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Implementation of Problem Based Learning (PBL) Learning Model Integrated with Culturally Responsive Teaching (CRT) to Increase Motivation to Learn Mathematics

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ABSTRACT

This study was conducted to improve the quality of learning in the classroom, low motivation in Mathematics subjects in class X DKV 1 SMK Negeri 10 Medan. Through observation that students have low learning motivation. Learning that is carried out continuously without innovation makes the level of student motivation low, with this study the researcher combines the Problem Based Learning (PBL) learning model with the Culturally Responsive Teaching (CRT) approach. This type of research is classroom action research which is carried out in 2 cycles. The subjects of the study were 33 students. The data taken were in the form of observations and questionnaires. The results of the study showed that there was an increase in student learning motivation of 19% which was obtained through a motivation questionnaire based on student learning motivation indicators. Significant results can be seen from the percentage obtained during cycle I which was only 61%, while in cycle II it was 80%. This shows that the implementation of the Problem Based Learning (PBL) model integrated with Culturally Responsive Teaching (CRT) can increase students' motivation to learn mathematics so that learning becomes more innovative and enjoyable.

Keyword : ***Learning Model, PBL, CRT, Motivation, Mathematics***

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1. INTRODUCTION

The main text format Education creates superior human resources that can improve the quality of the nation. One aspect that can be assessed by other countries, therefore the government always tries to create a curriculum that follows the changing times. Where the independent curriculum is designed to side with students. Teachers serve as facilitators who guide the natural strength of students and the nature of the times so that students can achieve safety and happiness as human beings. Although students are the center of learning, they are encouraged to be actively involved in learning activities. Good and quality human data sources can be realized through an effective education system. Through education, a person can also experience a transformation from ignorance to having knowledge, thus becoming a better individual. (Putri N. S, dkk, 2018:258).

A title of One of the obstacles or problems of the learning process is low learning motivation. One thing that can improve learning achievement is learning motivation. The higher the motivation of students in learning, the better the results they will get. Learning motivation will facilitate the learning process. Therefore, providing the right motivation is needed for success in learning. Teachers must design learning models and approaches that can increase student motivation.

Student learning motivation is very influential in the learning process, because it can change student behavior in learning. Students can develop themselves well if they have a desire to achieve success. Motivation will encourage students to be active in learning. Conversely, if students do not have the enthusiasm to learn, it will cause various other problems, such as students being lazy to follow learning, students having difficulty understanding learning, and being unable to do assignments. Student learning outcomes will be of higher quality if they have high motivation. Student motivation is closely related to the role of the subject teacher himself. The design of an appropriate and interesting learning model, which includes approaches, strategies, methods, and techniques will encourage student motivation to be enthusiastic in following learning. Teachers can create good classroom conditions in order to create effective learning, and in line with the individual needs of students (Ayu, dkk., 2023: 435).

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The learning method that can be used to meet students' needs is Problem Based Learning. PBL is a learning model that can make students actively involved and think critically in understanding lesson concepts. This is done by presenting situations and problems from the beginning of learning, with the intention of being a learning material for students in solving problems through a problem-solving approach. (Utomo dkk, 2014:6).

The Culturally Responsive Teaching approach is a culture-based approach that looks at the cultural background of students in its application. In this learning, teachers integrate cultural content into learning materials. The CRT approach will make students close to their culture, appreciate cultural diversity, and can make students enthusiastic to participate because the learning material is relevant to their daily lives. The application of learning with the CRT approach has the potential to increase student interest and motivation. Hernandez (in Larasati Anggi, 2023: 84) that learning that is linked to the culture and daily experiences of students will make it easier for students to understand the concepts of science.

So it can be concluded that learning with the CRT approach is important to train students to understand learning materials, and to increase students' motivation to learn mathematics, teachers must meet students' learning needs through learning models. One of the learning models applied in class X DKV 1 is the PBL learning model to increase student motivation, so that the quality of learning becomes better.

Through observations at SMK Negeri 10 Medan, it was found that students were less motivated in learning, many students were still afraid to give arguments, lacked self-confidence, and lacked curiosity in learning. It can be concluded that students cannot be said to be active in learning. Learning that is less interesting and still conventional makes students not focus on following the learning. In addition, learning is less related to the background of student participants, such as social conditions, environment, and culture of students.

2. RESEARCH METHOD

This type of research is Classroom Action Research. (*Clasroom Action Reseacrh* (CAR)). This research follows the flow *planning-acting-observing-reflecting*.

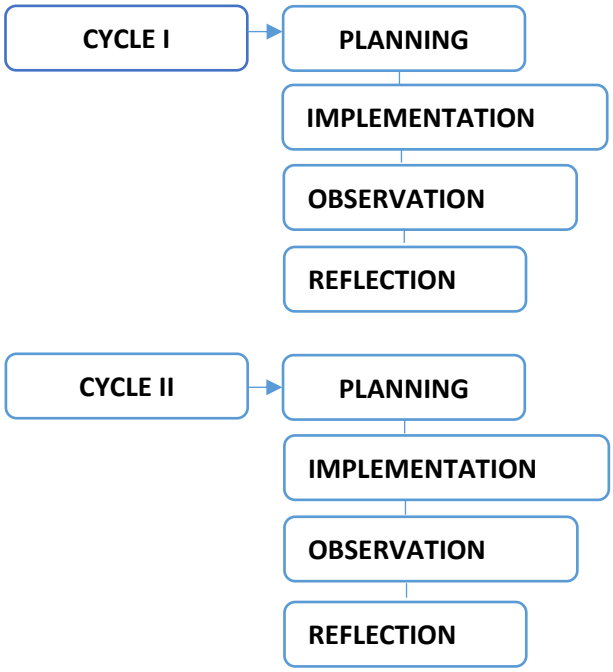

Fig 1. Classroom Action Research Activity Cycle Concept Map

The subjects of this study were students of class X DKV 1 at SMKN 10 Medan with a total of 33 students, of which there were 16 male students and 17 female students. The school was chosen because it has characteristics that are suitable for testing the relationship between motivation to learn

mathematics. The study will be conducted in 2 cycles. Cycle I and Cycle II are given 2 face-to-face meetings.

In this study, two techniques were used to collect data: observation and questionnaire. Observation was carried out by directly observing activities in the field and conducting interviews with teachers and students. Meanwhile, the questionnaire was compiled in the form of statements made through Google Form and given to respondents to be filled in. To assess learning motivation, a questionnaire was distributed covering 20 statements, of which 10 were positive and the others were negative. The results of measuring students' mathematics learning motivation were then processed with a Likert-based scoring system with four answer choices, and analyzed using student motivation indicators. The measurement of student motivation questionnaires was carried out using the indicators contained in the following table.

Table 1. Aspects of Learning Motivation

Number of Item	**Aspects of Learning Motivation**
1	Seriousness in completing tasks
2	Strong motivation and drive to achieve success.
3	Interesting and stimulating learning activities
4	Enjoyment in finding and solving problems.
5	A supportive and comfortable learning environment.

3. RESULTS AND DISCUSSION

Before the research was conducted, an observation of the Mathematics learning process in class X DKV 1 SMK Negeri 10 Medan had been conducted. This observation aims to evaluate the problems faced by students during the learning process.

Classroom action research is carried out in two cycles, namely cycle I and cycle II. The data presented are the results of observations obtained through student questionnaires. The following is a schedule of classroom action research activities related to efforts to improve students' motivation to learn mathematics in each cycle. Classroom Action Research Activity Schedule Table.

Cycle	**Date**	**Students Who Attend**
Cycle I	02 August 2024	33 Students
Cycle II	30 August 2024	33 Students

The findings during the implementation along with their discussion are:

a. Cycle I

In the planning stage, the first step taken is to prepare a learning module for the Mathematics subject. Using the PBL learning model with the CRT approach. In addition, the teacher also prepares learning resources, student worksheet, assessment rubrics, learning tools and media. At this planning stage, the things that need to be prepared are research instruments as data collectors on observation sheets and research questionnaires. In cycle I learning activities carried out on Friday, August 2, 2024 with a time of 4JP. In this learning, students are given a CRT approach with the PBL learning model. The media used are interactive display materials, flipbooks, google classrooms, learning videos, claw machines, and curipods that are integrated with student culture, for example Malay culture, North Sumatra.

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Fig 2. Cycle I

Based on the observation results of the learning motivation of class X DKV 1 students of SMKN 10 Medan in cycle I, the average value of student learning motivation is 61%. This shows that the learning motivation of class X DKV 1 students has not reached the expected success indicators. The results of the observation cycle I show that the average value of student motivation in the questionnaire is 61%. The following are the results of the analysis of student learning motivation in cycle I of class X DKV 1 at SMKN 10 Medan:

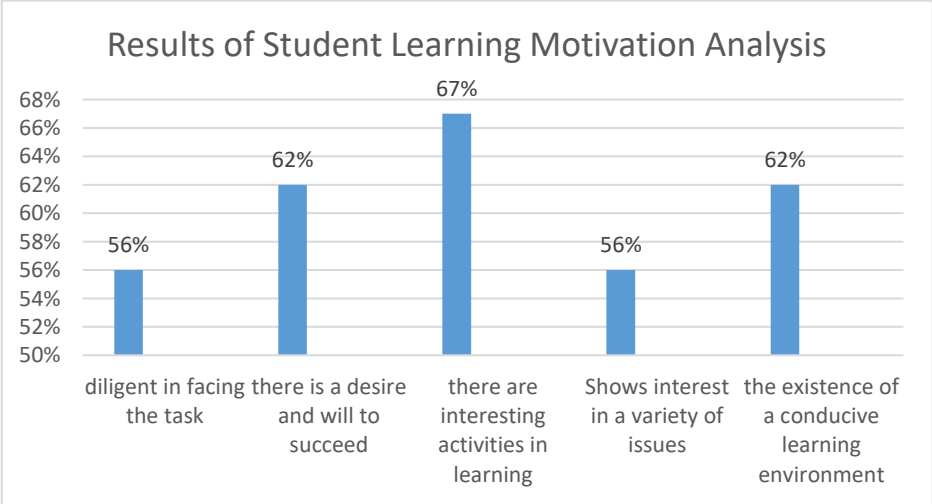

Fig. 3 Results of Student Learning Motivation Analysis

The results of students' mathematics learning motivation after implementing the CRT approach can be seen in the table above. The percentage obtained from each indicator is: indicator 1 is 56.37%, indicator 2 reaches 61.87%, indicator 3 is 67.05%, indicator 4 is 56.21%, and indicator 5 reaches 61.87%. From these data, it can be concluded that the implementation of CRT increases students' learning motivation. However, there are still some students with low motivation, so a further cycle is needed, namely cycle II, to further increase students' learning motivation.

Based on the data of cycle I actions, observation and questionnaire data have not reached the success indicators. So that several shortcomings can be obtained that can be used as reflection materials.

1. In solving HOTS problems, there are still students who are less confident in the material of arithmetic and geometric sequences related to culture
2. The CRT approach is not widely applied in cycle 1, in the next cycle examples of North Sumatra culture will be added to inspire students.
3. In the next cycle, add cultural elements to LKPD and learning resources so that students become more interested and enthusiastic.

b. Cycle II

The initial step in the planning stage is to prepare a learning module for Mathematics subjects using the PBL model and the CRT approach. In addition, teachers also prepare various learning resources, Student Worksheets, assessment rubrics, and the necessary learning tools and media. At this stage, research instruments must also be prepared to collect data through observation sheets and

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questionnaires. Learning in cycle II is scheduled to take place on Friday, August 30, 2024, with a time allocation of 4JP. In this learning, students are given a CRT approach with the PBL learning model. The media used are interactive display materials, flipbooks, google classrooms, learning videos, claw machines, and curipods that are integrated with the culture of students of X DKV 1 SMKN 10 Medan, for example Malay culture, North Sumatra.

Fig. 4 Cycle II

According to the results of observations on the learning motivation of class X DKV 1 students at SMKN 10 Medan in cycle II, the average score was 80%. This figure shows that the learning motivation of class X DKV 1 students has met the requirements for the agreed level of success. The results of observations from cycle II indicate that the average value of student motivation in the questionnaire is 80%. Below is an analysis of student learning motivation in cycle II in class X DKV 1 SMKN 10 Medan:

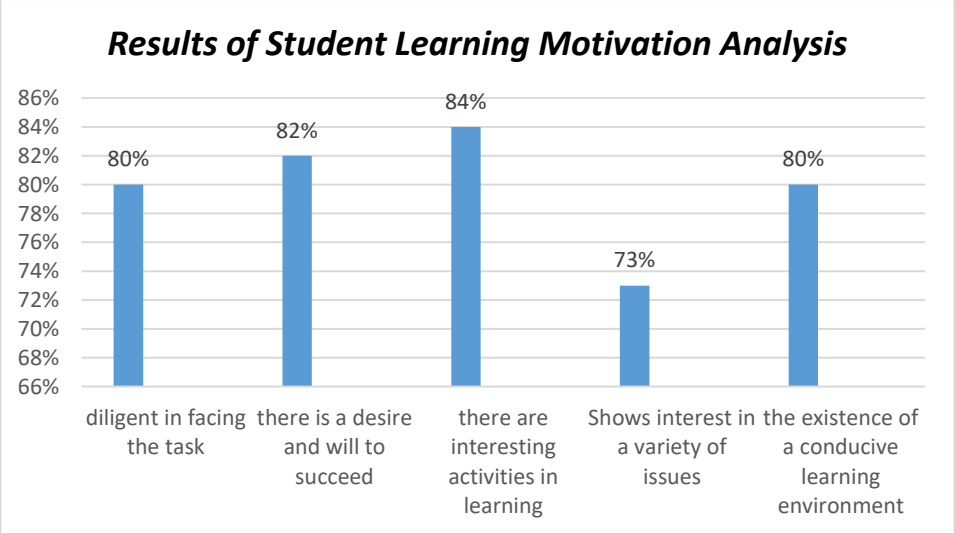

Fig. 5 Results of Student Learning Motivation Analysis

The results of the study on students' mathematics learning motivation after the implementation of the Culturally Responsive Teaching (CRT) approach can be seen in the attached table. The percentage value of motivation per indicator is as follows: indicator 1 recorded 80.30%, indicator 2 reached 82.33%, indicator 3 was 83.90%, indicator 4 was 73.03%, and indicator 5 was also 80.30%. Based on these data, it can be concluded that the implementation of the CRT approach in cycle II was effective in significantly increasing students' learning motivation. Therefore, the researcher believes that there is no need to continue to the next cycle because the research objectives have been achieved.

Research on students of class X DKV 1 on the material "Arithmetic and Geometric Sequences" revealed that the application of the PBL model with the CRT approach succeeded in fostering students' learning motivation. Student motivation increased by 19% from cycle I to cycle II, from 61% to 80%.

The percentage of student learning motivation can be seen in the diagram below. Data obtained from cycle II showed that the motivation indicator had reached an optimal level. This shows that learning using the PBL model and the CRT approach is effective in increasing the motivation to learn mathematics for students of class X DKV 1 at SMKN 10 Medan.

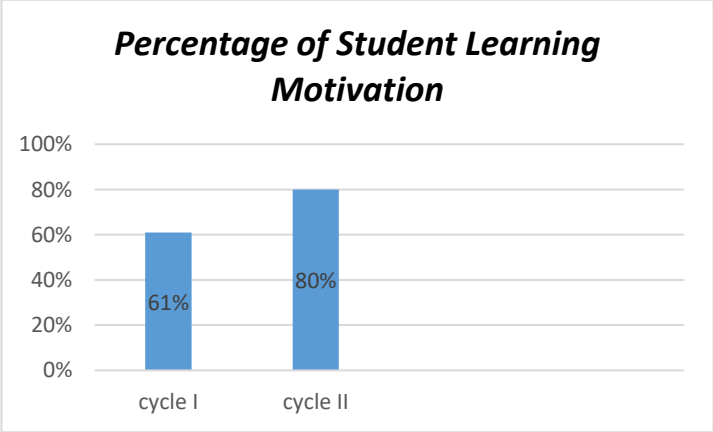

Fig. 6 Percentage of Student Learning Motivation

4. CONCLUSION

A study conducted on students of class X DKV 1 at SMKN 10 Medan discussing the material "Arithmetic and Geometric Sequences" indicated that in learning using the PBL model and the CRT approach, it can effectively foster student motivation. Learning motivation increased by 19% from cycle I to cycle II, namely from 61% to 80%. The increase can be seen from the score of the mathematics learning motivation questionnaire where each cycle experienced an increase. After undergoing learning with the CRT approach, students showed increased motivation, greater enthusiasm, and perseverance in understanding mathematics material. Therefore, students have achieved the established success indicators, so there is no need to continue this research to the next cycle.

