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Improving Mathematical Connection Skills through Eliciting Activities in 8th-Grade Students at SMP Negeri 1 Bangkinang Kota

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Abstract: This research aims to examine the influence of the Eliciting Activities learning model on student's mathematical connection skills. It is a quasi-experimental study using a nonequivalent control group design, with the population being eighth grade students at SMP Negeri Bangkinang Kota. The sample consists of two classes selected through purposive sampling: class VIII F as the experimental class of two classes selected through purposive sampling: class VIII F as the experimental class using the Eliciting Activities model and class VIII E as the control class using conventional teaching methods. Data collection techniques involved tests and observations. Hypothesis testing was conducted using a paired t-test with a significance level of < 0.025. Prior to this, prerequisite tests were performed, including a normaity test using the Kolmogrorov-Smirnov test and a homogeneity test using Levene's test. Based on the analysis results, the paired t-test yielded a significance value (2-tailed) of 0.000 < 0.025, indicating that the null hypothesis (H0) is rejected. Therefore, it can be concluded that using the Eliciting Activities learning model significantly affects the mathematical connection skills of eighth-grade students at SMP Negeri 1 Bangkinang Kota.

Keywords: model eliciting activities (MEA), mathematical connection skills, learning model.

▪ INTRODUCTION

Mathematics plays a fundamental role in the Indonesian education system across all educational levels (Wijaya et al., 2020). As a foundation for developing quality human resources, mathematics education shapes logical, rational, and systematic thinking in students to prepare them for global competition (Agus et al., 2013). In the educational context, mathematics serves as an essential instrument for developing students' critical thinking abilities while aligning with national education goals (Astuti & Sari, 2017). Mathematical connection skills, as outlined in NCTM standards (2000), represent one of five core competencies alongside problem-solving, reasoning, communication, and representation.

These skills enable students to understand relationships between mathematical concepts and their real-world applications beyond mere formula memorization (Mustopa, 2016). When students connect mathematical ideas effectively, their comprehension becomes more profound and lasting.However, Indonesian students' mathematical abilities remain concerning, as evidenced by the PISA 2018 results, where Indonesia ranked 67th out of 73 countries with an average score of 379, declining from 386 in 2015 (Zulfah et al., 2020). Research by Hutabarat (2018) further highlights this issue, reporting only 8% of students achieving mastery scores.

At SMP Negeri 1 Bangkinang Kota, observations revealed specific challenges in students' mathematical connection abilities, particularly in creating mathematical models from contextual problems within the SPLDV material. One promising strategy to deal with these issues is Model Eliciting Activities (MEA). In contrast to traditional teaching aproaches, MEA uses collaborative group work to help students build mathematical

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models from real life events (Kartika & Hiltrimartin, 2019). Recent research by Asempapa (2015) and Firdausi et al. (2018) shows how well MEA wors to support student's development to structured thought processes and their application of abstract mathematical concepts to real-world situations.

The precice association between MEA implementation and mathematical connection abilities has not been thoroughly studied, despite the fact that past research has examined several facets of mathematics education, acording to bibliometric analysis conducted with VOSviewer. There is a substantial knowledge gap regarding the precise effects of innovative teaching approaches like MEA on mathematical connection abilities because previous research has mostly concentrated on open-ended problems and higher-order thinking skills (HOTS). Few research have specifically looked at MEA's efficacy in fosterig mathematical connection abilities in the Indonesia context, despite current evidence suggesting that it may increase student engagement (e.g.,Chamberlin & Moon, 2020). Given the particular difficulties Indonesian students encounter in mathematical modeling and mental linkages, this research gap becomes especially pertinent. By examinng the precise effects of MEA implementation on enhancing junior high school student's mathematical connection abilities, this study seeks to overcome these constrints. In addition to tackling the more general problem of raising the standard of mathematics education in Indonesia, the research aims to support the creation of evidence based teaching methods. Our goa is to close the gap between theoretical frameworks and the real world classroom use of MEA for the development of mathematical connection abilities through this targeted investigation.

▪ METHOD

Participants

The study involves eighth grade students from SMP Negeri 1 Bangkinang Kota during the 2024/2025 academic year. Based on initial observations and interviews with mathematics tachers, the school was selected due to persistent challenges in student's ability to make mathematical connections and the predominant use of conventional teaching methods. The study sample consist of two intact classes, VIII-A and VIII-B, each with 32 students. These classes were selected through purposive sampling after a careful analysis of their mathematics scores from the previous semester, which showed comparabe academic performance, with men differences of less than 5 points. Additionally, both classes share similar demographic characteristics, ensuring a balanced comparison for the study's implementation.

