis and evaluation. Researchers used fingers as a learning media to help distinguish the number of days in each month and also utilized the 'Matific' platform to quiz students on measuring units of time.

3. Observation

In this observation stage, researchers analyzed the results of the acquisition of mathematics learning interest questionnaire scores of grade II students, with the following results.

Table 6. Results of Questionnaire of Learning Interest of Grade II Students in Cycle II

Indicator	Cycle II
Feeling happy or like	100%
Interest in learning material	78%
Attention when the teacher presents the material	83%
Participation in learning activities	89%
Average	87%

Overall, the questionnaire results in cycle II show that students' interest in learning has increased significantly. Indicators of learning interest are in the high and very high categories, with an average percentage of the overall learning interest indicator of 87%, which is in the very high category. This evidence proves that the application of the TPACK approach has succeeded in increasing students' interest in learning mathematics.

4. Reflection

The results of reflection on the implementation of the TPACK learning approach in cycle II have shown a significant increase in interest in learning. The data analysis indicates a progressive increase in students' learning interest from the pre-cycle phase through Cycle I to Cycle II. The detailed progression of students' interest can be observed in the table below.

Table 7. Increase in Student Learning Interest Per-Indicator

Indicator	Pra-cycle	Cycle I	Cycle II	Percentage Increase Cycle I to Cycle II	Description
Feeling happy or like	42%	83%	100%	17%	Medium
Interest in learning material	33%	50%	78%	28%	High
Attention when the teacher presents the material	58%	75%	83%	8%	Low
Participation in learning activities	50%	78%	89%	11%	Medium
Average	**45%**	**70%**	**87%**	**17%**	**Medium**

In addition to the table, data on the increase in student interest in learning can be seen in the following diagram.

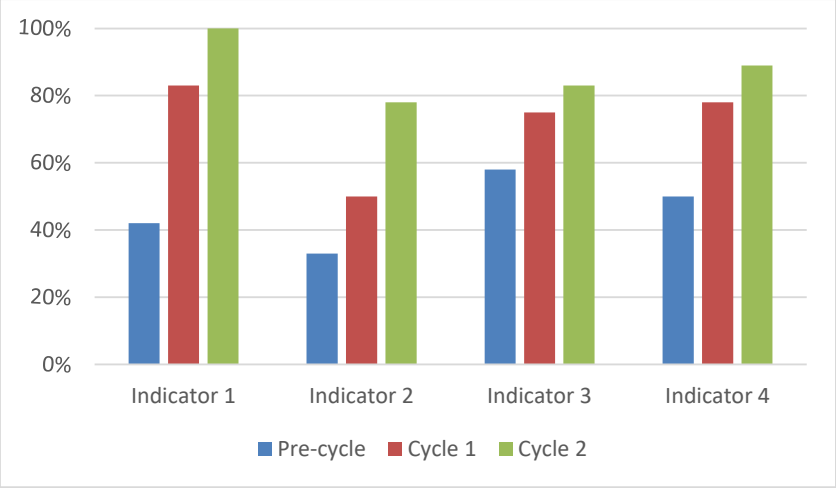

Figure 2. Percentage of Achievement of Learning Interest Indicators for Grade II Students

Based on the table above, the results of the increase in each indicator are obtained. In the "feeling happy or like" indicator, an increase of 17% from cycle I to cycle II is classified as moderate. This shows that students began to like the math learning process after participating in learning by applying the TPACK approach. According to Kartika et al. (2019), when someone does or learns something with pleasure, it will produce its own satisfaction after doing or learning the material, and usually a sense of pleasure will encourage someone to do or learn something until he feels satisfied or successful. This can be seen when students are eager to participate in the mathematics learning process with the TPACK approach.

The indicator "interest in learning material" experienced the highest increase, which was 28%, including in the high category. Kartono (1995) said "interested" is like being happy but has not done the activity. Interest is a feeling that each individual has in the expression of like, pleasure, and sympathy for something before carrying out activities as a positive assessment of an object. Students' interest is seen when they want to learn math material again and again; when the learning is over, they immediately ask when they will learn math again with various interesting activities. As the researcher has done, the researcher applies the TPACK approach in learning mathematics to increase the learning interest of grade II students. Teachers' teaching skills as one of the factors in the school environment that influence learning interest become very important when students' interest in learning arises on the basis of interest. The teacher's ability to increase students' interest in learning is very important and has a big influence. The role of the teacher can encourage student activeness. Teachers strive to provide opportunities for students to be active, both actively seeking and processing and managing their learning gains.

The indicator for "attention when the teacher conveys the material" has increased by 8%, but it is still classified as being in the low category. However, as can be seen in the previous table, this indicator has a significant increase from pre-cycle to cycle I, namely 17%, and then an increase from cycle I to cycle II of only 8%. This calculation allows for other factors that affect student focus, such as learning in cycle II, which was carried out during the month of Ramadan, when, incidentally, students were also in a

state of practicing fasting and learning, which was carried out at the end of the school day. According to Fatmala (2018), attention is the concentration or activity of our soul toward observation, understanding, and so on to the exclusion of other things.

The indicator of *"participation in learning activities"* showed an 11% increase, placing it within the moderate category. Student involvement refers to their active engagement as participants in the teaching and learning process. According to Dimjati and Mudjiono (1994), student activeness can be fostered through the teacher's role. Teachers are encouraged to create opportunities that allow students to be active in seeking, processing, and managing the knowledge they acquire. To enhance student involvement, teachers can employ strategies such as engaging students directly in both individual and group activities, creating opportunities that motivate students to conduct experiments, assigning tasks that require students to gather information from sources beyond the classroom or school, and encouraging students to summarize or conclude key learning points.

Overall, the increase in interest in learning mathematics in grade II students can be seen in the following graph.

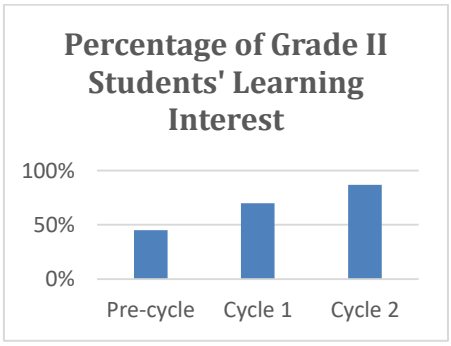

Figure 3. Percentage of Grade II Students' Learning Interest

There has been an improvement in the mathematics learning interest of Grade II students from the pre-cycle stage through Cycle I to Cycle II. The mathematics learning interest of grade II students at the pre-cycle stage only reached 45%, which was included in the sufficient category, with details, namely 3 students had a low category of mathematics learning interest and 3 students had a moderate category of mathematics learning interest. After that, there was an increase in cycle I to 70%, which is included in the high category. 1 student was found to have a low level of interest in learning mathematics, 3 students had a medium level, and 2 students had a high category of interest in learning mathematics. Furthermore, it increased again in cycle II To reach 87%, which is included in the very high category, 5 children have a very high interest in learning mathematics, while 1 child has a moderate interest in learning.

CONCLUSIONS

Based on the results of research and data analysis, grade II students of SDN Demangan have 87% interest in learning mathematics, which is included in the "Very High" category. Furthermore, we advise teachers to utilize technology to implement a wider range of approaches, methods, models, and learning media. The learning atmosphere should also be made fun, such as while playing, so that students are more

actively involved, not easily bored, and remain enthusiastic about learning math. Meanwhile, students are expected to maintain and continue to increase their interest in learning, especially in math subjects.

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