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The Influence of Principal Academic Supervision on Teacher Performance

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ABSTRACT

The improvement of teacher performance in elementary schools is the focus of this study, which seeks to identify and prove the significant relationship between academic supervision by the principal and the enhancement of teaching effectiveness. The study involved 17 teachers from SD Negeri 51 Sungai Kunyit in the Sekadau Hilir District of Sekadau Regency, West Kalimantan Province, and employed a questionnaire instrument based on a Likert scale, using a quantitative approach and survey method. With a significance value of 0.000 (< 0.005) and a correlation of 65.2%, the results of the linear regression analysis revealed that academic supervision by the principal significantly influenced teacher performance. Improving teacher performance can be achieved through effective academic supervision, as emphasized by these findings. To improve the teaching process, support teachers' professional development, and enhance the quality of school programs and student achievements, it is recommended that principals strengthen their qualifications and supervisory competencies to provide more comprehensive guidance.

Keyword: Academic Supervision, Principal, Teacher Performance

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1. INTRODUCTION

True quality human resources can be created, namely through national development in which education plays an important role. In Indonesia, national education aims to build the character of responsible individuals, by instilling the values of Pancasila as a basis, and focusing on spiritual, intellectual, skills, and ethical development to create a superior and integrated society (Iskandar, 2020). In order for education to be able to support the progress of national development, a structured system is needed in accordance with the goals of national education. The Indonesian education system is designed to develop human potential, improve the quality of life, and uphold the dignity of the Indonesian people in order to realize national ideals (Wahib et al., 2022).

To improve the quality and quality of education, the main goal of the education system in Indonesia is to achieve it. For this success to be achieved, cooperation between students in the learning and teaching process is one of the main keys. As responsible citizens, students must be formed into individuals with good character, and this is the responsibility of the teacher, in addition to teaching knowledge. Teacher professionalism must be a priority, this is because this activity is not an ordinary activity (Rusnawati, MA, 2022). A teacher must have qualifications in pedagogical competencies, personality is also included in it, professional, and social ones, namely those that are based on the regulations of the Minister of Education and Culture Number 16 of 2007 (Manueke et al., 2021).

However, many teachers still do not fully master these competencies. As a result, students' interest in learning decreases because teachers are less able to apply relevant methods or create a learning atmosphere according to student characteristics (Hasanah & Kristiawan, 2019). When compared to neighboring countries in the ASEAN region such as Malaysia, Thailand and Singapore, Indonesia is still far behind, reflecting other factors of low quality education, especially those related to teacher performance (Rosmawati et al., 2020). Solving this problem requires collaboration between the government and educational institutions, with principals playing a crucial role as supervisors in encouraging improved teacher performance (Hariyanto & Tyas, 2021).

As a supervisor, the principal acts based on the principles: Democratic implementation, consultative relationships that replace hierarchy, fulfillment of educational staff needs, focus on teacher

development, and provision of professional assistance through cooperative discussions are some aspects that need to be considered (Susilo & Sutoyo, 2019). Purbasari's research (2015) The results illustrate that the involvement of the principal through supervision contributes to improving the quality of teacher performance in learning activities. Meanwhile, Pujianto et al. (2020) claim that teacher performance is greatly influenced by the principal's academic supervision by 5.94%, with the rest influenced by other factors. This supervision also contributes up to 49.63% to improving teacher performance. As has been revealed by relevant studies, it states that the role of the principal in the learning and teaching process and teacher performance is very crucial.

Through optimizing competencies in community learning activities and collaboration, teacher performance at SD Negeri 51 Sungai Kunyit, Sekadau Regency, has increased, as expressed by the Principal in an interview. The teacher activity development program, which includes academic supervision, observation sheets, implementation follow-up, and evaluation, is planned by the principal, including in the accreditation program. A supportive and cooperative working environment is created through discussions with teachers.

As a crucial element in the educational process, supervision focuses on leadership that supports teachers in developing their skills to improve learning effectiveness (Zulqaidah et al., 2023). In addition to assessing teacher performance, academic supervision also plays a role in supporting their professional development. As an educational leader, the principal has a role in mapping the sustainability of operations and improving the quality of teacher teaching in the learning and teaching process. According to Colquitt, matters relating to work attitude, responsibility and tasks are some of the crucial factors in determining the success of teacher performance.

2. RESEARCH METHOD

The survey method with a quantitative approach was used in this study, involving 17 teachers as research subjects at SD Negeri 51 Sungai Kunyit, Sekadau Regency, West Kalimantan. A Likert scale with level 4 was used in this study, consisting of the following answer options:

Table 1. Four Level of Likert Scale

Score	Criteria
1	Never (N)
2	Sometimes (S)
3	Often (O)
4	Always (A)

This instrument is designed based on aspects and indicators that are closely related to the two main variables: the independent variable, namely the principal's academic supervision or (X) and the dependent variable, namely teacher performance or (Y). Furthermore, the academic supervision variable has three indicators, namely:

1. Evaluation of supervision results and procedures,
2. Instruments and methods used in supervision,
3. Planning of academic supervision programs.

Teacher performances' indicators include:

1. Learning evaluation process,
2. Learning implementation process,
3. Learning planning,

Furthermore, this study also applies simple linear regression analysis, which includes several conditions as follows:

1. With the Kolmogorov-Smirnov method, namely the significance criteria > 0.05 is used for the data normality test.
2. Linearity test with F test mode at a significance level of 5% was carried out in this study.

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3. RESULTS AND DISCUSSION

To determine the normality and linearity of the data, the data analysis process is carried out by testing the prerequisites first. Furthermore, the data can be said to be normal or not must be tested, so the test used in this study is the normality test. This test is carried out using SPP software with the help of the Kolmogorov-Smirnov formula. Data is said to be abnormal if the significance value is <0.05, while if the significance value is> 0.05, then the data is considered to be normally distributed. The table below presents the results obtained from the normality test.

Table 2. SPSS Data Normality Test

Variable	*Asymp. Sig. (p-value)*	Analysis results
(X) Principal's Academic Supervision Variable	0,751	$p > 0,05$
(Y) Teacher Performance Variable	0,890	$p > 0,05$

The table above basically proves that the data is normally distributed. The data meets the requirements to continue to the next test, namely linearity, the p-value for variable X 0.751 and variable Y 0.890 is far from its significance value of 5% or 0.05.

In terms of conducting a linearity test, 'deviation from linearity' is applied in this study. Which test is carried out because it is to reveal the influence that occurs between the independent and dependent variables in this study. The decision is taken based on the following criteria: if the coefficient value, namely 'deviation from linearity', is far beyond or more than 0.05, then there is a linear relationship. If it is below 0.05, the p-value means that the relationship is not linear. The table below shows how the linearity relationship is.

Table 3. SPSS Data Linearity Test

Variable	*Deviation From Linearity*	*p-value*	Criteria
(X) Principal's Academic Supervision Variable on (Y) Teacher Performance	0,473	$p > 0,05$	Linier

The results of the linearity test shown in the table reveal that the coefficient of 'deviation from linearity', namely in variables X and Y, is obtained with a value of 0.473, which is far beyond 0.05. Thus, there is a linear relationship between the independent and dependent variables.

Furthermore, to find out the simple linear relationship, testing is done using SPSS software. At a probability of 0.05, it functions to find out the relationship between variables. The following criteria are the reference for determining decisions: if the significance value is below 0.05, it can be said that the principal's academic supervision variable has a significant influence on the teacher performance variable. If the significance value is above 0.05, then the variables X and Y have no influence. Below is a linear regression test using SPSS software.

Table 4. Linear Regression Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	92.401	1	92.401	46.641	.000[a]
	Residual	29.717	15	1.981		
	Total	122.118	16			

a. Predictors: (Constant), Academic Supervision

b. Dependent Variable: Teacher Performance

The significance value of variable X on variable Y is obtained at 0.000, while the value of the calculated F obtained is 46.641 which is at a significance level of 0.000, so it is less than 0.005 (0.000 <0.005). The conclusion is that academic supervision of schools has a very significant influence on teacher performance.

Table 5. SPSS Correlation Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.790[a]	.652	.740	1.408

a. Predictors: (Constant), Academic Supervision

The table measures the variables of academic supervision and teacher performance. 0.652 is the value of the coefficient of determination or (R-square) while the correlation value (R) obtained is 0.790. So it can be said that academic supervision has an influence of 65.2% on teacher performance in this study.

4. CONCLUSION

Academic supervision to schools in this study basically greatly affects teacher performance at SD Negeri 51 Sungai Kunyit. The analysis conducted on the correlation test actually proves that there is an influence between variable X (principal academic supervision) which in this study contributed 75.7% to variable Y, namely (teacher performance), in accordance with a significance level of 0.000 (<0.005), as evidenced by linear regression analysis.

The principal's ability to plan has been proven to have a positive influence on improving teacher performance, implementing methods and instruments, carrying out supervision, and conducting evaluations and follow-ups. Utilizing various existing instruments, this case can be seen from how teachers can provide examples in the learning and teaching process in the classroom.

In supporting the improvement of teacher performance, the role of the principal is very optimal in improving teacher performance. To improve the learning process and develop relevant competencies, the recommendation proposed is to expand exploration and collaboration with teachers as work partners. So that the quality and quality of education as a whole can be optimized, student achievement can be improved with these steps.

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Analysis of Mathematics Problem Solving Ability Viewed from Self-Regulated Learning

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ABSTRACT

The goal of this study was to assess SMA Wachid Hasyim 5 Surabaya students' abilities to solve arithmetic problems in the low, medium, and high self-regulated learning categories. Three students from class X IPA 3 participated in this qualitative study. Data for this study were gathered by questionnaires, tests, and interviews and analyzed through data reduction, data presentation, and drawing conclusions. The authenticity of the data in this investigation was determined via time triangulation. Based on the findings and discussion, the researcher concluded that the four steps of problem solving for students with high and moderate independence when learning can be fulfilled properly; however, independent students are experiencing difficulties at the stage of carrying out the settlement plan because students are not careful about the results of their calculations. Meanwhile, students with low learning independence meet one of the indications, namely understanding the problem, but are unable to appropriately put down what is learned in the questions, resulting in incorrect calculations.

Keywords: Mathematical Problem Solving Ability, Self-Regulated Learning

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1. INTRODUCTION

One of the subjects that must be applied at all levels of education in Indonesia is mathematics. According to Hasratuddin (F Assyifa et al., 2020) mathematics is the study of regularity and structured concepts ranging from the most basic to the most complex. Therefore, the existence of a structured concept of mathematics will make it easier for students to understand various problems. With a variety of different structured concepts that students have, they can develop logical, critical, and creative thinking skills as well as skills for studying independently or in groups.

Permendikbud No.59 of 2014 states that learning mathematics has a goal, especially at the high school level, namely students can master how to explain mathematical concepts by explaining relationships between concepts when solving problems, using formulas as estimates when solving problems, applying arguments when solving math problems, conveying ideas and doing proof using tables, symbols and diagrams (R. K. Putri & Roichan, 2021). Therefore, to achieve a learning goal, students need to master their mathematical problem solving skills.

Students with the ability to solve a problem, can solve the problem with several efforts as related to the knowledge or understanding previously possessed. Therefore, students can determine the appropriate technique or strategy to solve the problem. According to George Polya (S. M. S. Putri & Putri, 2022) the problem solving step indicators consist of 4 stages, namely the stage of understanding the problem, the stage of making a plan, the stage of carrying out the plan, and the stage of re-examining. Student independence in learning is one aspect that influences students' problem-solving abilities. Independent learning is the ability of students to carry out independent learning through appropriate learning methods to maximize learning outcomes. However, in reality, many students also believe that a subject that is difficult to master and understand is mathematics (Purwasih & Rani Kurnia Putri, 2020). Because of this, student independence in learning is reduced.

Based on the results of the researchers' observations and discussions with the mathematics teacher during the Introductory Field Schooling activities at Wachid Hasyim 5 Surabaya High School, it was found that the 2 classes were different with the same material. Different treatment was given to the two classes. This is based on the difference in problem-solving abilities of each student because the level of independence of students in learning is different. Students who have low independence tend to always want to be explained before working on problems, as well as solving problems that are done in groups. In contrast to students who have high learning independence, these students are able to solve

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problems on their own without the help of friends or teachers. Schunk and Zimmerman (1998) revealed that independent learning is a learning process that occurs when one's thoughts, feelings, strategies, and actions are used to achieve learning goals. Agree with this Ellis, J.M., & Helaire, L.J. (Agustina et al., 2019) also states that learning independence is an ability that encourages students to set learning goals, monitor, regulate, lead and control cognition, motivation, and behavior to achieve learning goals. Therefore, in (Ekadiarsi & Khusna, 2022) study, students with high independence in learning have superior problem-solving abilities compared to students with moderate and low independence in learning.

Based on the description above, the researcher is interested in conducting research entitled "Analysis of Mathematical Problem Solving Ability Viewed From Self-Regulated Learning" with the aim of assessing the mathematical problem solving abilities of SMA Wachid Hasyim 5 Surabaya based on their high, medium, and low learning independence.

2. RESEARCH METHOD

This descriptive qualitative research involved all X IPA 3 SMA Wachid Hasyim 5 Surabaya students who were used as research data sources and three students were selected as research data sources based on low, medium, and high levels of self-regulated learning. To collect research data, a questionnaire test was carried out, a problem solving ability test, and an interview test. The questionnaire given was about learning independence. The test is presented in the form of a problem solving test with descriptive questions. Then data from the results of the questionnaire were taken to group students based on their independent learning and tests were used to assess students' problem solving skills. Data were analyzed in stages including data reduction, data presentation, and drawing conclusions. To assess the accuracy of the data in this study, time triangulation was used.

3. RESULTS AND DISCUSSION

Based on the analysis of the Self-Regulated Learning questionnaire test according to Zimmerman (1989) it was found that out of a total of 36 students in class X IPA 3 there were 6 students having low learning independence, 14 students having moderate learning independence, and 16 students having high learning independence. In this study three subjects were selected for each one student based on the level of self-regulated learning.

Table 1. Data of Three Selected Subjects

Number	Initials Name	Score	Category	Subject Code
1.	MAK	84	High	ST
2.	NPS	69	Moderate	SS
3.	WDN	54	Low	SR

The three selected subjects were given the Mathematical Problem Solving Ability Test twice at different times. After conducting the Mathematical Problem Solving Ability Test, interviews were conducted with three selected subjects to strengthen the results of the problem solving ability test, especially on Rows and Series material.

A. Results

The following are the results of high, medium, and low subject tests on problem-solving ability questions based on Polya Theory.

Table 2. Results of Subject Data Analysis ST

Number	Polya's Problem Solving Stages	Question 1	Question 2
1.	Understanding the Problem	Good	Good
2.	Making a Plan	Good	Good

Number	Polya's Problem Solving Stages	Question 1	Question 2
3.	Carrying out the Plan	Good	Good
4.	Re-Examining	Good	Good

In the first and second tests of problem solving ability (TKPM 1 & TKPM 2), subjects in this category were able to solve them well and were structured according to their mathematical problem solving ability. The ST subject can plan the solution well and can apply it to the problems given in the TKPM Test 1 and TKPM 2. Based on the results of the interview test, the ST subject always feels confident about what he is doing and previously the ST subject has studied the material in rows and rows.