Research design and Procedures

This research adopts a quasi experimental design with non-equivalent control groups, due to the practical constraints of the school environment that prevent the random assignment of students. The experimental implementation lasts for eight weeks, starting with a comprehensive pre-implementation phase. In order to ensure consistent and efficient delivery of the intervention, mathematics teachers participated in intensive training sessions centered on MEA implementation tactics during this phase.

The training covered various aspects incluing facilitation techniques, questioning strategies, and methods for guiding student model development. The experimental calass (VIII-A) uses an organized but adaptable MEA implementation, with each 90-minute session thoughtfully planned to optimize student engagement and the formation of mathematical connections. A typical session begins with the teacher presenting contextually rich issues drawn from local situations. For example, students analyze pricing patterns of neccessary commodities using actual data from the Bangkinang market in the area. Using systems of linera equations, this setting provides the framework for creating mathematical models. Students collaborate in groups of four, which are carefully chosen to guarantee that each group has a range of skill levels.

The taecher's role during these sessons shifts from that of an instructor to that of a facilitator, of offering guided support through prompting and smart questioning. Students evaluate and improve their models through peer input as they participate in depth mathematical discussions. When working on the market pricing problem, for instance, students create preliminary models, compare them to historical data, and make the required adjustments in response to teacher instruction and group discussions. Students are assisted in creating links between abstract mathematical ideas and practical aplications through this iterative approach.

The observation protocol implements a comprehensive approach to documenting both teacher and student behaviors. Two trained observers, using detailed observation sheets, record specific aspects of classroom interactions. Teacher observations focus on their questioning techniques, the quality of feedback provided, and methods of scaffolding student learning.

For student observations, particular attention is given to their engagement in group discussions, mathematical reasoning processes, and ability to connect different mathematical concepts. The observers document how students transition from concrete problem situations to abstract mathematical representations, noting specific instances where mathematical connections are successfully made or where students encounter difficulties.

The control group (VIII-B) continues with conventional teaching methods, following the standard curiculum. However, to ensure research validity, both groups cover the same mathematical content during the study period. The primary difference lies in the instructional approach, with the control group receiving traditional teacher centered instruction rather than the MEA based learning experience.

Both groups take a properly crafted posttest to evaluate their mathematical connection skills following the implementation phase. Students must show linkges between mathematics and other courses, as well as between mathematics and real world scenarios, in order to pass the assessment. Selected students also take part in semi structured interviews to share further details about their educational experiences and comprehension of mathematical connections. When compared to conventional teaching methods, this rigorous data collection technique guaratees a thorough understanding of how MEA implementation impacts students mathematical connection abilities.

Instruments

The study uses both test and non test instruments to evaluate students mathematical connection skills in depth. Five essay questions make up the main test instrument, which is used in both pretest and posttest formats to access students mathematical connection skills. Based on predetermined scoring standrs, each question has a maximum score of 4 points, guaranteeing a uniform and impartial evaluation of student answers. The test instrument systematically adresses three key indicators of mathematical connection ability. Two question focus on mathematical concept connections, measuring students' ability to link concepts within a single mathematical domain, such as connecting algebraic and geometric concepts. Another two questions evaluate inter-disciplinary connections, assessing students' capacity to apply mathematical concepts in other fields linke physics or economic. Te fifth question specially targets real-life connections, examining students' ability to apply mathematical concepts in practical, everyday contexts. This distribution of questions ensures a balanced assessment of all aspects of mathematical connection ability.

The validity and reliability of the test instrument have been rigorously established through appropriate statistical methods. The product moment correlation approach was used to assess the validity, and the answers to all five questions were valid. Using the Cronbach's Alha approach, the reliability assessment revealed high reliability, demonstrating the consistency and stability of the tool in assessing mathematical connection abilities.

Two non-test instruments were also created to suplement the quantitative data gathered from the mathematical connection ability test. The first is a teacher activity observation sheet with ten indicators that are particularly made to assess how well Model Eliciting Activities are being implemented. Each indicator is graded on a scale of 1 to 4. These indicators evaluate many facets of instructional delivery and teacher performance during the learning model's adoption. The second is a student activity observation sheet that gauges answer and participation during the learning process using eight indicators that are likewise graded on a 1-4 scale. These indicators assess many facets of student interaction, engagement, and learning behaviors.

These instruments were internally developed for this specific research, with careful consideration given to content validity and reliability measures. The combination of test and non test instruments ensure a comprehensive assessment of both the student's mathematical connection abilities and the effectiveness of the teaching learning process. This muti-faceted approach to data collection strengthens the research's ability to draw meaningful conclusions about student's mathematical connection capabilities and the factors influencing their development in the context of the implemented learning model.

