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# Application of the Model-Eliciting Activities (MEAs) Learning Model on Mathematics Learning Based on higher-order thinking Skills (HOTS)

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**Abstract**

The MEAs learning model is interactive, utilising technology, simulations, and creative methods to stimulate curiosity in students. This study aims to know whether or not significant differences occur in Mathematics learning by applying the Model-Eliciting Activities (MEAs) learning model based on higher-order thinking Skills (HOTS). Besides that, it is expected to provide a perspective on the effectiveness of the learning model in improving the quality of mathematics learning based on HOTS. This study was conducted at SMPN 1 Wanayasa with a quantitative research approach. The research method was a survey method and one-way ANOVA test analysis to see the relationship between students' learning outcomes of class VIII A, B, C, D, E, and F. The population of this study was students at SMPN 1 Wanayasa with a sample of 191 students of class VIII consisting of 31 students in class VIII A and 32 students in classes B, C, D, E, and F. The results show that students' learning outcomes differ only between classes VIII A and VIII D and between classes VIII C and VIII D.

## INTRODUCTION

Developing an effective mathematics learning model is one of the critical aspects of achieving learning and educational goals (Pancawardana et al., 2023). Educators are expected to be able to apply a fun learning model in order to attract students' interest and motivation in learning mathematics because the learning model carried out will significantly determine the learning outcomes of students at the end of the learning process (Murharyana et al., 2023). In other words, learning done with a suitable learning model can positively affect students' learning outcomes (Al Ayyubi & Rohmatulloh, 2023). In addition, gradually training and activating students' non-conventional ways of thinking will support the learning process (Rifanti & Ananda, 2020). The equilibrium can see the accuracy of the learning model of students in responding to learning carried out either explicitly or implicitly (Berlian et al., 2023; Meisya & Arnawa, 2021; Rusliah et al., 2021).

Mathematics learning still has many incompatibilities between the material taught

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and the learning model applied (Salafy & Susanah, 2022). It gives less positive causality for students to respond, so they become bored and lack interest in mathematics (Mei et al., 2022; Savitri et al., 2021; Wijayanti et al., 2021). In other words, mathematics is often used as a scourge by students in abstract things that are difficult to understand (Hafiz et al., 2020; Nurhidayat et al., 2023; Sulistyarini, 2022; Zaenuri et al., 2020). One exciting learning model that can be applied to mathematics learning is Model-Eliciting Activities (MEAs), which encourages learning activities in mathematics by stimulating higher-order thinking in students (Auliya et al., 2022). Mathematics education is one of the crucial aspects of constructing skills in higher-order thinking (Ramadhan et al., 2023; Zaeni et al., 2021). Through innovative and evolving approaches, Model-Eliciting Activities are increasinglyin the spotlight in mathematics learning based on higher-order thinking Skills (HOTS) (Agusta et al., 2021; Fitri et al., 2022; Niswah, 2022; Rumain, 2020; Wiono & Meriza, 2022). The activities in MEAs learning create a dynamic and challenging learning environment for students and create a nuance for students to engage in a deep and complex thought process.

The MEAs learning model is interactive, utilising technology, simulations, and creative methods to stimulate curiosity in students (Ariyanto et al., 2021). In addition, it emphasises the context ofproblem-solving and critical thinking of students, which can open up the possibility for higher-order thinking skills that have been neglected in mathematics learning (Wilansyah, 2020). In addition, it was found that there is still a lack of studies that examine the correlation between mathematics learning and the MEAs learning model (Susanti et al., 2020; Widayanti, 2021). Utilising the MEAs in the mathematics learning process is hoped to provide students with an inspiring and challenging experience. Moreover, to fill the gaps of the previous studies, in this study, the MEAs learning model is elaborated with students' higher-order thinking Skills (HOTS) to provide alternatives and new perspectives in designing an inclusive mathematicscurriculum.

This MEAs learning model can also be adapted to various levels of ability and various learning. Thus, this study aims to see whether or not there is a significant difference in mathematics learning by applying the MEAs learning model based on students' HOTS conducted at junior high schools. In addition, this study is expected to provide a perspective on the effectiveness of applying MEAs in improving the quality of mathematics learning based on HOTS because this research offers novelty with its study in the application of the AEC learning model, which is rarely used in learning and research analysis not only in one or two classes.

