24 (4), 2023, 837-845
Jurnal Pendidikan MIPA
e-ISSN: 2685-5488 | p-ISSN: 1411-2531
http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

# The Effect of Scientific Approach Contextual Teaching and Learning on Students' Mathematical Power

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**Abstract:** Unlike traditional learning models, this study aimed to evaluate the effects of applying a scientific method that incorporates CTL (Contextual Teaching and Learning) on students' mathematical ability. A quasi-experimental study with a posttest-only control group design was the research methodology employed. There were 200 pupils in grade VIII at SMPK Immaculata Ruteng who made up the study population. Class VIII D (33 students) was the experimental class that utilized the CTL-based scientific method, while class VIII F (34 students) was the control class that followed the traditional learning paradigm. Sampling was done at random. A multiple-choice test was the research tool employed, and the t-test was used to analyze the results. At the 5% significance level, the t-table was 1.668 according to the analysis results, and the t-count value was 5.114. The rejection of $H_0$ (the null hypothesis) is possible when taking into account the decision rule where $t_{hitung} > t_{tabel}$. Therefore, it can be said that students' mathematical proficiency is greatly impacted by the use of a CTL-based scientific method

**Keywords:** CTL; mathematical power; scientific approach.

***Abstrak:*** *Penelitian ini dilakukan dengan tujuan untuk menilai dampak dari penerapan pendekatan saintifik yang memuat CTL (Contextual Teaching and Learning) terhadap kemampuan matematis siswa, dibandingkan dengan penggunaan model pembelajaran konvensional terhadap kemampuan matematis siswa. Metode penelitian yang digunakan adalah penelitian eksperimen semu dengan desain posttest-only control group. Populasi penelitian mencakup seluruh siswa kelas VIII di SMPK Immaculata Ruteng, dengan jumlah keseluruhan 200 siswa. Pengambilan sampel dilakukan secara acak, dengan kelas VIII D (33 siswa) sebagai kelas eksperimen yang menerapkan pendekatan saintifik berbasis CTL, sedangkan kelas VIII F (34 siswa) menjadi kelas kontrol yang menggunakan model pembelajaran konvensional. Instrumen penelitian yang digunakan adalah tes pilihan ganda, dan analisis data dilakukan menggunakan uji-t. Hasil analisis menunjukkan nilai thitung sebesar 5,114, sementara ttabel adalah 1,668 pada tingkat signifikansi 5%. Dengan mempertimbangkan aturan keputusan di mana* $t_{count} > t_{tabel}$*, maka H0 (hipotesis nol) dapat ditolak. Dengan demikian, dapat disimpulkan bahwa penerapan pendekatan saintifik berbasis CTL memiliki pengaruh signifikan terhadap kemampuan matematis siswa.*

***Kata kunci:*** *CTL; daya matematis; pendekatan saintifik*

## ▪ INTRODUCTION

A new period of education has begun with a new paradigm that focuses more on the process of learning and instruction to prepare individuals for real life and careers, not just for some narrowly scoped exams. In this new period, the purpose and focus of teaching is to generate individuals who can reach and construct information, construct why-and-how reasoning, make analysis/connections, solve problems, and learn actively on their own rather than memorizing information/concepts and learning to pass certain

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DOI: http://dx.doi.org/10.23960/jpmipa/v24i4.pp837-845
Received: 02 December 2023
Accepted: 21 December 2023
Published: 26 December 2023

exams. On the other hand, the assessment and evaluation system also began to be reformed in line with this new paradigm.