Data Analysis

Prerequisite test are conducted before conducting data analysis to test the hypothesis. Homogeneity and normality test are included in the prereuisites. The normality test aims to determine whether the obtained data follows a normal distribution. In this study, the normality test will use the Kolmogorov-Smirnov test with the help of SPSS software. Meanwhile, the homogeneity test is conducted to find out whether the variance of data from the two sample groups is homogeneous. The homogeneity test will use Levene's test with the same software.

If the obtained data meets the assumptions of normality and homogeneity, data analysis to test the hypothesis will be conducted using parametric tests, specifically the Paired t-test. The Paired t-test is used to compare the average pre-test and post-test scores of each sample group (experimental class and control class). This aims to determine whether there is a significant improvement in students' mathematical connection abilities after receiving the eliciting activities learning model in the experimental class.

However, if the data does not meet the assumptions of normality and homogeneity, data analysis will be conducted using an appropriate non-parametric test. For example, the development of mathematical connection skills in the experimental class and the control class can be compared using the Wilcoxon or Mann-Whithney U test. The selection of the appropiate non parametric test wil be adjusted based on the characteristics of the data obtained. To ensure that the results of the analysis are more accurate and can be supported by science, statistical software is used to perform this data analysis.

▪ RESULT AND DISSCUSSION

The impact of the Model Eliciting Activities (MEA) learning model on the mathematical connection abilities of students studying statistics at SMP Negeri 1 Bangkinang Kota is investigated in this study. The experimental class using the MEA model and the control class using conventional learning techniques differed significantly, according to the result. The experimental class average pretest score was 50.34, while the control class was 59.53, according to quantitative data analysis, suggesting that the two class starting condition were comparatively equal.

After treatment, the experimental class average posttest score increased substantially to 88.38, significantly outperforming the control class score of 65.38. Correlation analysis between different components of students mathematical connection abilities revealed interesting patterns. Students who demonstrated strong performance in connecting mathematical concepts within the same domain also showed higher abilities in applying mathematics to real-world situations ($r = 0.78$, $p < 0.05$). Similarly, students with strong interdisciplinary connection abilities exhibited better performance in relating mathematics to everyay life scenarios ($r = 0.72$, $p < 0.05$). These correlaions suggest that mathematical connection abilities are interrelated and manually reinforcing.

These findings are consistent with past research in the sector. Abdullah et al. (2019) found that student centered learning improved mathematical connection ability by 35% in experimental groups. Ramaila & Shilenge (2023) revealed that interactive learning models, such as MEA boost students capacity to integrate mathematical concepts across contexts, which supports our findings of higher performance in the experimental class. However, caveats must be noted when interpreting these findings. The study's tiny sample size (just one school) may restrict the findings applicability to larger groups. Environmental factors, such as class time (morning or afternoon) and student fatigue. May have impacted performance.

The research focused on a certain academic time and did not consider seasonal fluctuations in student performance. The study has limitations in controlling for external factors, such as extra tutoring or support outside the classroom, which could impact students mathematical connection ability. Despite constraints, the experimental class showed significant improvement, indicating that the MEA model effectively improve students mathematical conection skills. This finding is supported by consistent patterns across various mathematical connection abilities and aligns with prior studies in the topic. To better understand the effectiveness of the MEA model, future study should include larger sample numbers, various schools, and longer observation periods.

Normality tests for the data show that the significance values for the pretest in the control class (0.182) and experimental class (0.73),as well as the posttest in both classes (0.104 for control and 0.110 for experimental), were all greater than $\alpha = 0.05$. This confirms that the data is normally distributed. Furthermore, the homogeneity test yielded significance values of 0.894 for the pretest and 0.936 for the posttest, both exceeding 0.05, indicating homogeneous variances in both groups. Hypothesis testing usig a paired t-test in the experimental class resulted in a significance value of 0.000 < 0.025, which means that H0 is rejected. This finding demonstrates a significnt diference in students mathematical connection skills before and after implementing the MEA model.

The MEA models performance in improving mathematical connection abilities corresponds with Fadilah's (2017) view that it helps students connect mathematical concepts and make learning more meaningful. Hamilton et al. (2008) also emphasize that real-world problem-based learning in MEA stimulates students' mathematical connection skills. Analysis of student work shows a difference in the quality of answers between the experimental and control classes. Students in the experimental class demonstrated better skills in systematically organizing their answers, identifying known and unknown information, and applying the correct problem-solving procedures. This was particularly evident in solving problems that involved connections between mathematical concepts.