Table 3. Results of Subject Data Analysis SS

Number	Polya's Problem Solving Stages	Question 1	Question 2
1.	Understanding the Problem	Good	Good
2.	Making a Plan	Good	Good
3.	Carrying out the Plan	Less	Less
4.	Re-Examining	Less	Less

In the first and second tests of problem solving abilities (TKPM 1 & TKPM 2), subjects in this category were able to solve the two TKPM test questions well even though there were errors in calculating the final results. SS subjects were able to plan their solutions well and were able to apply them to the problems given in the TKPM1 and TKPM 2 test questions even though there were a few errors such as inaccuracy when calculating number operations, and at the end of the solution they did not write a conclusion. Based on the results of the interview test, SS subjects who were self-reliant in learning were able to explain it again in their own language and already understood the methods or formulas used in the questions, even though when the process was still a little difficult.

Table 4. Results of Subject Data Analysis SR

Number	Polya's Problem Solving Stages	Question 1	Question 2
1.	Understanding the Problem	Good	Good
2.	Making a Plan	Less	Less
3.	Carrying out the Plan	Less	Less
4.	Re-Examining	Less	Less

In the first and second tests of problem solving abilities (TKPM 1 & TKPM 2), subjects in this category were able to solve the two TKPM test questions well even though there were errors in calculating the final results. The SR subject could plan the solution well and be able to apply it to the problems contained in the questions so that the 2 questions on the TKPM 1 and TKPM 2 tests could be solved properly even though there were a few errors such as errors in entering values in formulas, inaccuracies when calculating number operations, and at the end of the settlement they did not write a conclusion. Based on the results of the interview test, subjects with low learning independence were able to explain it again in their own language, but experienced confusion about determining what formula to use, this was because the SR subject did not memorize and rarely reviewed the material provided by the teacher. So that the problem can not be resolved properly.

B. Discussion

The findings obtained by the research data are that from a total of 36 students in class X IPA 3 there are 6 students who have low learning independence, 14 students have moderate learning independence, and 16 students have high learning independence. Students who have high learning independence also have high ability to solve problems because they always feel confident in what they do. In addition, students with high learning independence have shortcomings in terms of interacting with friends. This causes students to tend to be able to solve problems without the help of others. This statement is reinforced by Zimmerman (in Sutikno, 2016) students who have high independence have difficulties when interacting with other students.

As for students who have moderate learning independence, the ability to solve problems is moderate. However, students in the moderate category actually feel confident in what they do. However, sometimes they need help from friends when they find it difficult to solve problems. This is reinforced by research (Ansori & Herdiman, 2019) students who have good enough independence have a tendency to learn independently but when they encounter difficulties these students tend to be silent and ask a few questions to students who understand better.

Students who have low learning independence also have low problem solving skills. Because students in the low category always feel less confident in what they do this is because they do not memorize the formula and rarely review the material that has been given by the teacher. In addition, students with low learning independence tend to dislike or have no interest in learning math. Thus, they always feel the need for help from friends when they find it difficult to solve problems. This is reinforced by research (Etika et al., 2013) that students who have low independence do not have a good response to learning, do not have curiosity and interest in learning, and students with low learning independence always feel less confident in their abilities.

4. CONCLUSION

Based on the findings and discussion, the researcher concluded that the four steps of problem solving for students with high and moderate independence when learning can be fulfilled properly; however, independent students are experiencing difficulties at the stage of carrying out the settlement plan because students are not careful about the results of their calculations. Meanwhile, children with low learning independence meet one of the indications, namely understanding the problem, but are unable to appropriately put down what is learned in the questions, resulting in incorrect calculations.

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Development of an Interactive Website based on Chemo-edutainment using Google Sites on Chemical Bonding Material

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ABSTRACT

The research aims to develop an interactive website based on Chemo-edutainment using Google Sites as a learning medium on chemical bonding material. This research was motivated by students low understanding of the abstract and complex concept of chemical bonds, as well as learning methods that still tend to be monotonous. A chemo-edutainment approach that integrates elements of education and entertainment can make learning more interesting and enjoyable. The research method used is research and development (Research and Develoment) with the Lee and Owens model (Analysis, Design, Development, Implementation, Evaluation). The Research results show that : (1) the website development process is carried out through the stages of needs analysis, media design, interactive content development, and implementation for students; (2) The Validation results from material and media experts show that the website is suitable for use in the "Very good" category, (3) Teacher assessments and student responses to the website show high enthusiasm, the majority of students feel helped in understanding the concept of chemical bonds through this media. Thus, chemo-edutainment based website have proven to be effective in increasing students motivation, interest in learning and understanding of chemical bonding material.

Keywords: Chemo-edutainment, Chemical bond, Google Site

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1. INTRODUCTION

Education is a conscious and planned effort that aims to create a learning atmosphere so that students can actively develop their potential, as regulated in the National Education System Law (UU SISDIKNAS) No. 20 of 2003. One effort to achieve the goal of quality education is to utilize technology, such as the internet, as a supporting learning media. Technology integration aims to form competencies in students' attitudes, knowledge and skills.

The Merdeka Curriculum in Indonesia is designed to improve students' mastery of concepts and competencies through a more diverse intracurricular learning approach, giving students the opportunity to explore the material in more depth. This curriculum also introduces the six main elements in the Pancasila Student Profile, namely faith and piety, global diversity, mutual cooperation, independence, critical reasoning and creativity. These elements are internalized in daily life through school culture, and applied in intracurricular, co-curricular and extracurricular learning. Apart from that, the Merdeka Curriculum also utilizes digital technology to support learning which is expected to create an interesting, safe, fun and memorable learning atmosphere for students (Fildza et al., 2023).

At high school level, chemistry is often considered difficult and less interesting by students, making it one of the less popular subjects(Priliyanti et al., 2021). To overcome this, learning media needs to be designed by integrating elements of entertainment and education to make it more interesting, enjoyable, and able to increase student interest and understanding.

Chemical bonding is one of the important basic concepts in chemistry. However, in practice, many students experience difficulty in learning this material. These difficulties are caused by abstract and complex chemical concepts, so they require in-depth understanding(Sariati et al., 2020). Understanding concepts is one aspect that needs special attention from teachers in the learning process (Miharti et al., 2024). In chemical bonding material, students often face challenges in understanding sub-concepts such as electronic configuration, number of valence electrons, Lewis structures, writing molecular formulas, the tendency of elements towards stability, evaluating compliance with the octet or duplet rule, predicting the formula of the compound formed, and types of bonds based on Lewis structure (Ismail & Alexandro, 2020).

The results of interviews and observations conducted on August 22 2024 with chemistry teachers at Al Falah Islamic High School, Jambi City revealed several problems in the learning process. One of the main problems is students' difficulty in understanding the material, especially the concept of chemical bonds, whose level of understanding only reaches 50-60%. Another influencing factor is students' lack of focus when studying material that involves calculations. Therefore, it is necessary to develop learning media that is able to integrate various concepts in chemical bonding material to facilitate students' understanding. The learning media currently used, such as PPT and textbooks, are still monotonous and only limited to lecture methods, so students tend to be passive and have difficulty learning independently. Even though the facilities and infrastructure in schools, such as focus in each class, are adequate, varied learning techniques are still an obstacle. Al Falah Islamic High School, which has implemented the Independent Curriculum, provides flexibility for teachers and students in carrying out learning that suits their needs and environment, so the development of innovative learning media is very important.

Based on the results of a needs analysis through a questionnaire, as many as 63.3% of Al Falah Islamic High School students in Jambi City stated that they strongly agreed that they had a smartphone, and 53.3% of them often used the internet to study. However, even though access to technology is quite high, 63.3% of students still experience difficulties in understanding chemistry material, especially on the topic of chemical bonds. Some students expressed difficulty in understanding concepts such as Lewis structures, the octet or duplet rule, and the types of bonds in compounds. The majority of students stated that learning media in the form of websites containing text, images, videos and games would really help them in studying chemical bonding material. Apart from that, the students also emphasized that they had never studied chemical bonding material through chemo-edutainment-based websites. As many as 76.7% of students stated the need to develop a chemo-edutainment-based website equipped with games to create more interesting and enjoyable learning. Furthermore, 73.3% of students agreed that an interactive website based on chemo-edutainment on chemical bonding material needed to be developed to help their learning process.

Chemo-edutainment (CET) is an effective chemistry learning method that integrates elements of education and entertainment through learning media. This approach aims to create a pleasant learning experience, according to the principle of edutainment, which combines entertainment and education in one medium (Awang et al., 2022). This game is designed to provide a fun experience for students while helping to achieve learning goals (Sipayung & Purba, 2024). Chemo-edutainment consists of two words, namely "chemo" and "edutainment." The word "chemo" comes from "chemistry," which means chemistry, while "edutainment" refers to the concept of education that is packaged in a fun way in terms of language.(Suryana & Imam Supardi, 2018).In accordance with the Independent Curriculum, a pleasant learning atmosphere is very necessary to support student understanding (Mellyzar, Ratna Unaida, Muliani, 2021). Through Chemo-edutainment, material on chemical bonds which tends to be difficult to understand can be conveyed through educational media that is interesting, interactive and not boring. Technology is one solution to reduce boredom in learning, especially through the efficient application of digital media in space and time(Maulana et al., 2019). Even though it has great potential, the results of interviews with teachers at Al Falah Islamic High School show that a chemo-edutainment-based approach has not been implemented at the school.

A website is an information medium that consists of various components, such as text, images, sound and animation, which are designed to attract attention and encourage visitors to access it (Kurniawan et al., 2020).The website doubles as a promotional tool and source of teaching materials that can be accessed by various parties. Therefore, almost all educational institutions currently have websites as part of their learning strategy (Wiryotinoyo et al., 2020). One platform that is often used to create websites is Google Sites, a free platform from Google that allows users to develop websites according to various needs (Sembung et al., 2022). Google Sites can be used as a learning medium that can be accessed at any time by teachers and students. Based on the results of interviews with teachers at Al Falah Islamic High School, Jambi City, it is known that the Google Sites platform has never been used at the school. However, research by (Wahyudi et al., 2023) shows that using Google Sites as a learning medium can increase students' motivation, interest in learning, and understanding of concepts.

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2. RESEARCH METHOD

The type of research carried out is development research or Research and Development (R&D) which produces products in the form of Chemo-edutainment based interactive websites using Google sites in chemical bonding material. The development model used in this research is the Lee & Owens development model. This model has five stages, namely assessment/analysis which consists of needs analysis and front-end analysis, design, development, implementation, and evaluation. This research was only carried out at the evaluation stage.

1. **Analysis:** At this stage the researcher carried out an analysis of learning problems at Al Falah Islamic High School, Jambi City. There were five analyzes carried out, namely (a) needs analysis, (b) analysis of student characteristics, (c) goal analysis, (d) material analysis, (e) analysis of educational technology.

2. Design: After the analysis stage is complete, the next step is product design. In planning this research, the next step is to create a product design that will be developed into teaching media in the form of an interactive website product based on Chemo-Edutainment using Google Sites, which will be applied to chemical bonding material. The product design plan for developing this media is explained as follows. (a) Team Building, (b) Research Schedule, (c) Media Specifications (d) Structure of Matter, (e) Making Flowcharts (f) Making Storyboards (g) Evaluation.

3. Development: At the development stage, it includes: (a) product manufacturing, (b)Material expert validation, (c) Media expert validation, (d)Teacher assessment.

4. Implementation: At this stage, products that have been improved and declared feasible by a team of experts will be tested on small groups consisting of 10 participants to obtain data about the quality of the learning media. Sample selection was carried out based on recommendations from the chemistry teacher.

5. Evaluation: The evaluation stage was carried out to assess the extent to which the developed Chemo-Edutainment based interactive website succeeded in achieving its objectives and met expectations. The evaluation carried out is in the form of a formative evaluation. The results of the formative evaluation are used as feedback to make improvements.

Data collection techniques in this research include qualitative and quantitative data. Qualitative research aims to understand phenomena in depth through descriptive interpretation and analysis, while quantitative research aims to measure and analyze data statistically (Kholidah, Hidayat, Jamaludin, Leksono & ISSN, 2023).Qualitative data was obtained through observation, interviews with teachers, as well as validation questionnaires from media experts, material experts and teachers, which were equipped with suggestions and input for improving the products being developed. Meanwhile, quantitative data was obtained from assessment scores given by media experts, material experts, teachers, as well as student responses to Chemo-edutainment-based interactive websites using Google Sites on the chemical bond material that will be developed. The instruments used in this research were interviews with chemistry teachers, student needs, validation by media experts and material experts, teacher assessments, and student responses.

After the data is collected, the next step is to carry out an analysis of the assessment results from the initial analysis questionnaire, material expert validation questionnaire, media expert validation questionnaire, teacher assessment questionnaire, and student response questionnaire.

1. Validation Questionnaire for Media Experts, Material Experts and Teacher Assessment

Data analysis carried out on validation questionnaires for media experts, material experts and teacher assessments includes qualitative data in the form of suggestions and comments, as well as quantitative data. For the interval distance on the Likert scale, the following formula is used.

$$Interval\ distance \frac{Highest - Lowest\ score}{Number\ Of\ interval\ classes}\ 100\%$$

Table 1. Validation and teacher assessment criteria

Number	Mean Answer Score	Criteria
1.	>4,2 – 5,0	Very worthy
2.	>3,4 – 4,2	Worthy
3.	>2,6 – 3,4	Not worthy

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4.	>1,8 – 2,6	Not Feasible
5.	>1,0 – 1,8	Very Unworthy

2. Student responses

$$K = \frac{F}{N \times I \times R} \times 100\%$$

Table 2. Criteria for student responses

Number	Percentage	Criteria
1.	81 – 100%	Very good
2.	61 – 80%	Good
3.	41 – 60%	Not good
4.	21 – 40%	Not good
5.	0 – 20%	Very not good

3. RESULTS AND DISCUSSION

A. Analysis

Based on the results of interviews, observations and needs analysis at Al Falah Islamic High School, Jambi City, several main problems were found in learning chemistry, especially chemical bonding material, such as lack of student focus when studying calculation material, low student understanding (50-60%), as well as monotonous learning techniques through PPT media and textbooks, so that students have difficulty learning independently. Adequate facilities and infrastructure, such as focus in each class and the implementation of an independent curriculum, provide opportunities to develop innovative learning media. Based on the questionnaire, 63.3% of students have smartphones, 53.3% often use the internet to study, but 63.3% still find it difficult to understand Lewis structures, octet or duplet rules, and types of chemical bonds. As many as 76.7% of students stated the need for a chemo-edutainment-based website that contains text, images, videos and interactive games to help learning, and 73.3% of students supported the development of this website to make learning more interesting, independent and effective in understanding. abstract concepts on chemical bonding material.

B. Design

After the analysis stage is complete, the next step is product design. In planning this research, the next step is to create a product design that will be developed into teaching media in the form of an interactive website product based on Chemo-Edutainment using Google Sites, which will be applied to chemical bonding material. The resulting product is an interactive website based on Chemo-Edutainment using Google sites which contains a cover, Learning Outcomes (CP), Learning Objectives (TP), Learning Objectives Flow (ATP), Chemical bond material, Videos related to chemical bond material, Games, Evaluation questions and development profile. The appearance of the website being developed can be seen in Figure 1.