Mathematics is one of the main fields of study in primary and secondary education units. Mathematics has been regarded as a fundamental subject because arithmetic and logical reasoning are the basis of science and technology (Shone et al., 2023). Therefore, it is an inevitable fact that the learning and teaching process has an important role in mathematics education. Depdiknas asserts that mathematics education trains ways of thinking and reasoning in concluding, for example through investigation, exploration, experimentation, showing similarities, differences, consistency, and inconsistency (Jarmita, 2018). In other words, mathematics education shapes personality and organizes students' reasoning in the ability to solve problems, communicate, and apply mathematics. Goals for mathematics instruction depend on one’s conceptualization of what mathematics is, and what it means to understand mathematics. Such conceptualizations vary widely (Schoenfeld, 2016)

Throughout the process of learning mathematics, students are expected to learn mathematics through understanding and actively building new knowledge from prior experience and knowledge. One of the important purposes of this process is to determine the level of mathematical knowledge and mental process ability of students. Five process standards are the goal in learning mathematics which The National Council of Teachers of Mathematics (NCTM) commonly referred to as mathematical power, namely: learning to solve problems (mathematical problem solving); learning to reason (mathematical reasoning); learning to communicate (mathematical communication); learning to connect ideas (mathematical connections); and learning to represent (mathematical representation) (NCTM, 2000). Since the adoption and implementation of the concept of mathematical power (MP) by the NTCM in the 1990s, MP assessment-oriented processes have been increasingly incorporated into mathematics. The MP concept was also incorporated into the objectives of the new mathematics curriculum in Indonesia

According to NCTM (Margana, 2012) mathematical power includes the ability to explore, conjecture, reason logically to solve unusual problems communicate about mathematics, and connect mathematical ideas and between mathematics and other intellectual activities. Mathematical power (MP) can develop confidence, and character to search, evaluate, and use quantitative, spatial information in problem-solving and decision-making. This is the opinion of (Şahin & Baki, 2010) who said that mathematical power is the ability of students to use their conceptual and operational knowledge in solving problems experienced with reasoning, communication, and connection skills simultaneously.

The concept of MP is an overall mathematical proficiency that can be described as an individual's mathematical ability in conceptual understanding, procedural knowledge, connections, reasoning, conjecture, problem-solving, mathematical thinking, and communication (Çimen, 2010). (Kusmaryono, 2014) describes the characteristics of students with mathematical power abilities. The characteristics of students who have mathematical strength characterized by the emergence of a sense of fun and enthusiasm with their current math, if given the job on a group or individual has always done well and quickly, if you have problems do not hesitate to ask the teacher and other things difficult they will be to solve the challenges in learning.

Mathematical power can also be interpreted as the ability to deal with problems both in mathematics and everyday life. In addition, in this ability, students are required to be able to use mathematical communication, mathematical reasoning, problem-solving skills, connecting mathematical ideas, and shaping student behavior when solving problems given by the teacher. However, there are still many students who have not developed their mathematical power abilities or whose mathematical power abilities are still low.

Learning mathematics has many challenges. Low mathematics achievement is the main problem experienced by most students worldwide (Nurkarim et al., 2020). Factors that hinder students' mathematical abilities can be caused by various things, one of which is the application of learning models that are still teacher-centered or using conventional models, such as direct learning. Learning tends to be centered on teachers who emphasize the procedural process, and mechanistic task and less provide opportunities for students to develop the ability to think mathematically (Rafianti & Pujiastuti, 2017). According to (Richardo, 2017), conventional learning tends to provide more information than providing opportunities for students to actively participate, for example by practicing or presenting their work directly in front of friends. In this context, teachers have a very active role, while students tend to be passive in the learning process. As a result, students participate less in learning, which in turn can hinder the development of mathematics learning activities and the improvement of students' abilities in the subject. In addition, mathematics remains a less favored and often disliked subject in the school environment. As a result, a large number of junior secondary students do not successfully enroll in math and science classes at the senior secondary level. This is not due to a lack of ability, but rather a tendency or negative view of math (Kusmaryono et al., 2019).

This kind of learning model needs to be improved. To this end, researchers have documented many current mathematics learning conditions that evidence a rich and valued type of student mathematical engagement. Learning should position students as capable mathematical learners through teacher support for equitable and meaningful participation in the classroom (Jelatu et al., 2019; Richardo, 2017). Mathematics learning should be transformed by implementing tasks with high cognitive demands, encouraging exploration of multidimensional solutions, supporting argumentation, and creating supportive and equitable communities (Jelatu et al., 2018; Kurnila et al., 2019).