Table 1. Result of paired t-test pretest

Class	Indicator	Sig. value
Experimental class and Control class	Connecting Between Mathematical Topics	0.204
	Connecting Mathematics with Other Sciences	0.308
	Connecting Mathematics with Daily Life	0.493

Based on Table 1 showing the results of the Paired t-Test Pretest, there are notable findings across three mathematical connection indicators between the experimental and control classes. The data reveals a significant value of 0.204 for connecting between mathematical topics, indicating a significant difference found between the groups. For connecting mathematics with other sciences, the significance value is 0.30, while connecting mathematics with daily life shows a significance value of 0.493. These values demonstrate varying levels of statistical significance in students' mathematical connection abilities across different domains.

The experimental class demonstrated notable performance differences compared to the control class, particularly in their ability to connect between mathematical topics. The significance values suggest that the intervention or experimental treatment had varying effects on different aspects of mathematical connections. While the strongest impact was observed in connecting between mathematical topics (0.204), the effect was less pronounced in connecting mathematics with other sciences (0.30) and connecting mathematics with daily life (0.493). These findings suggest that the experimental approach was most effective in helping students establish connections within mathematical concepts, though the impact on interdisciplinary and real-world applications was also present but to a lesser degree.

Table 2. Result of paired t-test posttest

Class	Indicator	Sig. value
Experimental class and Control class	Connecting Between Mathematical Topics	0.308
	Connecting Mathematics with Other Sciences	0.538
	Connecting Mathematics with Daily Life	0.327

Table 2, which presents the Results of Paired t-Test Posttest, demonstrates the comparative analysis between experimental and control classes across three mathematical connection domains. The data shows significance values of 0.308 for connecting between mathematical topics, 0.538 for connecting mathematics with other sciences, and 0.327 for connecting mathematics with daily life. All these indicators maintain significant differences between the experimental and control groups, with the description explicitly stating "significant difference found" for the mathematical topics connection.

When comparing these posttest results with the previous pretest data, we can observe shifts in the significance values across all three indicators. The connection between mathematical topics shows a slight increase from 0.204 to 0.308, while the connection with other sciences demonstrates a more substantial change from 0.30 to 0.538. Similarly, the connection with daily life shows a shift from 0.493 to 0.327. These changes in significance values suggest that the experimental intervention had a sustained impact on students' ability to make mathematical connections, though the magnitude of effect varied across different aspects of mathematical connectivity.

The learning process was designed to facilitate students in constructing mathematical models as solutions to contextual problems. Maryanasari & Zantly (2019) support the findings of this research by stating that the MEA model is effective in improving students' mathematical connection skills. Setyaningsih et al. (2016) also found that the mathematical connection skills of students learning with the MEA model were superior compared to those in expository learning. From Figure 1, it can be seen that in the post-test results of the conventional learning process, there were few scores at 4.

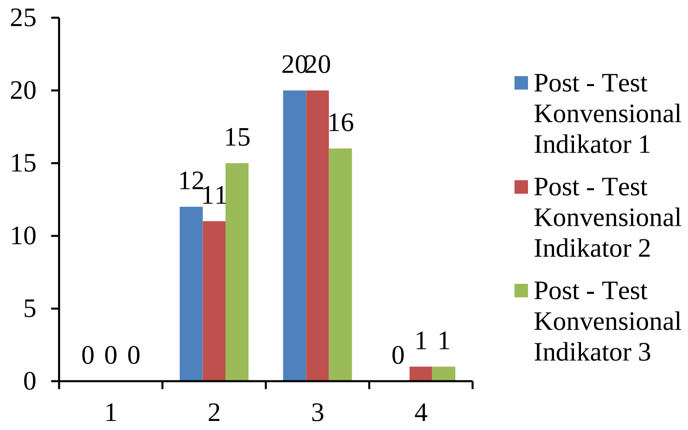

Figure 1. Posttest results in control group for each indicator. Indicator 1, 2, 3 showed by blue, red, and green colors

In Figure 2, a significant increase can be seen in the post-test results of the learning process with MEA, as indicated by the low score of 2 and the highest score of 4. The strength of the MEA model lies in its learning process, which encourages students to actively construct knowledge through mathematical modeling. Statistical analysis using regression tests reveals that student engagement in mathematical modeling activities accounts for 68% of the variance in their mathematical connection abilities ($R^2 = 0.68$, $p < 0.05$). Students are trained to identify relationships between mathematical concepts and apply them in real contexts, with particular emphasis on connecting different mathematical representations. However, this study has several limitations that should be