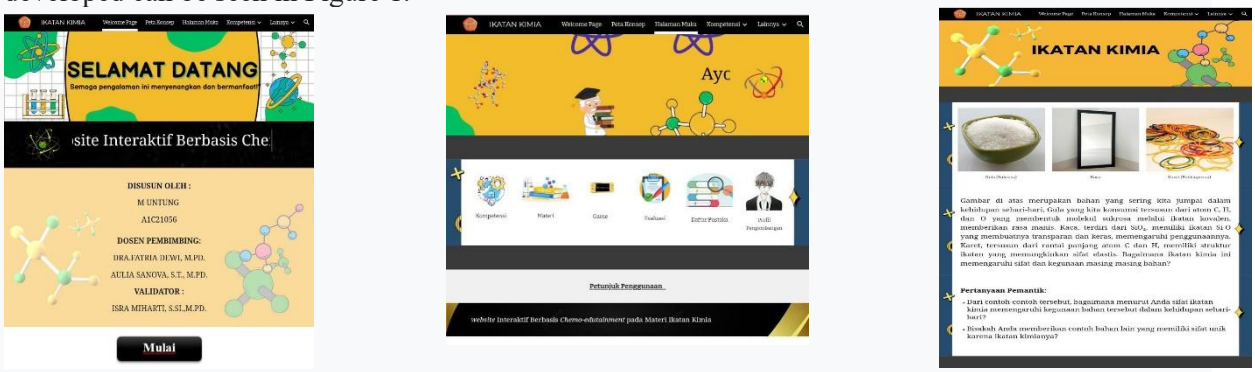

Fig 1. Appearance of the chemo-edutainment based learning website

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C. Development

The products that have been made are then validated by a team of experts, namely material experts and
media experts to find out whether the e-module that has been created is feasible or not conceptually, the product will later be tested. Product those that have been assessed will be revised according to suggestions and comments from the expert team. After validation was carried out and declared suitable for further assessment by the teacher.

Table 3. Material validation results

Amount	**49**
Average	**4,08**
Category	**worthy**

From the validation data by material experts in the table above, it is obtained total score of 49 with an average of 4.08 is in the interval > 3.4-4.2 in the category "Worthy". All suggestions are provided by material experts at the validation stage has been carried out, so from the table above it can be seen that everything is appropriate with what is suggested. This second stage of validation obtained results that the material The teaching developed was declared suitable for testing in the field without repair or revision.

Table 4. Media Validation Results

Amount	**64**
Average	**4,2**
Category	**worthy**

From the validation data by media experts as in the table above, it was obtained a total score of 64 with an average of 4.2 is in the interval > 4.3-5.0 in the category “Very Worth It”. The validation score states that the website is chemo-edutainment based What the developer has done is worthy of being tested in the field.

4. Implementation

Before entering the implementation stage of website product development, First, the developer asks for the subject teacher's assessment and response chemistry on the website that has been created. Teacher assessment is carried out before the product is tested on students small group. At this stage, the developer gives a questionnaire to the chemistry teacher to ask for assessments and suggestions on the website.

Table 3 Data on Assessment Instrument Results and Teacher Responses

Amount	**57**
Average	**4,3**
Category	**worthy**

Based on the results of the teacher assessment instrument, a total score of 57 was obtained an average of 4.3 is in the interval >4.3-5.0 in the "Very Eligible" criteria. Beside Moreover, the teacher also provides general comments and suggestions regarding the product developed, namely an e-module product that is easy to use by students, the material is presented is easy to understand so that it attracts students' interest in learning Can be used as teaching material independently.

Next, students operate chemo-based website productsedutainment, researchers ask students to fill in participant response instruments educate about chemo-edutainment based e-module products that have been developed by filling in the distributed sheet.

Table 4. Small Group Trial Results Data

Total number	**546**

Percentage	**86,3 %**
Criteria	**Very good**

Based on the calculation above, the percentage of all answers is obtained 86.3% of respondents, this value is in the value range 81% - 100%, namely the criteria student response "Very Good". Based on data obtained from both teacher assessment and student responses, it can be concluded that the teaching materials are has been developed to be very interesting and very good at supporting learning on Chemical Bonding material.

4. CONCLUSION

Based on the findings from the development research and discussions regarding the use of a chemo-edutainment-based website for learning Chemical Bonding material, the following conclusions can be drawn:

1. Feasibility and Validation:
   The chemo-edutainment-based website on Chemical Bonding material has been deemed highly suitable for use in educational contexts. This conclusion is supported by validation scores from media and material experts, with an average media expert validation score of 4.2 and an average material expert score of 4.08, placing it in the "Decent" category. These results suggest that the website is a viable and effective open material resource for teaching chemistry, providing an engaging alternative to traditional methods.
2. Teacher and Student Evaluations:
   For the chemo-edutainment-based website on colloidal materials, an average teacher assessment score of 4.3 was recorded. Additionally, the small group trial yielded a positive response, with a percentage of 86.3%, classifying it in the "Very Good" category. These results indicate that the website effectively enhances student understanding and engagement, demonstrating its suitability as a learning tool in chemistry education.

Implications for Education and Research:

The findings highlight the potential of chemo-edutainment as an innovative approach to improve student engagement and comprehension in chemistry. This approach aligns with the growing demand for interactive and technology-based learning media. Future research could explore the following areas:

- Expanding the chemo-edutainment concept to other complex chemistry topics or disciplines.
- Investigating the long-term impact of such tools on student performance and interest in STEM fields.
- Developing more personalized or adaptive features within the website to cater to diverse learning styles and needs.
- Conducting larger-scale trials to validate the effectiveness of the approach across different educational settings.

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Evaluation of Learning in Cognitive, Affective and Psychomotor Aspects in Junior High School

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ABSTRACT

Evaluation in Junior High School plays a crucial role in measuring student achievement across cognitive, affective, and psychomotor aspects. The cognitive aspect pertains to thinking, understanding, and applying knowledge, while the affective aspect involves attitudes, values, and socio-emotional development. The psychomotor aspect evaluates practical skills and abilities. This study employs a qualitative approach, utilizing observation and interviews for data collection and analyzing the findings using the Miles and Huberman method.The results highlight that evaluation serves not only as a measurement tool but also as feedback to enhance learning quality. It underscores the necessity of an evaluation strategy that incorporates diverse methods, recognizing each student's uniqueness and adopting an inclusive and holistic approach. The study concludes that a comprehensive evaluation system supports students' holistic development effectively.The implications of these findings suggest that schools should prioritize implementing evaluation strategies that promote individual growth and inclusivity. This can inform teacher training programs and policy decisions to foster more effective and equitable learning environments.
Keywords: Learning Evaluation, Cognitive, Affective and Psychomotor Aspects

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1. INTRODUCTION

Evaluation is part of the learning process which as a whole cannot be separated from teaching activities, carrying out evaluations carried out in educational activities has a very main meaning, because evaluation is a measuring tool or process to determine the level of achievement of success that students have achieved on the material that has been delivered, so that with the evaluation, the learning objectives will look accurate and convincing.According to Febriana (2019; 1), states that learning evaluation is an ongoing process regarding the collection and interpretation of information, evaluation is used to assess decisions that have been made and materials for designing learning systems. Based on this opinion, evaluation is an ongoing process of collecting information and consuming it.

In the context of the learning system, evaluation constitutes a crucial element and phase of the learning process, whereby the efficacy of the learning can be ascertained. The results obtained can be used as feedback to improve and refine learning programs and activities. Evaluation represents the final stage of the learning process, whereby the success of the learning process can be determined in accordance with the expected goals. Consequently, evaluation is an activity that is of equal importance to the learning process itself. Evaluation encompasses all aspects of learning, including intellectual abilities (cognitive), emotions, attitudes, and behavior (affective), as well as skills (psychomotor).

In the cognitive domain, evaluation is intended to determine the extent to which the knowledge acquired through the learning process aligns with the learning objectives. This pertains to the capacity of students to comprehend, synthesize, and analyze the learning subject provided by the instructor. The affective domain concerns the capacity of students to organize and manage their emotions, attitudes, and behaviors in a learning context. The psychomotor domain concerns the learners' ability to perform perception, guided movements, habitual movements, complex movements, and make adjustments to movement patterns. Additionally, it encompasses the development of creativity.

The objective of this study is to provide a comprehensive understanding of effective evaluation methods, the challenges inherent to the learning evaluation process, and recommendations for

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improvement at this level. This understanding is derived from an appreciation of the significance of learning evaluation.

At the junior high school level, learning evaluation is of significant importance and offers notable benefits. Evaluation is a crucial element in the learning process, as it enables the identification of whether the employed teaching methods are effective or not. In junior high school, learning evaluation is a vital tool for gauging student achievement and enhancing the quality of education. Evaluation techniques, including examinations, assignments, projects, and competency-based assessments, are utilized to assess student comprehension.

In some respects, the aforementioned approach to learning evaluation is further subdivided into multiple levels. With regard to the cognitive aspect, these levels can be delineated as follows: remembering data, understanding, application, analysis (structure or elements), synthesis (creation or construction), and evaluation. Moreover, the affective aspect is comprised of five levels: receiving, responding, giving value, organizing or conceptualizing, and internalizing values. Similarly, the psychomotor aspect is also divided into five levels: imitation, manipulation, precision, articulation, and neutralization.The assessment of cognitive, affective, and psychomotor development plays a pivotal role in the intellectual growth of students. The following are key reasons why evaluation in these three domains merits particular attention at the junior secondary level.

2. RESEARCH METHOD

This study employs a qualitative research methodology for data collection, utilizing observation and interviews as primary techniques. Data collection techniques in qualitative research encompass observation, interviews, and field notes.The data analysis technique employed is in accordance with the analysis method of Miles and Huberman. This method comprises three stages: data reduction, data presentation, and data verification or conclusion making and the essence of the results of the discussion. The data reduction stage aims to simplify the data obtained, while the data presentation stage entails simplifying the data that has been reduced. The final stage, data verification or conclusion making, involves establishing the findings and conclusions based on the data presented.

3. RESULTS AND DISCUSSION

The term "evaluation" in the context of language is derived from the English language, specifically from the word "evaluation," which signifies the estimation or valuation of something. In its broader sense, it encompasses the systematic assessment of the merit and utility of objects. William Wiersma and Stepen G. Jurs define evaluation as a process that incorporates measurement and testing, encompassing concepts related to decision-making based on established standards. As Anas Sudijono notes, evaluation is an activity undertaken to ascertain the value of a given object. Djali and Muljono stress that evaluation is a process of assessing an object based on pre-established criteria, with the objective of making a decision regarding that object. Anthony J. Niko, meanwhile, characterizes evaluation as a process for making decisions about student products and performance.

From some of these definitions, it can be concluded that evaluation is a domain of learning that can be defined as a process used to determine the learning outcomes of learning by measuring and assessing.

The evaluation of learning in the cognitive, affective, and psychomotor domains at the junior secondary education level encompasses a multitude of pertinent elements. It is imperative to commence the discourse by elucidating the rationale behind the assessment of learning in these domains. The objectives may encompass the gauging of students' comprehension of fundamental concepts, the analysis of their critical thinking abilities, or the assessment of the efficacy of pedagogical strategies in attaining learning objectives.

The discussion should include an evaluation of the methods used to assess students' cognitive, affective, and psychomotor aspects. The evaluation methods may include written tests, oral exams, project assignments, portfolios, or a combination of several methods. The selection of evaluation methods should also be based on the purpose of the evaluation and the characteristics of the students to be evaluated. The discussion can include the evaluation design used, such as formative evaluation, which is carried out during the learning process to provide feedback and improvement to students, and

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summative evaluation, which is carried out after learning is complete to provide a final assessment of student understanding.

The cognitive domain encompasses mental activities, such as the capacity to think, understand, apply, analyze, and evaluate. Bloom categorizes the cognitive domain into six categories of increasing complexity, which are arranged in a hierarchical structure. The attainment of a higher level of cognition is contingent upon the completion of the preceding level. The levels are as follows: the first level is remembering, the second level is understanding, the third level is applying, the fourth level is analyzing, the fifth level is evaluating, and the highest level is creating.

In addition, the affective domain pertains to attitudes and values. The field of psychology that deals with attitudes and behaviors is called attitude theory. In English, the term "attitude" is used to describe this concept. In the K13 assessment, this affective domain is divided into two categories: spiritual attitudes and social attitudes. Bloom categorizes the affective domain into five levels, ranging from the lowest to the highest level of ability, as follows: The affective domain encompasses five levels of cognitive development: receiving (awareness), responding (reacting), appreciating (assessing/acting), organizing, and internalizing the value system (adopting behavior). The benefits of the affective domain are twofold: firstly, it improves the achievement of instructional goals by students; secondly, it enhances the level of acceptance, participation, assessment, organization, and internalization. Furthermore, it improves students' attitudes towards correction.

Meanwhile, the psychomotor domain is the domain related to skills or the ability to act after someone receives certain experiences. Psychomotor assessment is carried out in three ways, namely: Direct observation, after the teaching and learning process and some time after the teaching and learning process, in the K13 assessment the psychomotor domain is usually directly proportional to the cognitive domain. Bloom divides the psychomotor domain into 5 levels from the lowest ability to the maximum ability, namely: Copying, Manipulating / re-creating (following orders), Developing accuracy, Articulating (combining, integrating related skills), Naturalization (automatically becoming an expert).

Evaluation of learning in these cognitive, affective and psychomotor aspects should be closely linked to the teaching done by the teacher. The results of the evaluation should be used to inform teaching decision-making, curriculum adjustments and subsequent lesson planning. The discussion may include challenges that will be faced in evaluating learning in cognitive, affective and psychomotor aspects at the junior secondary level, as well as efforts that can be made to improve such evaluations. Challenges may include time constraints, the tendency for assessments to be reproducible or the need for more inclusive and holistic assessments (haryati, 2012).

Evaluation of learning in cognitive aspects at the junior secondary education level must also consider the context and uniqueness of students. The discussion can include contextual evaluation approaches, such as connecting students with individual needs and appreciating the diversity of students' cognitive, affective and psychomotor abilities (Putri, 2022).

Collaboration between teachers and students in learning evaluation can improve the success of the evaluation. The discussion may include collaborative strategies, such as reflective discussions, individual conferences or joint projects that involve teachers and their students in planning, implementing and evaluating the teaching and learning process. Evaluation of learning in cognitive, affective and psychomotor aspects can support competency-based learning approaches that emphasize concept understanding and application in relevant contexts.

The utilization of evaluation as a monitoring tool for the student learning process on a regular basis is a viable approach. The provision of continuous feedback enables teachers to identify students' needs and difficulties in the cognitive, affective, and psychomotor domains. This, in turn, allows them to select appropriate teaching strategies to facilitate students' progress. Collaboration between teachers and parents is also essential for effective learning evaluation. Parents can provide valuable insight and additional information about their children's cognitive, affective, and psychomotor development outside the school environment. This communication enhances the comprehensiveness of learning evaluation, supporting students' cognitive, affective, and psychomotor development holistically.

Furthermore, the evaluation of learning in the cognitive, affective, and psychomotor domains should consider the influence of the learning environment on students' comprehension. Factors such as cleanliness, comfort, and environmental stimulation can impact students' capacity to focus and learn effectively. The discussion may encompass strategies to enhance the learning environment and facilitate more effective learning evaluation.

The findings of this study support previous research emphasizing the importance of learning evaluation as a tool to holistically measure students' achievements in cognitive, affective, and psychomotor aspects. For instance, the study by Attamimi et al. (2023) found that online-based learning evaluation can provide in-depth insights into students' cognitive achievements. This research reinforces the argument that evaluations incorporating Bloom's taxonomy analysis can provide significant feedback to improve learning quality.

Additionally, these findings align with Huljannah's (2021) research, which highlights the necessity of continuous evaluation in elementary education to ensure the development of students' cognitive, affective, and psychomotor aspects. However, this study offers new contributions by emphasizing the importance of inclusive and holistic evaluation strategies within the context of junior secondary education, which previous studies have not thoroughly discussed.

In contrast to Suprihatien et al. (2023), which focused more on comparing synchronous and asynchronous evaluation methods, this study emphasizes the role of the learning environment and collaboration between teachers, students, and parents in supporting learning evaluation. Thus, this research not only supports prior findings but also provides additional perspectives on the importance of a positive and collaborative evaluation context.

An evaluation of learning in cognitive aspects at the junior secondary education level may employ a competency-based approach. The evaluation should encompass not only the mastery of concepts but also the ability of students to apply their knowledge and skills in relevant contexts. This encourages the holistic development of students' cognitive, affective, and psychomotor competencies.

The evaluation of learning in these cognitive, affective, and psychomotor aspects must be conducted in a supportive and positive context. Discussion can facilitate the establishment of an evaluation culture that does not intimidate or frighten students, but instead encourages them to take risks and learn from mistakes. In a fair evaluation, every student is afforded an equal opportunity to demonstrate their cognitive, affective, and psychomotor abilities.