## METHOD

This research uses a quantitative approach with survey and analysis methods using Analysis of Variance which was carried out at SMPN 1 Wanayasa with a population of 463 students with a sample in this study of 191 students consisting of 31 students in class VIII A, 32 students in class VIII B, 32 students in class VIII C, 32 students in class VIII D, 32 students in class VIII E, and 32 students in class VIII F (Sugiyono, 2021). The sampling technique used the Slovin formula in the context of cluster area sampling (A. Santoso, 2023). So, this research focuses on the differences and interactions that occur in applying mathematics learning using the HOTS-based MEA model, which provided that the data analysis consists of a data normality test using Kolmogorov Smirnov assisted by SPSS 26. If the data is usually distributed, use a parametric or non-parametric statistical test. Thus, the procedures for this research include formulating a problem by paying attention to the novelty and gaps in existing research, then surveying the field to be able to see the issues with the application of the HOTS-based AEC model, and carrying out data analysis to make conclusions that are inherently based on descriptive and inferential statistics.

## RESULTS

The results show the Alternative Hypothesis ($H_1$) and Null Hypothesis ($H_0$) with the test criteria accepting $H_0$ if the sig value. $\geq 0.05$ and reject $H_0$ if the sig. value $< 0.05$ is as follows:

**Table 1.** Descriptives

| | N | Mean | Std. Deviation |
|---|---|---|---|
| VIII A | 31 | 54.06 | 20.471 |
| VIII B | 32 | 51.38 | 17.659 |
| VIII C | 32 | 53.63 | 20.967 |
| VIII D | 32 | 38.75 | 13.984 |
| VIII E | 32 | 48.06 | 20.525 |
| VIII F | 32 | 49.75 | 16.317 |

Based on Table 1 above, it can be known that the number of students in class VIII A is 31 students, with an average score of 54.06 and a standard deviation of 20.471. As for classes VIII B, C, D, E, and F, there are 32 students with an average score of 51.38, 53.63,38.75, 48.06, and 49.75, and the standard deviation values of the five classes are 17.659, 20.967, 13.984, 20.525, and 16.317.

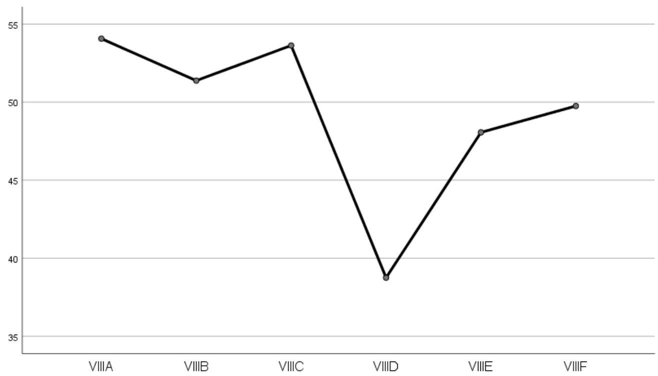


**Figure 1.** Means Plots

**Table 2.** Tests of Normality

| | Kolmogorov-Smirnov[a] | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| VIII A | .109 | 31 | .200* |
| VIII B | .125 | 32 | .200* |
| VIII C | .119 | 32 | .200* |
| VIII D | .152 | 32 | .058 |
| VIII E | .141 | 32 | .106 |
| VIII F | .138 | 32 | .128 |

Based on Table 2 above, it can be known that the significance values of classes VIII A, B, C, D, E, and F in Kolmogorov-Smirnov are 0.200, 0.200, 0.200, 0.058, 0.106, and 0.128. These data show that the significance value of the six groups is more significant than 0.05. It can be concluded that the data is usually distributed, while the distribution of data from classes VIII A, B, C, D, E, and F can be seen in the Normal Q- Q Figure as follows.