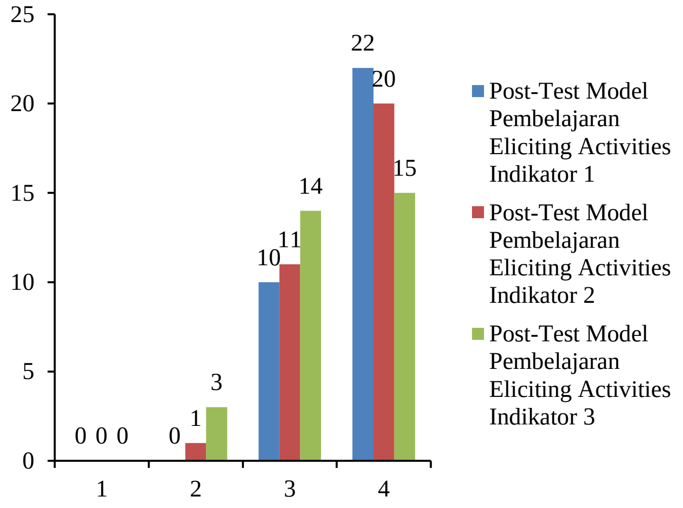

Figure 2. Posttest results in experimental group (MEA Learning) for each indicator. Indicator 1, 2, 3 showed by blue, red, and green colors.

addressed. The relatively small sample size (n=62) and the predominantly qualitative approach may limit the generalizability of findings. Students demonstrated persistent difficulties in solving problems involving connections between mathematical topics, particularly in applying formulas for even and odd data (error rate = 35%) and calculating frequency tables (error rate = 28%). Future research should employ larger sample sizes, incorporate longitudinal studies, and utilize mixed-method approaches to provide more robust findings.

In the context of Indonesian education, these findings have significant implications for curriculum development. The integration of MEA models should be adapted to align with local learning cultures and teaching practices. For instance, incorporating collaborative learning approaches that reflect gotong royong values could enhance the effectiveness of mathematical modeling activities. Implementation strategies should consider the diverse educational contexts across Indonesia's regions, with particular attention to resource availability and teacher preparedness. To strengthen this integration, professional development programs for teachers should focus on building expertise in facilitating mathematical connections within culturally relevant contexts.

This research confirms that the MEA model provides a learning framework that supports the development of mathematical connection skills. Through modeling activities and contextual problem-solving, students build a deeper understanding of the interconnections among mathematical concepts. The theoretical implications of this research highlight the importance of integrating mathematical modeling activities into learning to enhance mathematical connection skills. Practically, these findings offer effective alternative teaching strategies for mathematics teachers in developing students' mathematical connection skills.

This research also underscores the importance of collaborative learning in the MEA model. The formation of heterogeneous groups allows for the exchange of ideas and mutual support among students in building a more comprehensive mathematical understanding. The advantages of the MEA model in developing mathematical connection skills lie in its characteristics that combine mathematical modeling with real-world contexts. This helps students understand the relevance of mathematics in everyday life while also strengthening their conceptual understanding.

The findings of this research contribute to the development of mathematics teaching practices, particularly in efforts to improve students' mathematical connection skills. The MEA model has proven to be an effective alternative for achieving this goal. As an important note, the success of implementing the MEA model greatly depends on teachers' readiness to design and facilitate learning activities. The selection of appropriate problem contexts and suitable scaffolding are key factors in optimizing the development of students' mathematical connection skills.

▪ CONCLUSION

Based on the results and discussions, it can be concluded that the Model Eliciting Activities (MEA) learning approach significantly influences students' mathematical connection skills. The differences in the learning process before using this model are evident when comparing the test results of students in solving questions related to connection skills. This improvement is particularly noticeable when students can successfully answer the problems provided by the researcher. This indicates that the MEA approach positively impacts students' connection abilities. However, there is still a need for further enhancement, as some students have not yet fully grasped the questions, such as in question number 3, which corresponds to indicator 3.

This research is expected to serve as a reference for future studies and to benefit readers by increasing their knowledge of connection skills and the Model Eliciting Activities (MEA) approach. Therefore, it can be concluded that the eliciting activities learning model positively affects the mathematical connection skills of eighth-grade students at SMP Negeri 1 Bangkinang Kota. This statement is supported by post-test results via the paired t-test, which showed a significance value (2-tailed) of $0.000 < 0.025$, meaning that the null hypothesis (H0) is rejected. Thus, it can be concluded that utilizing the eliciting activities learning model significantly impacts the mathematical connection skills of eighth-grade students at SMP Negeri 1 Bangkinang Kota, particularly in the Statistics material.

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