Involvement in the evaluation process facilitates a more comprehensive understanding of the significance of cognitive, affective, and psychomotor aspects of learning. Furthermore, it fosters a collaborative approach to enhance both evaluation and learning.

4. CONCLUSION

The assessment of learning in cognitive, affective, and psychomotor domains at the junior high school level can serve as a pivotal tool for monitoring and assessing student growth and development. Furthermore, it can enhance the overall quality of learning.

In conducting this evaluation, it is essential to consider several key elements. Firstly, the evaluation must encompass a range of cognitive, affective and psychomotor aspects, including critical thinking, creativity and higher-order thinking skills. The evaluation of learning must employ methods and instruments that are in accordance with the multiple intelligences of students, as each student is unique in their thinking and understanding of the various information provided. In order to consider these variations and utilize methods that encompass diverse modes of thinking, evaluation must be conducted in a manner that is fair and impartial. Each student should be afforded an equal opportunity to demonstrate their cognitive, affective, and psychomotor abilities, and the evaluation process must be designed to minimize any potential for bias. A good evaluation will provide insight into student development, can help teachers in planning instruction and encourage holistic cognitive, affective and psychomotor development.

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Development of Student Worksheets with the Context of Local Wisdom in Mathematics Learning

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ABSTRACT

The development of student worksheets ensures that the instructional materials produced are relevant, effective, and suitable for students' learning needs in various educational contexts. This research aims to develop Student Worksheets based on Papuan local wisdom for mathematics learning at MAN Insan Cendekia Sorong. The research method used is R&D with the ADDIE model approach. The study was conducted at MAN Insan Cendekia Sorong involving one educator and 30 students of grade XII IPA. The results show that student worksheets based on local wisdom successfully enhances students' understanding of mathematics. Evaluation regarding practicality indicates that more than 87,5% of teachers and 91,12% of students. They find student worksheets highly practical in its use. In terms of effectiveness, student worksheets achieved an average level of learning completeness of 100%, with students demonstrating increased learning motivation and active participation in the learning process. From a validity perspective, student worksheets is assessed to be aligned with curriculum standards and relevant to the educational needs of mathematics in Papua.

Keywords: Student worksheets, local wisdom, mathematics learning, effectiveness, product development

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1. INTRODUCTION

Based on Law Number. 20 of 2003 concerning the National Education System, learning is a relationship between students, educators and learning resources (RI, 2003). Miarso (2012) argues that learning is a process that is carried out consciously that brings change to a person.

This process aims to support the acquisition of knowledge, knowledge, skills, attitudes, and beliefs in students. According to Gagne, learning involves a series of external events designed to enable, support, and sustain the internal learning process. This approach ensures students can learn effectively through carefully designed external situations (Directorate of Education and Learning, 2019).

According to the experts above, learning in this study is one of the efforts carried out in a conscious and systematic way to create certain conditions in order to realize effective learning so that students can obtain learning goals.

According to the Great Dictionary of Indonesian, mathematics is a science that is related to numbers (Great Dictionary of Indonesian, 2018). Mathematics, according to experts such as Kline, James, Johnson & Rising, and Reys et al., is defined as a discipline that studies logic, mindsets, and solid proof of doubt. As a symbolic language, mathematics provides an appropriate way to express ideas and organized structures.

With a focus on patterns, relationships, and order, mathematics helps individuals understand and explore truth in various aspects of life. Mathematics is not only about numbers and formulas, but it is also the basis that allows individuals to master social, economic, and natural aspects, broaden their horizons, and facilitate wise decision-making in various fields (Aspia, 2021). At its core, mathematics is an essential means that allows individuals to better understand the world.

According to Susanto (2016), mathematics learning involves a teaching and learning process designed by teachers to stimulate students' creativity in thinking and improve their ability to construct new knowledge to gain a deep understanding of mathematics material. Meanwhile, Hamzah and Muhlisrarini (2016) revealed that mathematics learning is an effort to build students' understanding of facts, concepts, principles, and skills conveyed by teachers or lecturers, with students constructing their own understanding based on their respective potentials and ability to solve problems.

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Based on the experts' understanding of learning and mathematics as previously described, it can be said that mathematics learning is a process of structured interaction between students, teachers, and learning resources in an educational environment. The goal is to strengthen students' mastery of knowledge, skills, and attitudes by associating mathematics with daily life. Mathematics, as the study of logic and mindset, helps to articulate ideas and structures systematically. In addition to numbers and formulas, mathematics is also important in social, economic, and environmental understanding, as well as in supporting thoughtful decision-making.

Contextual learning in mathematics has been shown to be effective in helping students master complex mathematical concepts. This method allows students to relate the subject matter to their daily lives, so they can more easily understand basic operations such as addition, subtraction, multiplication, and division (Arifin et al., 2020; Fahyuni et al., 2020). Taking into account students' thinking abilities, the contextual learning approach offers a more meaningful and immersive learning experience, especially in mathematics.

Contextual-based mathematics education allows students to gain a deeper understanding by relating learning materials to real-life situations. According to Rahmah (2021), this approach has characteristics such as deep understanding, increased knowledge, application in daily life, and providing feedback to students. In addition, there are seven important steps in contextual learning, namely constructivism, inquiry, questioning, group work, modeling, reflection, and assessment that are appropriate to the real context.

In education, constructivism emphasizes the importance of students actively building their knowledge through interaction with the surrounding environment. The inquiry approach encourages students to do independent exploration, while the questioning activity helps them think more deeply. The learning community emphasizes cooperation between students and teachers, while modeling provides examples of expected behaviors. Reflection facilitates deeper understanding, and authentic assessments evaluate students' skills through tasks that mirror real-world situations. All of these elements form a comprehensive learning environment for student development (Sugrah, 2019).

Contextual learning in mathematics has been shown to be effective in helping students master complex concepts. By connecting the subject matter to everyday life, this approach allows for a deeper understanding. Steps such as constructivism, inquiry, and modeling also play a role in creating a more meaningful learning experience. This significantly increases students' understanding and interest in Mathematics subjects.

The theory of the development of mathematics learning materials (Student Worksheet) is a structure designed to compile and develop mathematics teaching materials in a structured manner. Student worksheets aim to make it easier for students to understand mathematical concepts through presentations, exercises provided, and evaluative assessments (Faiq, 2023).

Student worksheets are learning materials in the form of sheets that contain brief learning materials and tasks that will be done by students (Koerniawati, 2020). Student worksheets also mean learning materials that contain instructions for activities that will be carried out by students so that they can achieve the competency goals that have been designed (Triana, 2021).

A student worksheet is a printed educational material designed to guide students in developing their abilities. The process of preparing student worksheets involves several steps, such as analyzing the curriculum, designing a map of student worksheet needs, determining titles, formulating basic competencies, selecting assessment tools, and compiling the structure of student worksheets. The implementation of the 2013 Curriculum revised version in 2017 encourages the improvement of the learning process by focusing on improving character education, literacy, 21st century skills, and Higher Order Thinking Skills (HOTS) (Rahmawati and Wulandari, 2020).

As explained above, so we can conclude that a student worksheet is a learning material made by educators to their students for the sustainability of the teaching and learning process in accordance with the achievement of competencies to be achieved.

Local wisdom is knowledge, habits, practices, and values that have accumulated and developed in the local community over the years. It covers cultural traditions, agricultural practices, traditional medicine methods, ecological knowledge systems, and various other aspects of local people's lives.

Local wisdom refers to the philosophy of life and wisdom values that are embedded in the local culture of a community. It involves knowledge, practices, and beliefs that are passed down from generation to generation. The characteristics of local wisdom include proven experiences throughout

the centuries, adaptability to changing times, integration with daily life, commonly used, dynamic, and closely related to the community's belief system (Sholeha, 2024).

Overall, local wisdom plays an important role in maintaining the cultural heritage and identity of a community. It is important to continue to maintain and strengthen this wisdom so that it is not eroded in the era of globalization and modernization that continues to develop. By linking local wisdom to mathematics learning, students can develop a deeper understanding of the relevance of mathematics in everyday life and how mathematical concepts apply solutions to real challenges in their cultural and environmental contexts.

The benefits of local wisdom vary, including nature preservation, individual development, cultural and knowledge advancement, and moral and ethical guidelines. However, efforts to develop and maintain local wisdom are faced with challenges such as the influence of globalization that threatens traditional values, lack of conformity with modern logic, time-consuming processes for implementation, lack of consistent support from governments, and sometimes religious interpretations that hinder traditional practices (Sholeha, 2024).

Local wisdom in Papua encompasses various aspects of culture, traditions, and knowledge that are passed down from one generation to the next by local indigenous peoples. More than 250 tribes in the region retain their unique languages, traditions, and customs (Choliq, 2020).

Papuan local wisdom includes various cultural aspects such as Honai and Kariwari traditional houses, Asmat wood carving art, traditional tifa musical instruments, and traditional noken bags. Honai, a traditional house of the Dani tribe, has a circular base shape with a conical roof made of straw, while Kariwari, a traditional house of the Tobati-Enggros tribe, is in the shape of an octagonal five. The art of Asmat wood carving depicts daily life and the surrounding nature, while tifa has deep cultural value as a traditional musical instrument. Noken, a bag made of bark fiber, also plays an important role as a symbol of Papuan life and culture (Rustam, 2023).

Overall, local Papuan wisdom makes an important contribution to Indonesia's national identity, enriching the concept of "*Bhinneka Tunggal Ika*" with its cultural diversity.

Mathematics learning in schools still has low learning outcomes. Every student in the regions of Indonesia has their own local habits or wisdom, while the learning that is made still contains local wisdom found in certain regions. So that teachers must be able to make a more effective learning student worksheets for the needs of students. Based on the description above, it is necessary to conduct a study on **"DEVELOPMENT OF STUDENT WORKSHEETS WITH THE CONTEXT OF LOCAL WISDOM IN MATHEMATICS LEARNING"**.

2. RESEARCH METHOD

The type of research used in this study is R&D (Research Development). According to (Sugiyono, 2008) Research Development (R&D) is a research method that produces outputs. This planned development model follows the ADDIE (analys, design, development, implementation, evaluation) rules developed by Branch (2009) in Sugiyono (2016).

The following is the flow of ADDIE:

1) Analysis stage: In this first stage, the researcher observes and analyzes the problems found in the research site from the results of the analysis;
2) Design stage: In the second stage, the researcher makes a learning tool design in the form of student worksheets that contains local wisdom to be used in the learning process;
3) Develop stage: In the third stage, the researcher describes the results of the development of the student worksheets design or design in the context of local wisdom and evaluates the results of validation and testing in limited tests and wide trials so that they can find out whether the development product is worthy of testing or not;
4) Implementation stage: In this fourth stage, the results of the research that have been evaluated in the form of student worksheets that are ready to be used and applied to the research site;
5) Evaluation stage: At this stage is a follow-up stage if the application of the development product has a positive impact on mathematics learning.

This research product is designed, developed and validated by experts. So that the product is ready to be tested to students. The test subjects of this study were carried out in class XII IPA MAN IC, Sorong Regency. In this study, 1 educator was taken as a respondent, 10 students for a small-scale trial

by conducting learning activities using the student worksheets developed, giving questions, and seeing the students' responses. For large-scale trials, the number of students was taken by 20 students, by conducting learning activities using the student worksheets developed, providing questions, seeing student responses, and analyzing the results of the trial. Students and educators who are in charge of being respondents will be given student worksheets based on local wisdom that has been developed, then respondents are given the opportunity to ask about student worksheets based on local wisdom. Then respondents were directed to fill out a questionnaire to find out the response of students and educators to the student worksheets based on local wisdom that has been developed.

Data collection techniques are the methods that can be used in collecting data. Based on the problem studied, there are three data collection techniques used in this study, namely questionnaire, observation and assessment.

The questionnaire was used to collect data from students and teachers about their views on the practicality and effectiveness of the student worksheets that has been developed. This questionnaire was created to obtain more structured and quantitative feedback on their experience using the student worksheets. The questions in the questionnaire cover various aspects, such as ease of use, relevance of the content, and its influence on students' understanding and motivation to learn. The data collected from the questionnaire was analyzed quantitatively to provide a clearer picture of the effectiveness of the student worksheets.

Observations were carried out during product trials, the data from the observations were analyzed quantitatively. This is because at the first and second meetings, students' independent learning activities both in the classroom and outside the classroom can be observed. Observation of students' activities outside the classroom is reviewed from the collection of assignments and quizzes and their activities of discussing either with the teacher or with fellow students through the space provided (through the comment column of a question given by the teacher).

The assessment was carried out with a quiz, this was carried out to obtain data on student learning outcomes after learning using student worksheets products for mathematics learning based on local wisdom. The quiz was carried out after students carried out learning using the mathematics learning student worksheets product developed by the researcher.

The data analysis techniques used in this study are qualitative and quantitative. The following is a description of the data analysis techniques used in this development research: Qualitative data was obtained from the results of the questionnaire. The questionnaire is filled out by students after learning with the teacher to obtain more in-depth evaluation results. The results of the questionnaire are analyzed qualitatively and then a conclusion is drawn to see the practicality of the product developed.

1) Validity

The relevance of the two experts as a whole is a validation of Gregory's content. Furthermore, the reliability value will be determined in the form of a consistent coefficient of the content item (content reality) in the following way.

$$vi = \frac{d}{a + b + c + d} \times 100$$

The following is an agreement between assessors for content validation:

Table 1. Agreement model between two experts

		Validator 1	
		Less relevant Score 1-2	Highly relevant Score 3-4
Validator 2	Less relevant Scores1-2	A	B
	Highly relevant Score 3-4	C	D

Description:
vi = Validation of the content construct
A = Both validators disagree
B = Validator 1 agrees, Validator 2 disagrees
C = Validator 1 disagrees, Validator 2 agrees
D = Both validators agree

The Gregory agreement model used with the criteria of the assessment results of the two validators is at least of strong relevance. If the result of the consistency coefficient of this content (Rg> 75%) then it can be stated that the results provided by the validator team have a strong assumption of consistency.

2) Practicality analysis
Measuring the practicality and effectiveness of the mathematics learning student worksheets involves collecting data on how well the student worksheets functions in the desired learning context. Here are some steps that can be taken to measure the practicality and effectiveness of the mathematics learning student worksheets:

- Direct observation: observing how teachers and students interact with the student worksheets in the classroom. Pay attention to whether the student worksheets is easy for teachers to understand and use, as well as how well students respond to it.
- Questionnaire: ask questions to teachers and students about their experience using the student worksheets. Ask them if they find the student worksheets practical and easy to use.

This practicality analysis, of course, must meet the practicality criteria. The following are some criteria for practicality according to (Sugiyono, 2018):

$81\% \leq P$: Very practical

$61\% \leq P \leq 80\%$: Practical

$41\% \leq P \leq 60\%$: Quite practical

$21\% \leq P \leq 40\%$: Less practical

$P < 21\%$: Impractical

3) Effectiveness analysis
Analysis of the effectiveness of students' learning materials after obtaining student worksheets learning based on local wisdom is complete. It is said to be effective if 70% of all subjects of this study meet the learning completeness. Calculate the presentation of the completeness of the student test using the formula:

$$\boldsymbol{Completion\ Percentage(x) = \frac{Many\ students\ completed}{Number\ of\ students} \times 100}$$

The following are the steps to analyze the effectiveness: 1) give an answer score on each answer item obtained by students based on the assessment rubric that has been made; 2) summing up the scores obtained by students; 3) calculate the grades obtained by each student; 4) Calculate the percentage of student test completion, using formulas; 5) categorize the percentage of completeness with the interval of the completeness criteria of the student learning outcome test results as follows (Widoyoko, 2009):

Table 2. Criteria for the Completeness of Learning Test Results

Presentation of completeness	Category
80 % ≤ P	Very Effective
70% ≤ P < 80%	Effective
50 % ≤ P < 70%	Quite Effective
P <50%	Less Effective

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Description: P = Student completeness presentation

Based on the effectiveness analysis above, the resulting learning student worksheets is said to be effective if the completeness of the student learning outcome test meets the minimum effective criteria.