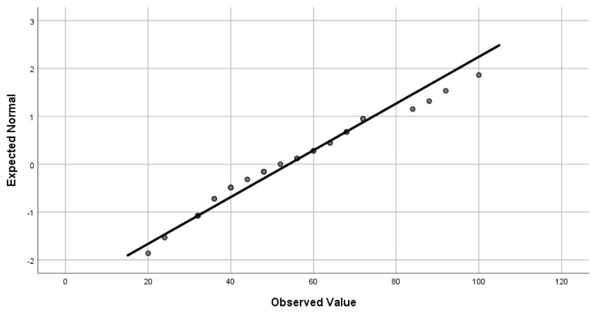


**Figure 2.** Standard Q-Q Plot of Learning Outcomes of Class VIII A

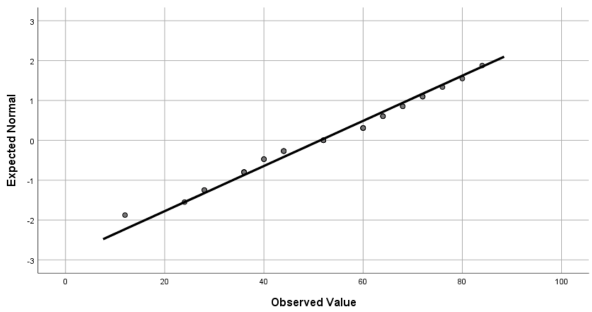


**Figure 3.** Standard Q-Q Plot of Learning Outcomes of Class VIII B

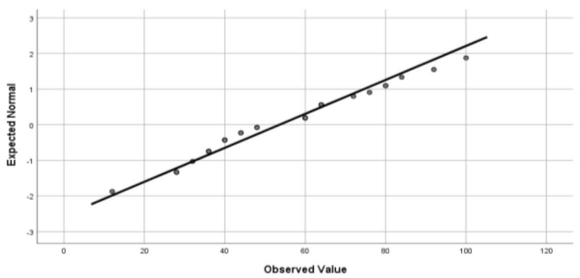


**Figure 4.** Normal Q-Q Learning Outcomes of Class VIII C

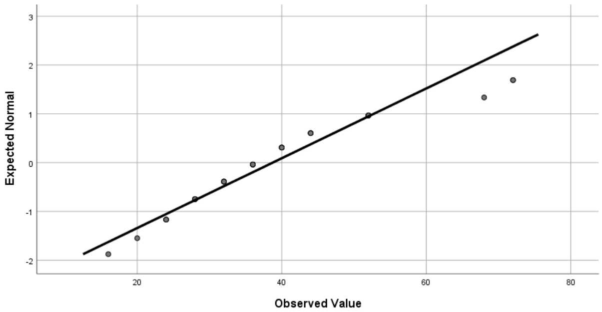


**Figure 5.** Standard Q-Q Plot of Learning Outcomes of Class VIII D

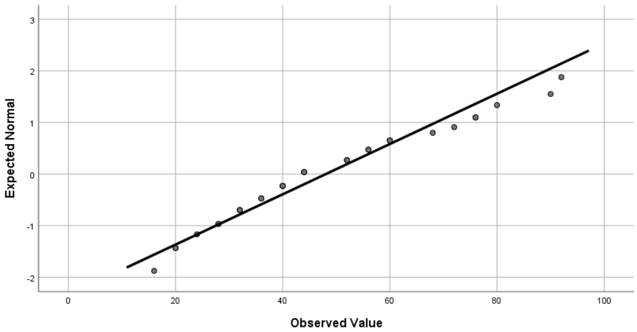


**Figure 6.** Standard Q-Q Plot of Learning Outcomes of Class VIII E

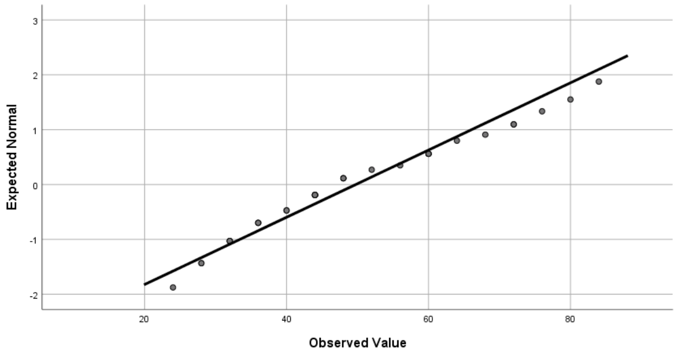


**Figure 7.** Standard Q-Q Plot of Learning Outcomes of Class VIII F

Based on the figures above, it can be known that most of the data on learning outcomes in the MEAs learning model based on students' HOTS in classes VIII A, B, C, D, E, and F are around the diagonal line. It shows that the data is normally distributed. Then, the Homogeneity test is carried out to determine whether the students' learning outcomes data can be collected using the one-way ANOVA or Kruskal-Wallis test.