The curriculum in Indonesia has directed learning according to current conditions. Therefore, it is necessary to implement and or develop the latest learning strategies that can improve mathematical abilities, one of which is student mathematical power. The combination of recommendation implementation and strategy development can be in the form of a scientific approach with CTL content.

The scientific approach with CTL content is an approach and learning model that designs learning activities in such a way that students actively construct competencies in attitudes, knowledge, and skills by centering the learning process on students so that they find the meaning and benefits of the material they have learned and then apply it in their daily lives (Capriati et al., 2017; Febrianti & Mahmudi, n.d.; Kesuma & Parwoto, 2021; Lestari et al., 2020; Maryani & Widjajanti, 2021). The same thing was also conveyed by (Wulandari et al., 2014), that the scientific approach with the CTL model can increase students' understanding of the concept of the material provided because this approach and learning model can make students fully active by finding the material themselves so that learning becomes more fun. The scientific approach with CTL content fully emphasizes student activity in learning through linking material with the context of everyday life using a scientific approach (observing, asking questions, reasoning, digging for information, and communicating) to find out so that students have knowledge and skills.

## ▪ METHOD

### Research Design and Procedures

This study used a posttest-only control group design. Posttest-only control group design is a form of experimental research design. This design involves the formation of an experimental group (with treatment) and a control group (without treatment), followed by the measurement of the response variable (posttest) after the administration of the treatment. The main characteristic of this design is that the measurement is done after the treatment is given, and there is no measurement before the treatment.

### Participants

This study used a posttest-only control group design. All VIII grade students of SMPK Immaculata Ruteng were the population in this study, with a total of 200 students in six classrooms. The sampling method in this study was by selecting classes randomly. The class equality test determined the class that became the research class. In this study, researchers used the value of the middle assessment of the even semester of SMPK Immaculata Ruteng in the 2022/2023 school year using the separated variant formula.

The class equivalence test using the even PTS score of SMPK Immaculata Ruteng 2022/2023 was carried out using the separated variant formula and all classes were found to be equivalent. Of the six classes, two classes appeared first and were taken as sample classes using the cluster random sampling technique, a lottery system. Then, 2 classes were selected as control and experimental classes. Class F and Class D were selected as the control and experimental classes based on the results of the lottery. In this study, the control class included 34 students and the experimental class included 33 students.

### Instrument

In this study, a posttest was used to collect data. The posttest included 25 multiple-choice questions designed to assess students' mathematical power. For the indicators of mathematical power, several indicators were taken from 5 abilities, namely mathematical communication ability, mathematical connection ability, mathematical problem-solving ability, mathematical representation ability, and mathematical reasoning ability.

Before the posttest questions were given to students, validity tests were carried out and the rails were tested. The formula to be used is point biserial. The instrument is declared valid if rcount> rtable with a significant level of 5%. The conclusion of the validity test results of the mathematical power posttest question instrument is shown in Table 1.

**Table 1**. Test question validity test results

| No. | Koefisien Korelasi | r tabel | Criteria |
|---|---|---|---|
| 1 | 0.433 | 0.374 | Valid |
| 2 | 0.473 | 0.374 | Valid |
| 3 | 0.466 | 0.374 | Valid |