3. RESULTS AND DISCUSSION

A. Research Results

Before the research instruments are used, all instruments will be validated by experts starting from observation sheets, teacher questionnaire sheets, student questionnaire sheets, student worksheets with the context of local wisdom, and quiz questions. There are 4 validators used in the development including 3 UNIMUDA lecturers and 1 teacher at MAN Insan Cendekia Sorong, namely, expert lecturer 1, expert lecturer 2, expert lecturer 3, and expert teacher 1. The results of the validation that have been carried out by several experts are declared valid with revision and valid without revision, and the instrument has been revised by the researcher in accordance with the validator's records and is suitable for use in the study. This validation uses Gregory's calculations. The following is a table of instrument validation results from experts:

Table 3. Observation Validation Results

No	Validator 1	Validator 2	Cross-tabulation
1.	4	4	D
2.	4	4	D
3.	4	3	D
4.	4	4	D
5.	4	3	D
6.	4	4	D

$$vi = \frac{d}{a+b+c+d} \times 100$$

$$\text{VI} = \frac{6}{0+0+0+6} = 1$$

Table 4. Student Worksheets Validation Results with the Context of Local Wisdom

No	Validator 1	Validator 2	Cross-tabulation
1.	3	4	D
2.	3	4	D
3.	3	4	D
4.	3	3	D
5.	3	3	D
6.	3	4	D
7.	3	4	D
8.	4	4	D
9.	4	4	D
10.	4	3	D
11.	3	4	D
12.	3	4	D
13.	3	4	D
14.	4	4	D
15.	4	4	D
16.	4	4	D

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$$\text{VI} = \frac{16}{0+0+0+16} = 1$$

Table 5. Results of Validation of Learning Questionnaires in the Classroom

No	Validator 1	Validator 2	Cross-tabulation
1.	4	4	D
2.	4	4	D
3.	4	4	D
4.	3	4	D
5.	3	3	D
6.	3	3	D
7.	3	3	D
8.	3	4	D

$$\text{VI} = \frac{8}{0+0+0+8} = 1$$

Table 6. Quiz Question Validation Results

No	Validator 1	Validator 2	Cross-tabulation
1.	4	4	D
2.	4	3	D
3.	4	4	D
4.	4	4	D
5.	4	4	D
6.	4	4	D
7.	4	3	D
8.	4	3	D
9.	3	3	D
10.	3	4	D
11.	3	4	D
12.	3	3	D
13.	3	4	D
14.	3	4	D
15.	4	4	D
16.	4	4	D

$$\text{VI} = \frac{16}{0+0+0+16} = 1$$

The results of the cross-tabulation above obtained the assessment results of the two validators using the formulation of Gregory with a value of 1. So that the criteria obtained, namely "Very Valid", therefore all instruments that have been made by the researcher can be used in research.

After the student worksheets with the context of local wisdom is ready to be developed, then the researcher conducts a trial stage. The first trial stage is a small-scale trial with a total of 10 students. In the first trial stage, student worksheets was piloted in small groups to identify and correct initial deficiencies and get direct feedback from students regarding the suitability and clarity of the material. After being revised based on the results of a small-scale trial, the student worksheets was then piloted in a larger group to observe its effectiveness in a more diverse environment and ensure its feasibility of use in various learning contexts. The following are the results of a small-scale trial on students:

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Table 7. Small-Scale Trial Result Score

No	Student's Name	Score	Description
1.	SK 1	62,5	Incomplete
2.	SK 2	87,5	Complete
3.	SK 3	100	Complete
4.	SK 4	75	Complete
5.	SK 5	87,5	Complete
6.	SK 6	100	Complete
7.	SK 7	75	Complete
8.	SK 8	62,5	Incomplete
9.	SK 9	75	Complete
10.	SK 10	87,5	Complete

$$x = \frac{\text{Many students who completed}}{\text{Number of students}} \times 100$$
$$x = \frac{8}{10} \times 100 = 80\%$$

In this large-scale trial, the researcher used students of class XII MAN IC Sorong. In this large-scale trial, students get 100% completeness scores. The following is the data on the value of the large-scale trial:

Table 8. Large-Scale Trial Results Value

No	Student's Name	Score	Description
1.	SB 1	100	Complete
2.	SB 2	100	Complete
3.	SB 3	100	Complete
4.	SB 4	100	Complete
5.	SB 5	100	Complete
6.	SB 6	100	Complete
7.	SB 7	100	Complete
8.	SB 8	87,5	Complete
9.	SB 9	87,5	Complete
10.	SB 10	87,5	Complete
11.	SB 11	87,5	Complete
12.	SB 12	87,5	Complete
13.	SB 13	100	Complete
14.	SB 14	87,5	Complete
15.	SB 15	87,5	Complete
16.	SB 16	87,5	Complete
17.	SB 17	87,5	Complete
18.	SB 18	100	Complete
19.	SB 19	87,5	Complete
20.	SB 20	100	Complete

$$x = \frac{\text{Many students who completed}}{\text{Number of students}} \times 100$$
$$x = \frac{20}{20} \times 100 = 100\%$$

The practicality test in this study was carried out to test the level of practicality of the teaching materials developed, namely in the form of student worksheets in the context of local wisdom. This

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practicality test uses a questionnaire instrument whose responses come from educators and students. The following are the results of filling out questionnaires from educators:

Table 9. Questionnaire Results by Educators

No	Indicators	Score
1.	The suitability of materials and activities in student worksheets based on local wisdom with the needs of students is appropriate	3
2.	The material in the student worksheets is based on local wisdom in accordance with KI-KD	3
3.	Materials in student worksheets with the context of local wisdom in accordance with indicators and learning objectives	3
4.	The material presented in the student worksheets is easy to understand and systematic	3
5.	Student worksheets with the context of local wisdom makes it easier for students to understand learning materials to build a space	4
6.	The use of spelling, words, and sentences, is precise, clear and easy to understand	4
7.	The clarity of the instructions for the use of student worksheets is in accordance	4
8.	The display of the student worksheets presented is attractive and innovative	4
9.	The language used is in accordance with the rules of the Indonesian language	3
10.	Student worksheets with the context of local wisdom helps students in remembering the material that has been given by the teacher	4
Number of Respondents		**1**
Total Score		**35**
Maximum Score		**40**
Score Percentage		**87,5**
Criterion		**Very Practical**

The results of the practicality test for educators received a score of 87.5%. This gets a classification with the criteria obtained, namely, "Very Practical". In addition, the results of filling out the questionnaire by students, as follows:

Table 10. Practical Test Results by Students

No	Indicators	Score
1.	The drawings presented in the student worksheets can add to my understanding and provide convenience for me regarding the building materials of the space	72
2.	I have no difficulty in doing student worksheets because the material is relevant to daily life	71
3.	I had no difficulty in doing the student worksheets because the material was clear and easy to understand	72
4.	The instruction helped me understand math concepts well	69
5.	I prefer to learn with student worksheets media based on local wisdom rather than just listening to the teacher's explanation	74
6.	The display presented caught my attention	76

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7.	Using simple language	77
8.	The display presented is attractive and innovative	76
9.	The instructions helped me in completing the task smoothly	67
10.	I feel motivated because student worksheets connects mathematics with daily life and makes me actively involved in learning	75
Number of Respondents		**20**
Total Score		**729**
Maximum Score		**800**
Score Percentage		**91,12%**
Criterion		**Very Practical**

The results of the practicality test for students received a score of 91.12%. So that the classification obtained is based on the criteria obtained, namely, "Very Practical".

Student worksheets which has gone through the validation and revision process has been introduced in learning in class XII Science at MAN Insan Cendekia Sorong during two meetings. During the meeting, this student worksheets was actively used in the mathematics learning process in the classroom. Both students and teachers are given the opportunity to take advantage of this customized material to improve their understanding of the mathematical concepts taught. In addition, with the same learning methods that have been used by educators, various aspects of the student worksheets are observed and evaluated to assess its effectiveness in improving student learning and ensure that the quality is in accordance with the needs of class XII Science at MAN Insan Cendekia Sorong. To test the effectiveness of this, a test in the form of a quiz question of 2 numbers was used. The following are the results of the student assessment test:

Table 11. Student Effectiveness Test Results

No	Student's Name	Score	Description
1	K 1	87,5	Complete
2	K 2	75	Complete
3	K 3	87,5	Complete
4	K 4	75	Complete
5	K 5	87,5	Complete
6	K 6	87,5	Complete
7	K 7	87,5	Complete
8	K 8	100	Complete
9	K 9	87,5	Complete
10	K 10	87,5	Complete
11	K 11	87,5	Complete
12	K 12	100	Complete
13	K 13	100	Complete
14	K 14	100	Complete
15	K 15	87,5	Complete
16	K 16	100	Complete
17	K 17	87,5	Complete
18	K 18	87,5	Complete
19	K 19	87,5	Complete
20	K 20	100	Complete

$$(x) = \frac{\text{Many students who completed}}{\text{Number of students}} \times 100$$

$$(x) = \frac{20}{20} \times 100 = 100\%$$

Based on the results of the student test, 100% completeness data was obtained so that the criteria achieved in the teaching materials in the form of student worksheets based on local wisdom were "Very Effective".

B. Discussion

This research aims to develop a Student Worksheet with the context of local Papuan wisdom in mathematics learning at MAN Insan Cendekia Sorong. The results in this study show that student worksheets with the context of local wisdom has succeeded in increasing students' understanding of mathematics material. The evaluation in terms of practicality showed 87.5% by teachers and 91.12% by students. So that students and teachers feel that this student worksheets is very practical in its use. In terms of effectiveness, student worksheets managed to achieve an average level of completeness of learning outcomes of 100%, with students showing increased learning motivation and being active in the learning process. The same thing is also in accordance with the opinion in previous research, that developing student worksheets in the context of local wisdom can increase students' interest and enthusiasm for learning mathematics, as well as improve students' learning outcomes and understanding of mathematics material (Musabihatul Kudsiah, 2022).

According to Yuniasih (2021), learning using student worksheets on students in the classroom can increase understanding and improve students' learning outcomes in learning. To realize appropriate learning, it is necessary to develop a learning tool, one of which is realized through the development of student worksheets in the context of local wisdom. The same thing is also in accordance with the opinion in the previous study, that the development of student worksheets can bring a new atmosphere in learning in the classroom to be more interesting. So that students' understanding and learning outcomes can increase (Muhammad Firdaus, 2018). In the 2013 curriculum, the government has prepared learning tools, one of which is student worksheets. Students understand learning more easily if the material is associated with the surrounding environment. The development of student worksheets in the context of local wisdom is expected to be a solution to facilitate students in learning activities in the classroom and can increase students' understanding of learning. This is similar to previous research, that by developing student worksheets, students are able to solve everyday problems. With the existence of student worksheets in the context of local wisdom, students not only learn about the material in learning, but also learn about the local culture around them (Sakdiyah & Annizar, 2021). Thus, in this study, the development of student worksheets with the context of local wisdom in mathematics learning was declared valid, effective, and practical.

4. CONCLUSION

The results of the research that have been conducted show that the development of student worksheets with the context of local wisdom in mathematics learning has succeeded in improving student learning outcomes towards the mathematical concepts taught. Evaluation in terms of practicality showed 87.5% by teachers and 91.12% by students. So that students and teachers feel that this student worksheets is very practical in its use. In terms of effectiveness, student worksheets managed to achieve an average level of completeness of learning outcomes of 100%, with students showing increased learning motivation and being active in the learning process. Thus, the development of student worksheets in the context of local wisdom in mathematics learning is declared valid, effective, and practical.

Teachers and students view these student worksheets as practical tools, showing that they can be used efficiently and effectively in the teaching and learning process in schools. Evaluation of learning outcomes showed that student worksheets succeeded in improving students' understanding of mathematics material. Students also demonstrate increased motivation to learn, active involvement in discussions, and the ability to apply mathematical concepts in everyday life. The average level of completeness of student learning outcomes reached 100%, indicating that student worksheets are effective in helping students achieve the expected understanding of mathematical material.

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Integrating Communication Strategies in Mathematics Education: A Qualitative Study in Medan, Indonesia

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ABSTRACT

This qualitative research investigates the integration of communication studies into mathematics education in Medan, Indonesia, focusing on the impact of interdisciplinary teaching strategies on student engagement teaching strategies on student engagement and understanding. Through semi-structured interviews and classroom observations, the study examines how mathematics educators in secondary schools incorporate communication techniques, such as visual aids, storytelling, and collaborative learning, to improve students' comprehension of mathematical concepts. The results highlight that integrating communication skill not only enhances students' mathematical literacy but also fosters critical thinking, problem-solving, and teamwork. The findings suggest that such interdisciplinary approaches are especially effective in Medan's diverse cultural and linguistic environment, offering a model for educational reform in Indonesia and similar multicultural contexts

Keywords: Communication studies, mathematics education, interdisciplinary learning, student engagement, Medan

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1. INTRODUCTION

The integration of communication strategies in mathematics education has garnered increasing attention as educators recognize the role of effective communication in facilitating student learning. Mathematics, often perceived as abstract and complex, poses challenges for students, particularly when traditional teaching methods prioritize rote memorization over conceptual understanding.

This issue is amplified in diverse educational setting such as Medan, Indonesia, where come from various cultural, linguistic, and socio-economic backgrounds. Despite the critical role of communication in teaching and learning, there is a significant gap in research exploring how communication strategies can be effectively incorporated into mathematics education to address these challenges.

Studies indicate that Indonesian students often underperform in mathematics compared to their international peers. According to the 2018 Programs for International Student Assessment (PISA), Indonesian students ranked below average in mathematics proficiency. This compounded by finding that suggest a lack of engagement and interest in the subject, particularly among secondary school student. In Medan, a multicultural city, these challenges are further exacerbated by linguistic diversity and varying levels of access to quality education.

While existing research highlights the importance of communication in education, few studies have examined its application in mathematic teaching within culturally diverse settings like Medan. Most studies focus on either communication in general education or the use of technology in mathematics education, leaving a gap in understanding how communication strategies can directly enhance student outcomes in mathematics. Moreover, while interdisciplinary teaching methods are gaining traction globally, their practical application in Indonesia classrooms remains underexplored.

In practice, mathematics teaching in Medan largely relies on traditional methods such as lectures and individual problem-solving tasks. These approaches often fail to engage students or address their unique learning needs. Teachers and reduced student confidence. On the other hand, innovative practice such as group discussions, storytelling, and visual aids have shown promise in proving student engagement and comprehension, though their implementation remains limited and inconsistent.

In today's globalized educational environment, interdisciplinary teaching approaches are becoming essential for promoting holistic learning. Particularly in diverse regions such as Medan,

Indonesia, where multiple cultures and languages coexist, there is an increasing need to explore how different disciplines can be integrated to enhance student understanding and engagement.

Communication skills are integral to learning and teaching across subjects, but their role in mathematics education is often overlooked. The present study seeks to fill this gap by exploring how mathematics educators in Medan incorporate communication strategies to improve the teaching and learning process. This research also aims to assess how such practices contribute to students' engagement with and understanding of mathematical concept.

The role of communication in education has been widely acknowledged in constructivist learning theories, particularly in promoting active learning and critical thinking (Vygotsky, 1978). In the context of mathematics education, research suggests that student often struggle with understanding abstract concepts, especially when they are not able to communicate their thought processes effectively (Adams et al., 2018).

Studies have also demonstrated that when mathematical problems are contextualized with real-world examples or visual representations, student are more likely to engage with the material (Miller & Garcia, 2020). Furthermore, interdisciplinary education has been shown to enhance collaboration and foster a deeper understanding of concepts across different field (Johnson et, 2021). Despite these findings, there is limited research exploring how educators in Medan apply these strategies, making this study particularly relevant to the region's educational needs.