**Table 3.** Test of Homogeneity of Variance

| | Levene Statistic | Sig. |
|---|---|---|
| Based on Mean | 2.176 | .059 |
| Based on Median | 2.037 | .075 |
| Based on Mediann and with adjusted df | 2.037 | .076 |
| Based on trimmed Mean | 2.178 | .058 |

Based on Table 3 above, it can be known that the significance value of Based on Mean is 0.059. These data show that the significance value of the six groups basedon school origin is more significant than 0.05. It can be concluded that the data is homogeneous.Thus, further hypothesis testing is carried out using parametric statistics, namely the one-way ANOVA test.

**Table 4.** ANOVA

| | Df | F | Sig. |
|---|---|---|---|
| Between Groups | 5 | 2.958 | .014 |

Based on Table 4 above, it can be known that the significance value of Between Groups is 0.014. From this data, it is obtained that the significance value is smaller than 0.05. It can be concluded that there are differences in students' learning outcomes in MEAs learning based on higher order thinking skills between students in class VIII A,B, C, D, E, and F at SMPN 1 Wanayasa. Because $H_0$ is rejected and $H_1$ is accepted, it is continued with the post-hoc test on students' learning outcomes in classes VIII A, B,C, D, E, and F.

**Table 5.** Multiple Comparisons

| Class | Class | Mean Difference | Sig. |
|---|---|---|---|
| VIII A | VIII B | 2.690 | 1.000 |
| | VIII C | .440 | 1.000 |
| | VIII D | 15.315* | 0.018 |
| | VIII E | 6.002 | 1.000 |
| | VIII F | 4.315 | 1.000 |
| VIII B | VIII C | -2.250 | 1.000 |
| | VIII D | 12.625 | .104 |
| | VIII E | 3.313 | 1.000 |
| | VIII F | 1.625 | 1.000 |
| VIII C | VIII D | 14.875* | .023 |
| | VIII E | 5.563 | 1.000 |
| | VIII F | 3.875 | 1.000 |
| VIII D | VIII E | -9.312 | .681 |
| | VIII F | -11.000 | .275 |
| VIII E | VIII F | -1.687 | 1.000 |

Based on Table 5 above, it can be known that the significance value between classes VIII A and class VIII B, C, E, and F is more significant than 0.05. The significance value between class VIII B and class VIII C, E and F is more significant than 0.05. The significance value between class VIII C and E and F is more significant than 0.05. The significance value between class VIII D, E, and F is more significant than 0.05. Then, the significance value between class VIII E and class VIII F is more significant than 0.05. A significance value that is less than 0.05 is class VIII A with VIII D and class VIII C with

VIII D. It can be concluded that there is no difference in students' learning outcomes which deal with MEAs in mathematics learning based on HOTS between students in class VIII A and classes VIII B, C, E, F; class VIII B and classes VIII C, E, F; VIII C and classes VIII E, F; VIII D and classes VIII E, F; and class VIII E and class VIII F, while there is a significant difference in students' learning outcomes between class VIII A and VIII D and also class VIII C and VIII D.

## DISCUSSION

Based on the explanation of the research results above, it can be known that the sample amounted to 191 students consisting of 31 students in class VIII A and 32 students in classes B, C, D, E, F and obtained an average value of 54.06, 51.38, 53.63, 38.75, 48.06, and 49.75 with standard deviation values of 20.471, 17.659, 20.967, 13.984, 20.525, and 16.317. Moreover, it was found that the significance value in the normality and homogeneity test was more significant than 0.05. Then, one-way ANOVA testing is carried out because the data is usually distributed on Kolmogorov- Smirnov and homogeneous data. In addition, the Normal Q-Q Plot also shows that the data on students' learning outcomes or points are around the diagnostic line, indicating that the data is usually distributed.