| | | | |
|---|---|---|---|
| 4 | 0.467 | 0.374 | Valid |
| 5 | 0.455 | 0.374 | Valid |
| 6 | 0.455 | 0.374 | Valid |
| 7 | 0.623 | 0.374 | Valid |
| 8 | 0.491 | 0.374 | Valid |
| 9 | 0.414 | 0.374 | Valid |
| 10 | 0.432 | 0.374 | Valid |
| 11 | 0.466 | 0.374 | Valid |
| 12 | 0.449 | 0.374 | Valid |
| 13 | 0.468 | 0.374 | Valid |
| 14 | 0.631 | 0.374 | Valid |
| 15 | 0.419 | 0.374 | Valid |
| 16 | 0.461 | 0.374 | Valid |
| 17 | 0.573 | 0.374 | Valid |
| 18 | 0.397 | 0.374 | Valid |
| 19 | 0.444 | 0.374 | Valid |
| 20 | 0.505 | 0.374 | Valid |
| 21 | 0.611 | 0.374 | Valid |
| 22 | 0.773 | 0.374 | Valid |
| 23 | 0.641 | 0.374 | Valid |
| 24 | 0.613 | 0.374 | Valid |
| 25 | 0.456 | 0.374 | Valid |

In this study, to carry out the test reliability analysis using the Cronbach alpha formula. Based on the reliability test of the test instrument, the value of r11 is 0.876.

**Data Analysis**

This study used the t-test to test the hypothesis, assuming that the data distribution was normal and all groups were selected from the same population with the same variance. The hypothesis test of this study tested whether the impact of the CTL with a scientific approach on students' mathematical power was better than the conventional model. Normality and homogeneity tests used Chi Kuadrat and Bartlet tests.

## ▪ RESULT AND DISSCUSSION

Based on the calculation results, mathematical power data was obtained through posttest in descriptive form which includes 25 questions given after the learning process. The data were analyzed to obtain descriptive and inferential statistics of the two classes. This data (descriptive analysis) provides an overview of the distribution of grades across the two groups. The experimental group had a higher mean (80,61), higher mode, as well as a slightly lower median compared to the control group. The variability in the control group was higher (73,483 > 59,121), as shown by its variance and standard deviation. The number of students in the two groups was also different. Further (inferential) analysis is required to understand the implications of the statistics and their significance in the context of the experiment or research conducted.

In addition, it is necessary to conduct a normality test and homogeneity test before proceeding with hypothesis testing. Normality testing of posttest data for the experimental class obtained $x^2_{count}$ = 7.7229 and from the table of critical values of normality test with

Chi Kuadrat obtained $x^2_{table}$ = 11.070 with df = 6 - 1 = 5 at a significant level α = 0.05. Because $x^2_{count} < x^2_{table}$ (7.7229 < 11.070), $H_0$ is accepted, meaning that the post-test data in the experimental class is normally distributed. normality testing of posttest data for the control class obtained $x^2_{count}$ = 3.7242 and from the table of critical values of normality test with Chi Kuadrat obtained $x^2_{table}$ = 11.070 with df = 6 - 1 = 5 at a significant level α = 0.05. Because $x^2_{count} < x^2_{table}$ (3.7242 < 11.070), H0 is accepted, meaning that the post-test data in the control class is normally distributed.

Homogeneity testing is done to ensure the sample is representative of the whole, to ensure homogeneity. The Bartlett test is used for this analysis. Ms Excel 2010 homogeneity test was used in this study. The results of testing the homogeneity of mathematical power obtained $x^2_{count}$ = 0.1677 and $x^2_{table}$ = 3.841 with a significant level α = 0.005, because $x^2_{coun} < x^2_{table}$ then $H_0$ is accepted, meaning that both samples come from the same population (homogeneous).

This study tested the hypothesis of whether the impact of the CTL-with scientific approach on students' mathematical power is better than the conventional learning model. The results of hypothesis testing using a t-test with $t_{count} =$ 3,8594. Thus there is a significant effect of CTL-loaded scientific approach on the mathematical power of VIII-grade students of SMPK Immaculata Ruteng. This research was conducted at SMPK Immaculata Ruteng. In this study, the population taken was 200 students from class VIII. The research sample consisted of 33 students of VIII D as the experimental class by applying the scientific approach with contextual teaching and learning (CTL) and 34 students of VIII F as the control class by applying the conventional learning model. Based on the results of the analysis of posttest data of experimental and control classes using t-test, it was obtained that the mathematical power of students using a scientific approach with contextual teaching and learning (CTL) was better than the mathematical power of students using conventional learning models.