In Medan, the integration of communication strategies in mathematics education is a relatively new concept. Many teachers still rely on traditional methods, such as lecture-based instruction and rote memorization. However with the growing emphasis on student-centered learning and the need to prepare students for a globalized world, educators in Medan are increasingly exploring innovative methods to engage students and foster deeper learning. This study seeks to understand how communication strategies are being implemented in the teaching of mathematics in Medan and their effect on learning outcome.

In summary, this study addresses the gap in existing research by examining the role of communication strategies in mathematics education within the unique context of Medan. By bridging the divide between theory and practice, it aims to provide insights into how educators can enhance student learning outcomes through innovative, interdisciplinary approaches.

2. RESEARCH METHOD

This research adopts a qualitative methodology to provide a comprehensive understanding of how communication strategies are integrated into mathematic education in Medan, Indonesia. The study was conducted in three secondary schools in Medan, with a focus on both public and private institutions. The following methods were used to collect data:

1. Participants: Ten mathematics educators from secondary schools in Medan participated in the study. These educators were selected based on their teaching experiences and willingness to engage in the research. This teachers varied in terms of age, teaching experience, and professional background, which provided a diverse range of perspectives on the integrations of communication in mathematics education.
2. Data Collection:

(a) Semi-structured Interviews: In-depth, semi-structured interviews were conducted with each educator to explore their experiences with incorporating communication strategies into their mathematics lessons. The interviews focused on the types of communication techniques they used, their perceptions of the effectiveness of these methods, and the challenges they faced

(b) Classroom Observation: Observations of mathematics lessons were conducted to document the teaching practices in action. These observations allowed the researchers to gain insight into how communication strategies were used in the classroom, including visual aids, storytelling, group work, and peer discussions.

3. Data Analysis: The data collected from interviews, observations, and documents were analyzed using thematic analyzed using thematic analysis (Braun & Clarke, 2006). This method involved identifying key themes and pattern in the data related to teaching strategies, student engagement, and the integration of communication in mathematics education

3. RESULTS AND DISCUSSION

A. Results

1. Improved Student Engagement: Educators reported that using communication strategies such as storytelling strategies such as storytelling and real-life examples made mathematics lessons more engaging for students. By contextualizing abstract concepts in term familiar to students, such as local customs or everyday experiences, teachers were able to make the content more relatable and easier to understand. Many students expressed greater interest in the subject, particularly when the lessons connected mathematical concept to practical applications in their lives.
2. Increased Comprehension and Retention: Visual aids and group discussions were freguently used in classroom to facilitate understanding. Teachers noted that when students worked in groups to solve problems and discuss mathematical concepts, they not only grasped the material more effectively but also developed communication skills. The process of explaining their thinking to peers helped solidify their own understanding of the concept.
3. Echanced Critical Thinking and Problem-Solving: The integration of communication strategies fostered critical thinking and problem-solving abilities. Educators noted that students became more adept at discussing mathematical concept, asking questions, and offering alternative solutions. These skills were especially valuable when students were encouraged to collaborate and engage in discussions that required them to justify their reasoning and think critically about their solutions.
4. Challenges in Implementation: Despite the positive outcomes, several challenges emerged in implementing communication-based strategies. Teachers mentioned time constraints, large class size, and a lack of resources as barriers to fully integrating communication techniques. In some cases, teachers felt that they needed more professional development to effectively use these strategies in their classrooms.

B. Discussion

These findings are consistent with the broader educational literature, which emphasizes the importance of communication in learning (Adam et al., 2018; Johnson et al., 2012). In particular, the use of communication techniques like storytelling, visual aids, and peer discussions can bridge the gap between abstract mathematical concepts and students' lived experiences. By contextualizing mathematical problems in culturally relevant ways, teachers in Medan were able to make the material more relatable and engaging for students from diverse linguistic and cultural backgrounds.

The positive influence on student engagement aligns with Vygotsky's (1978) social constructivist theory, which asserts that learning is most effective when students can connect new knowledge to their existing experiences. In this study, teachers utilized culturally specific examples, local stories, and real-life applications to make mathematical concepts more accessible.

This approach appears to be particularly valuable in Medan, where the student population is heterogeneous in terms of language, culture, and socio-economic background.

Such culturally responsive teaching techniques not only help demystify abstract concepts but also foster a sense of belonging among students, which can increase motivation and participation.

Furthermore, the use of visual aids and group discussions enhanced student comprehension and retention of mathematical concepts. When students are actively involved in the learning process-by discussing and solving problems together-they are more likely to retain information and apply it in different contexts (Miller & Garcia, 2020).

This collaborative learning environment of critical thinking skills, as students are challenged to explain their reasoning, listen to others' perspectives, and negotiate solutions. By engaging in these interactive activities, students become active participants in their learning rather than passive recipients of information.

This finding is consistent with the work of Brown et al. (2022), which argue that interdisciplinary approaches to teaching, particularly those that involve peer-to-peer interactions, improve students' ability to solve complex problems and think critically.

However, this study also revealed some challenges in implementing communication strategies effectively. Educators mentioned that time constraints, large class sizes, and limited resource were barriers to fully integrating communication techniques into their mathematics instruction. For instance, while group discussions were effective in enhancing student engagement, teachers noted that managing large classes could be difficult when trying to facilities meaningful interactions among all students. This

concern is consistent with the finding of previous studies, which highlight the logistical challenges that teachers face when implementing innovative teaching methods (Adams et al., 2018). To address these challenges, school could invest in smaller class sizes, more classroom resources, and professional development programs that equip teachers with strategies to manage larger classes and optimize the use of communication techniques.

Additionally, the study suggests that not all teachers feel adequately prepared to incorporate communication strategies into their teaching. Although some teachers were enthusiastic about using the approaches, others expressed a need for further training and support.

Professional development programs focused on the practical integration of communication in mathematics education could help address this gap. Providing teachers with concrete tools and strategies to effectively incorporate communication techniques into their lessons would not only enhance the quality of mathematics instruction but also empower teachers to implement more engaging and student-centered approaches.

In summary, the findings from this study supports the argument that communication strategies play a significant role in enhancing mathematic education. The integration of these strategies, particularly in the context of Medan's diverse student population, help create a more inclusive and engaging learning environment. By combining communication with mathematics instruction, teacher can foster deeper understanding, critical thinking, and collaboration among students.

However, to maximize the effectiveness of these strategies, it is essential to address the challenges faced by educators, such as large class sizes, time limitations, and a lack of professional development opportunities.

These finding highlight the importance of supporting teachers with the necessary resource and training to implement interdisciplinary teaching approaches successfully. Future research should explore how these strategies can be scaled to a larger number of schools in Indonesia and assess their long-term effects on student achievement and teacher satisfaction.

4. CONCLUSION

The integration of communication studies into mathematics education in Medan has shown to improve student engagement, comprehension, and critical thinking.

Communication strategies such as storytelling, visual aids, and group discussions have helped students connect abstract mathematical concepts to their own experiences and made learning more interactive and collaborative. However, challenges such as time constraints, large class sizes, and limited resource must be addressed to fully realize the potential of the approaches

Future research should focus on exploring the long-term impacts of these strategies on student performance and how they can be scaled up across different schools in Indonesia. Additionally, professional development program that equip teachers with the necessary skill and resources to integrate communication into their teaching practices will be crucial in advancing this approach.

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Implementation of Augmented Reality and Integrated Video as Interactive Learning Media for Mentally Disabled People in Recognizing Numbers and Letters Based on the Mathalfa Application

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ABSTRACT

Law No. 20 of 2003 on the National Education System mandates inclusive education for children with special needs (ABK) in order to optimize their potential. However, the learning process for kids with mental retardation is hampered by the lack of new learning resources. Thus, a solution is provided by the MathAlfa program with Integrated Video Augmented Reality (AR). In addition to promoting the use of technology in inclusive education, MathAlfa is intended to improve the learning achievement, comprehension, and engagement of children with mental retardation. It is anticipated that features like materials, AR films, and quizzes that rely on visual recognition and direct interaction will be able to give students with mental retardation a more engaging, inclusive, and adaptive learning environment. One technology that has great potential in supporting learning for students with intellectual disabilities is Augmented Reality (AR). AR is a technology that combines virtual objects with real environments in real-time, providing a more immersive interactive experience. By using AR, students can interact directly with learning materials that are visualized in the form of 3D objects, videos, or animations, which can help them understand abstract concepts more concretely and visually.

Keywords: Augmented Reality; Inclusive Education; Mental Retardation

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1. INTRODUCTION

Education is the process of gaining knowledge to improve, strengthen, and perfect all human potential. Everyone gets an equal opportunity to undergo the learning process, including children with special needs. In accordance with the provisions of Law Number 20 of 2003 concerning the National Education System, Article 5 paragraph (2) states that individuals with differences in physical, emotional, cognitive, mental, or social rights receive education that is tailored to their needs [1,2].

Children with special needs (ABK) are children who have physical, mental, emotional, or social limitations, who require special learning approaches to support their development. One type of ABK is children with intellectual disabilities, who experience delays in intellectual development and have difficulty understanding abstract concepts. Therefore, they need more concrete, visual, and interactive learning methods to help them understand the subject matter [3,4].

In Indonesia, there are 144,621 students with special needs who are currently studying in special educational institutions. Of that number, 82,326 are elementary school students, 36,884 are junior high school students, and 25,411 are high school students. Special schools face challenges in providing innovative and effective learning media for students with intellectual disabilities. The available learning media are still limited to conventional methods, such as textbooks and simple teaching aids, which are less able to attract attention and improve students' understanding. Therefore, innovation is needed in learning media that can provide a more interactive, adaptive, and interesting learning experience for students with intellectual disabilities [5,6].

One technology that has great potential in supporting learning for mentally retarded students is Augmented Reality (AR). AR is a technology that combines virtual objects with real environments in real-time, providing a more immersive interactive experience [10,11]. By using AR, students can interact directly with learning materials that are visualized in the form of 3D objects, videos, or animations, which can help them understand abstract concepts more concretely and visually.

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MathAlfa is an AR-based learning application specifically designed to help mentally retarded students recognize letters and numbers [8,9]. This application integrates video and AR technology to provide a more visual and interactive learning experience. With features such as AR video materials and interactive quizzes, MathAlfa is expected to be able to increase the engagement, understanding, and academic achievement of mentally retarded students.

Through this innovation, it is hoped that SLB can provide a more inclusive and adaptive learning environment for mentally retarded students, so that they can achieve their maximum potential in the teaching and learning process.

2. RESEARCH METHOD

The method used in this study is ADDIE (Analyze, Design, Development, Implementation, and Evaluation). The ADDIE method has 5 stages, namely analyze, design, development, implementation, and evaluation. All stages are carried out sequentially so that it is more structured.

Fig 1. ADDIE

1. Analyze, is the initial stage in all activities in the research development process. The focus of the analysis stage is to identify possible causes of performance gaps. These causes can be influenced by various parties, including teachers, students, education staff, and others.
2. Design, the next stage is design, in this design phase it is arranged by determining the learning skills needed by participants when following the learning program or media created. The purpose of the design phase is to determine whether the educational activities or platforms designed can intervene in the problems of performance limitations experienced by students [12].
3. Development, the purpose of this development step is to create a platform according to expectations. This stage consists of:
   a. Learning Platform Development
      This stage refers to the steps of creating and developing an educational platform as a means of assistance for teachers in implementing it in Letter and Number Recognition education in the Mentally Disabled class. Researchers implement the plans that have been made in the design stage, namely materials, Augmented Reality videos, and quizzes to then be included in the learning aids that will be prepared.
   b. Assessment by Media and Material Experts
      Evaluation by media experts and material experts "MathAlfa" is used as a means to evaluate and improve the quality of the media that has been prepared before moving on to the implementation stage.
4. Implementation, This step involves testing the media that has been completed and has been validated by experts in real classroom learning situations. Activities in this step include preparing the class, educators, students, and measurement tools in the form of questionnaires.

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5. Evaluation, The evaluation stage to assess the quality of the learning media, both before and after implementation [9]. When the development stage always ends with an assessment before proceeding to the next step. The assessment implemented through the stages of analyzing, designing, developing, and implementing is a formative assessment, which aims to improve the media.

3. RESULTS AND DISCUSSION

The MathAlfa application, an interactive learning tool based on Augmented Reality (AR), was created as a result of this research to assist children with mental retardation in recognizing letters and numbers. The five steps of the ADDIE method—analysis, design, development, implementation, and evaluation—are used in the application development process.

A. Analyze

At this point, the SLB Swasta Syafiq mentally handicapped kids' learning needs were identified. It was discovered through observations and instructor interviews that there were still few and uninteresting learning resources available to students. More visual and interactive media are therefore required to aid students in understanding the course content.

B. Design

Creating a learning flow that incorporates AR technology is the task at hand. Children with intellectual disabilities will find the user interface design appealing and simple to use. The offered educational resources include interactive films and 3D objects that represent letters and numerals.

Application Design :

Fig 2. Logo Design, Home Feature View

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Fig 3. Content Display

Fig 4. Augmented Reality Video Display

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Fig 5. Quiz View

C. Development

At this point, EasyAR and Unity 3D were used to create the MathAlfa application. providing 3D objects, including instructional films, and providing interactive tests to gauge students' comprehension were all part of the development process. The outcomes of the application testing are as follows:

Table 1. Black Box Test Results

No	Case/Tested	Test Scenario	Expected Result	Test Result
1	Splash screen page	Opening the application	Successfully displaying the splash screen with a waiting time of 3 seconds	Success
2	Main menu	Login after splash screen	Successfully logged in to the main page	Success
3	Close application button	Select exit button	Successfully closed application	Success
4	Mute sound button	Click mute sound button	Successfully mute back sound	Success
5	AR Interaction	Point camera at marker	Show 3D object	Success
6	Interactive quiz	Answering questions	Showing evaluation results	Success

D. Implementation

SLB Swasta Syafiq implemented the MathAlfa application. To make sure the program could be used correctly and offered the anticipated benefits, teachers and students participated in the application trial. The application was highly appreciated by users, as evidenced by the average SUS rating of 85, which was acquired during usability testing using the System Usability Scale (SUS) [10].

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Table 2. SUS Test Results

Respondents	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Calculation Result Score	Value (Amount x 2.5)
1	3	4	4	3	4	3	4	3	4	4	35	87.5
2	4	4	4	4	3	4	3	4	4	3	36	90
3	3	3	4	4	4	3	4	4	3	3	35	87.5
4	4	4	3	3	4	4	3	4	4	3	36	90
5	3	4	4	4	3	4	4	3	4	4	36	90
6	4	4	3	4	4	3	4	4	3	4	37	92.5
7	3	3	4	4	4	3	4	3	4	4	36	90
8	4	3	4	3	4	4	4	4	3	3	36	90
9	3	4	3	4	4	3	4	4	4	3	36	90
10	4	4	4	3	3	4	4	4	3	4	36	90
Total												893.5
Average												85

Each respondent's score is then calculated using the SUS formula, and the total is calculated as 85. The average SUS score is then calculated by dividing the total by the number of respondents. This indicates that the application is deemed acceptable as the average SUS evaluation of 85 respondents is higher than the lowest value shown in the problem limits. Based on these findings, it can be said that the user can understand the program with ease.

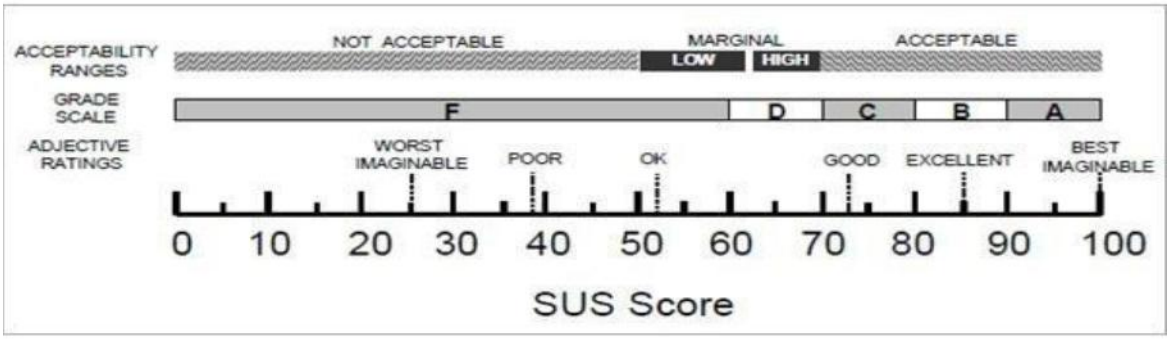

Fig 6. SUS score result interpretation scale

E. Evaluation

Teachers' and students' feedback is gathered in order to complete the evaluation step. The evaluation results indicate that this application can improve kids' interest in and comprehension of studying letters and numbers. The evaluation findings from tests conducted by media and material experts are as **follows:**

Table 3. Test Results by Media Experts and Material Experts

Testing Aspect	Media Expert	Materials Expert
Eligibility	91%	85%
Legibility	89%	83%
Involvement	92%	88%

Feedback from Teachers and Students:

a. Teachers: This application is very helpful in the learning process and makes students more enthusiastic.

b. Students: Learning becomes more fun and they find it easier to remember letters and numbers.

4. CONCLUSION

All things considered, the MathAlfa software has been successful in reaching its objective of improving the efficiency of letter and number learning for kids with intellectual disabilities. For kids with specific disabilities, augmented reality technology not only makes learning more engaging, but it also makes it simpler to comprehend. Particularly in institutions that educate students with exceptional needs, this application holds enormous promise for use in inclusive education. User evaluation reveals a high degree of acceptability and the effectiveness of the application in raising motivation for learning. Therefore, MathAlfa may serve as a template for future technologically based learning materials.

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The Effect of Articulation Type Cooperative Learning Model on Students' Mathematical Concept Understanding

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ABSTRACT

This study stems from the low understanding of mathematical concepts among students and aims to examine whether there is a difference in understanding mathematical concepts between students who learn using the cooperative learning model of the articulation type and those who learn using the conventional learning model. The study employs a **Quasi-Experimental design** with a **Pre-test Post-test Control Group Design**, involving class VII.1 (experimental class) and VII.2 (control class) at SMP Babussalam Pekanbaru. The results of data analysis using a t-test showed that $t_{calculated}$ **(2.98) >** t_{table} **(2.01)** at a 5% significance level, leading to the acceptance of H_a. This demonstrates that the cooperative learning model of the articulation type significantly improves students' understanding of mathematical concepts compared to the conventional learning model, with the average score of the experimental class being higher than that of the control class.

Keywords: ***articulation type cooperative learning model, mathematical concept understanding***

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1. INTRODUCTION

Mathematics is one of the fundamental fields of study that supports the advancement of technology and science. As a discipline that plays a crucial role in everyday life, mathematics serves as the foundation for many other fields of study, such as physics, economics, engineering, and computer science (Soedjadi, 2000). However, learning mathematics often becomes a significant challenge for students, especially in understanding abstract and complex concepts (Suryadi, 2015). Many students can only memorize procedural steps without understanding the underlying meaning, making it difficult for them to apply these concepts to real-life situations (Ruseffendi, 2006). International surveys like PISA (Programme for International Student Assessment) have also recorded low mathematical literacy levels among Indonesian students (OECD, 2024). This underscores the need for innovations in teaching models to enhance the quality of conceptual understanding in mathematics.

As an effort to overcome this challenge, the implementation of cooperative learning models has been recognized as an effective approach to improve the quality of mathematics learning. In this model, students are encouraged to work in small groups, facilitating active interactions that help deepen their understanding of the material (Nugraha, 2020). One of the intriguing types of cooperative learning models to study is the articulation type. Research by (Nurhayati E. , 2016)demonstrated that implementing the cooperative learning model of the articulation type could improve the mathematics learning outcomes of Grade VII junior high school students. In this study, students who learned through the articulation model showed better conceptual understanding compared to those taught using conventional methods. Additionally, another study by (Wijaksono, 2022)found that the cooperative learning model of the articulation type was effective in enhancing the mathematics learning outcomes of Grade VIII junior high school students. Students involved in this learning model showed significant improvements in their understanding of mathematical concepts.

The cooperative learning model of the articulation type provides students with the opportunity to articulate their understanding to their group members. This process encourages students to think more critically, reinforces their understanding, and enhances their communication skills (Irawan, 2018). By acting as both conveyers and receivers of information, students are trained to articulate their understanding, which in turn deepens their comprehension of mathematical concepts. This learning model also aligns with the principles of constructivism, where students learn through social interaction and build their own knowledge. This was evidenced by (Hasanah, 2022) research, which found that the articulation model improved students' ability to understand geometric concepts because they actively constructed their understanding through group discussions.

The implementation of the cooperative learning model of the articulation type requires thorough preparation by teachers, including material planning and effective time management. Teachers need to ensure that every student actively participates in discussions and the presentation of material (Hastuti, 2019). Thus, the goal of learning to enhance students' understanding of mathematical concepts can be achieved.

In the context of education in Indonesia, the application of the cooperative learning model of the articulation type aligns with the government's efforts to improve the quality of education, particularly in mathematics. By improving conceptual understanding in mathematics through innovative teaching methods, it is hoped that students will be better prepared to face challenges in the globalization era. However, the implementation of this model also requires appropriate strategies to be effective. The main challenges in applying the cooperative learning model of the articulation type are the need for teachers' thorough preparation and students' adaptation to the new teaching method (Hastuti, 2019). Therefore, in-depth research is needed to investigate the effectiveness of this model in various learning contexts.

This study aims to analyze the impact of the cooperative learning model of the articulation type on students' understanding of mathematical concepts. It also seeks to compare the effectiveness of this model with conventional teaching models in improving conceptual understanding. It is hoped that this study will provide significant contributions to the development of mathematics teaching methods in Indonesia. By utilizing the cooperative learning model of the articulation type, it is expected that students will find it easier to understand abstract mathematical concepts. Furthermore, the results of this study could serve as a reference for educators in designing innovative teaching strategies that are relevant to students' needs. Consequently, it is expected that the findings of this study will positively impact the quality of mathematics education in Indonesia.

2. RESEARCH METHOD

This research is part of a quantitative approach. The method applied is Quasi-Experimental, with a research design using the Pretest-Posttest Control Group Design. The population of this study consists of seventh-grade students at SMP Babussalam Pekanbaru for the 2023/2024 academic year, comprising four classes: VII.1, VII.2, VII.3, and VII.4. The sample in this study consists of classes VII.1 and VII.2, where VII.1 serves as the experimental class using the cooperative learning model of the articulation type, and VII.2 serves as the control class using the conventional learning model. In this study, the researcher uses the Random Sampling technique to select two classes randomly from the population, which will first be tested for homogeneity using the Bartlett's Test. Bartlett's Test is used to determine whether the population has the same or homogeneous variance.

The instruments used for data collection in this study are tests of mathematical concept comprehension abilities, consisting of pretests and posttests. The tests are in the form of questions regarding concept comprehension, and the assessment is based on the indicators of concept comprehension to evaluate the effectiveness of the applied learning models. The tests consist of four items. Before the pretest and posttest are administered to the experimental and control classes, they are first tested on a class other than the experimental and control classes, which is a member of the population, to assess the validity and reliability of the questions. The instrument test for data collection is conducted to ensure the appropriateness of the instruments in the data collection process. The instruments used must be valid and reliable. The validity test aims to determine the authenticity of each item while measuring how accurately the instrument can perform its measurement function (Muharni, 2024)). The validity of the items is determined by calculating the correlation between the score of each item and the total score using the Product Moment correlation formula. Meanwhile, the reliability of the test is analyzed using Cronbach's Alpha method to ensure the consistency of the test results in representing the measured construct (Muharni, 2024)

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Data analysis is performed by comparing the students' scores in the experimental and control classes to evaluate the effect of the articulation-type cooperative learning model on students' mathematical concept comprehension abilities. Data analysis techniques involve statistical tests, namely normality tests, homogeneity tests, and hypothesis tests. The normality test is conducted to determine whether the data from both sample groups follow a normal distribution. In this study, data normality is tested using the chi-square formula. The homogeneity test aims to check whether both sample groups have the same variance, and the homogeneity test used is the F-test. As for the hypothesis testing, this study uses the "t" test. The "t" test is used to test the comparative hypothesis of two independent samples, namely Separated Variance and Pooled Variance.

3. RESULTS AND DISCUSSION

A. Population and Sample of the Study

The sample selection was carried out through several stages, as follows:

1) Collecting the semester math exam scores of seventh-grade students at SMP Babussalam Pekanbaru.
2) Conducting a homogeneity test for each data group by:
   - Determining the variance for each class.

   The results of the variance calculations for each class can be seen in the table :

Table 1. Varians Values

Varians Values Sample	Class	S^2	N
Type of Variable: Comparison of Pretest Score	VII.1	16,29	31
	VII.2	8,04	31
	VII.3	20,40	31
	VII.4	21,04	31

- Insert the statistical values for the homogeneity test into Table 2 of the Bartlett's test as follows:

Table 2. The Barlett's Test

No	Sample	db = (n – 1)	S_i^2	Log S_i^2	Db (Log S_i^2)
1	VII.1	30	16,29	1,212	36,36
2.	VII.2	30	8,04	0,91	27,20
3.	VII.3	30	20,40	1,31	40,60
4.	VII.4	30	21,04	1,323	39,69
		Σ(n – 1)= 120	-	-	**143,85**

- Calculating the Variance of the Four Samples:

$$S^2 = \frac{n_1 S_1^2 + n_1 S_2^2 + n_1 S_3^2 + n_1 S_4^2}{n_1 + n_2 + n_3 + n_4} = 16{,}44$$

- Calculating the Value of $X^2_{calculated} = \ln(10) \times ((\text{LogS2 x } (\Sigma \text{ n} - 1)) - \Sigma db \log S^2) = 4{,}75.$

  Comparison of $X^2_{calculated}$ dengan X^2_{table} with testing criteria: If $X^2_{calculated} \geq X^2_{table}$, the variances are not homogeneous, but if $X^2_{calculated} \leq X^2_{table}$, the variances are homogeneous. For α = 0,05 and degrees of freedom (df) = n -1 = 4 – 1 = 3, the value of X^2_{tabel} = 7,81. The comparison result is 4,75 $\leq$ 7,81, atau $X^2_{calculated} \leq X^2_{tabel}$, Thus, the variances are homogeneous. Since the variances are homogeneous, it can be concluded that all four classes are homogeneous. Therefore, the researcher selected two classes as samples using the Random Sampling technique, namely Class VII.2 as the experimental class and Class VII.1 as the control class.

B. Analysis of Question Instruments

The steps in determining the question instruments were carried out through the following stages:

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1) **Question Validity Test**
The results of the validity calculations for the question items obtained in this study can be seen in Table 3:

Table 3. Validity Results of Question Items

Item Number Question	Correlation Coefficient	$t_{calculated}$	t_{table}	Decision	Interpretation
1.	0,561	3,586	1,701	Valid	Moderate
2.	0,957	17,462	1,701	Valid	Very High
3.	0,549	3,474	1,701	Valid	Moderate
4.	0,685	4,972	1,701	Valid	High

From Table 3, it can be observed that all four question items have $t_{calculated}$ values greater than ttable, indicating that the questions are valid.

2) **Question Reliability Test**
Based on the reliability test results for all question items, the test reliability coefficient was found to be 1.158. When compared to r_{table}=0.355, it is evident that $r_{calculated}$>rtable. This indicates that the test results are reliable.

3) **Preparing the Question Instruments**
Based on the results of the validity and reliability tests, it can be concluded that all the analyzed questions can be used as test instruments, as all four were found to be valid.

C. Data Analysis

1) Pre-test Data Analysis

The data analysis process was carried out through several steps, as follows:

a) Normality Test
The results of the normality test calculations for students' mathematical concept comprehension in the pre-test are presented in Table 4:

Table 4. Normality Test for Pre-test

Class	$X^2_{calculated}$	X^2_{table}	Criteria
Experimen	8,2071	11,070	Normal
Control	4,5910	11,070	Normal

Based on the calculations at a 5% significance level, it can be observed that $X^2_{hitung} \leq X^2_{tabel}$, Therefore, it can be concluded that the data from both the experimental class and the control class follow a normal distribution.

b) Homogeneity Test
Based on the calculations, the largest variance is 571.69, and the smallest variance is 193.65, resulting in $F_{hitung} = 2{,}95$. According to the testing criteria, $2{,}95 > 1{,}93$ atau $F_{hitung} > F_{tabel}$ indicating that the variances are not homogeneous.

c) Hypothesis Test
Based on the prerequisite hypothesis test results, the pre-test data for the experimental and control classes showed a normal distribution but had non-homogeneous variances. Subsequently, data analysis was conducted using the "t" test with the Separated Variance formula.

From the calculations, t_{hitung} was compared with t_{tabel} at a 5% significance level is 1,77 < 2,05 or $t_{hitung} < t_{tabel}$, Thus, H_0 is accepted, and H_a is rejected It can be concluded that there is no significant difference in concept comprehension between the students in the experimental class and the control class before the implementation of the cooperative learning model of the articulation type in mathematics learning.

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2) Post-test Data Analysis

The data analysis process was carried out through the following steps:

a) Normality Test

The results of the normality test for students' mathematical concept comprehension in the post-test are presented in Table 5.

Table 5. Normality Test for Post-Test

Class	X^2_{hitung}	X^2_{tabel}	Criteria
Experimen	6,6726	11,07	Normal

From the calculations, it can be observed that:

- For the experimental class: $X^2_{hitung} \leq X^2_{tabel}$ or 6,6726 ≤ 11,07, indicating that the data is normally distributed.
- For the control class: $X^2_{hitung} \leq X^2_{tabel}$ or 5,8595 ≤ 11,07, indicating that the data is normally distributed.

b) Homogeneity Test

From the homogeneity test table, the largest variance is 280.76, and the smallest variance is 159.64, resulting in $F_{hitung} = 1{,}76$. According to the testing criteria, 1,76 ≤ 1,88 or $F_{hitung} \leq F_{tabel}$ indicating that the variances are homogeneous.

c) Hypothesis Test

Based on the prerequisite hypothesis test results, the post-test data for the experimental and control classes showed normal distribution and homogeneous variances. Data analysis was then conducted using the "t" test with the Polled Variance formula.

From the calculations, t_{hitung} was compared with t_{tabel} at a 5% significance level is 2,98 > 2,01 or $t_{hitung} > t_{tabel}$, thus H_a is accepted, and H_0 is rejected.. This indicates a significant difference in mathematical concept comprehension between students who learned using the cooperative learning model of the articulation type and those who learned using the conventional learning model.

Based on the average scores, the experimental class achieved an average score of 79.31, which is higher than the control class's average score of 67.64. This indicates a positive impact of the cooperative learning model of the articulation type on students' mathematical concept comprehension. In addition to enhancing students' understanding of mathematical concepts, this study also found that the cooperative learning model of the articulation type helps students become more independent, collaborate in groups to complete learning materials, and improve interactions among peers. Furthermore, each student has the opportunity to share their group discussion results in front of the class.

Despite many indications of the positive impact of the cooperative learning model of the articulation type, there were some limitations in the study. These include difficulties in managing students due to the large number of groups, some groups being less active, and some students not participating in discussions, instead remaining passive and ignoring the researcher's instructions. Limited class time also meant not all groups had the opportunity to present their findings, as students did not utilize the allotted discussion time efficiently. Moreover, the cooperative learning model of the articulation type was only applied to the topic of sets and not to other mathematical topics.

4. CONCLUSION

The analysis results indicate that students taught using the cooperative learning model of the articulation type achieved higher levels of mathematical concept comprehension compared to those taught using conventional teaching methods. Therefore, the cooperative learning model of the articulation type can be considered to contribute positively to enhancing students' understanding of mathematical concepts. This model is expected to serve as an alternative teaching approach to help students develop other mathematical skills and apply them to various topics in mathematics learning.

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