The growth of a student's mathematical power is a crucial component of the teacher's professional competence. For pupils to possess mathematical power, educators must develop in them the ability to think critically, be creative and imaginative, and be able to replicate and materialize these qualities in all areas of the curriculum. One of the requirements that needs to be met is for students to learn mathematics in a planned way to enhance their mathematical ability and increase their capacity to think critically. This will make the practice of "learning how to learn" relevant. Here the student should be able to find connections between new knowledge with knowledge already owned by his order there was a meaningful learning process.

In the learning process at SMPK Immaculata Ruteng using the scientific approach with CTL content, students seem more ready to participate in learning, before the educator enters the classroom students are already in their respective seats. Learning that applies a scientific approach with CTL content begins with students observing contextual problems from this activity students can find and build their knowledge. In the second stage, students ask questions about the problems that have been observed. Then, in the third stage, students are distributed in small groups then in groups students search and study material from various sources to work on the problems that will be given. In the fourth stage, student worksheets (LKS) to students containing a contextual problem, and in groups students discuss and solve the problems given together. In the fifth stage, present the results of group discussions and other groups' responses.

By implementing learning like this, it can provide opportunities for students to actively participate in the classroom because in learning by applying a scientific approach with CTL content the teacher only acts as a facilitator who facilitates student learning (Kusmaryono & Suyitno, 2016; Maryani & Widjajanti, 2021; Wulandari et al., 2014). In the learning process, students are allowed to follow the steps in the scientific approach with CTL content which can encourage students to be able to think critically and logically so that they can solve the problems given by connecting them with other concepts outside the material then also students are not rigid in conveying their ideas and can deepen students' understanding of the material given because the material obtained is more deeply studied and studied by students themselves until they find results and solutions. Thus, students can improve mathematical power consisting of problem-solving ability, reasoning ability, communication ability, connection ability, and representation ability.

Collaborative learning practices such as the scientific approach and learning models have been widely tested for effectiveness in several empirical studies (Muhammad et al., 2022). Jazuli et al., (2017) emphasized that learning will be meaningful if it relates the students' real-life experiences to mathematical ideas or concepts in the learning process in the classroom through contextual problems. One of the mathematics meaningful learning and mathematical mathematics-meaningful oriented daily life experience learning is Scientific Plus Learning. With CTL, the learning process takes place naturally in the form of student activities and work experience, not a transfer of knowledge from teacher to student. Strategy of learning is more important than the outcome. As other learning strategies, contextual learning is developed with the aim to be more productive and meaningful (Ekowati et al., 2015; Yudha et al., 2019)

Conventional learning is learning that uses a teacher-centric approach in learning, in this case, communication is one-way from teacher to student, the learning methods used are mostly lecture and demonstration methods, and focus on mastery of knowledge, memorization learning is a hallmark of conventional learning models (Kurnila et al., 2019; Richardo, 2017). In the control class, students were taught with a conventional learning model through lecture and assignment methods. In the control class, students lack enthusiasm in participating in learning, such as when learning will begin students have not prepared their learning tools, and there are still students who are gathering in class and talking with friends. During the learning process, it was seen that students paid less attention to the material being taught because students tended to be passive. After all, they only listened, listened, and recorded what was conveyed by the educator. In the learning process, educators dominate the management of learning and students become inactive.

## ▪ CONCLUSION

Mathematical power has an impact on how people think about and process learning results in order to acquire knowledge, abilities, and attitudes that will be reflected in daily behavior. It also serves to inspire and stimulate an understanding of the complexity of students' performance in multidisciplinary studies. Based on this, of course, students' mathematical power will be better if taught with a scientific approach with contextual teaching and learning (CTL) rather than using conventional learning models. The results of this study state that students who get a scientific approach with CTL are better than conventional learning models. To achieve meaningful learning, teachers should implement a planned math lesson that develops students' mathematical power through the application of creative and innovative learning that occurs in the student's thinking.

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