In one-way ANOVA testing using the Bonferroni test, it was found that there were differences in students' learning outcomes in MEAs learning based on HOTS between students in classes VIII A, B, C, D, E, and F at SMPN 1 Wanayasa. Thus, the post-hoc test is done, and the difference in students' learning outcomes in the MEAs learning model based on HOTS is only found in class VIII A with VIII D and class VIII C with VIII D, and other these classes showed no difference. This is in line with previous studies by Hartati et al. (2020); Indiyanti et al. (2023); Irwan & Elniati (2021); Mbela et al. (2021); Pahlevi (2021); Roesdiana & Hidayati (2020) on the use of the MEAs model and the emphasis on HOTS-based learning.

Model Eliciting Activities (MEAs) learning models are problem-solving and engineering design tasks that engage students in creating, testing, and refining models to represent and solve complex real-world problems (Susanti et al., 2020). The MEAs learning model is commonly used in educational environments, especially in science, technology, engineering, and mathematics. The primary purpose of the MEAs learning model is to promote critical thinking, problem-solving skills, cooperation, and communication among students (Roesdiana & Hidayati, 2020). The MEAs learning model is designed to go beyond traditional problem-solving exercises by emphasising the importance of creating and refining models to understand and solve complex problems (Chamberlin, 2021).

The MEAs learning model is based on several fundamental principles that aim to enhance students' learning and skill development, which include (1) Problem-Based Learning (PBL), (2) Model-Centric Approach, (3) Iterative Process, (4) Collaborative Learning, (5) Realness; (6) Documentation and Reflection; (7) Advancing Different Viewpoints; (8) Inquiry-Based Learning; (9) Inquiry-Based Learning; (10) Inclusivity;

and (11) Assessment for Learning. MEAs learning model adopts a problem-based learning approach where students are exposed to complex real-world problems. This stimulates critical thinking and motivates students to develop a deep understanding of the material.

The MEA learning model focuses on creating, testing and refining. That is why students solve problems and create visual or conceptual representations reflecting their understanding. They engage in a literary cycle where they create initial models, test them, and refine them based on trial results and feedback. This learning model stimulates continuous reflection and critical thinking in students. In addition, the MEA learning model encourages collaboration and communication among students. The peer review process and class discussions allow them to share ideas, provide feedback, and construct shared understanding.

MEAs learning model creates situations that are authentic and relevant to the real world (Rusliah et al., 2021). This helpsstudents recognise the usefulness and application of the concepts learned in a real-world context. Students are encouraged to document steps, decisions, and changes made based on the model created. This helps understand the concepts and can also construct documentation and reflection skills. The MEA learning model stimulates them to consider multiple viewpoints and approaches. Group discussions and collaboration allow them to see a problem from multiple perspectives.

Then, the MEAs learning model is designed to be accessible to various student backgrounds and ability levels (Meisya & Arnawa, 2021). Creating an inclusive environment ensures that all students can participate and learn. Ita assessment is more formative, focusing on understanding the problem-solving process and model development rather than just the result. This provides valuable feedback for students to improve their understanding. By integrating these principles, the MEAs learning model can create an immersive, student-centred learning experience and encourage the development of critical skills that can be applied in daily life.

The stages in the MEAs learning model include a series of steps designed to guide students through problem-solving and model development. The general stages of the MEAs learning model include (1) Problem introduction, (2) Initial model building, (3) Model testing, (4) Reflection and updating, (5) Further testing and improvement, (6) Documentation, (7) Peer review; (8) Collaboration; (9) Final solution; and (10) Class discussion.

The MEAs learning model begins by introducing a complex and exciting real-world problem (Zaenuri et al., 2020). The problem stimulates interest and motivates students to seek a solution. Students are asked to create an initial model representing their understanding of the problem. This demonstration can be in graphs, charts, concepts, or other visual representations. By doing this activity, students test their initial model to see how it can solve a problem or represent a situation correctly. This process involves identifying the strengths and weaknesses of the model.

Based on the results of the tests, students then reflect on the model that has been created. They then make transformative changes or refinements to the model to increase its effectiveness. The cycle of testing and refinement continues through repeated iterations. Students continue to test, reflect, and update their models until they reach a satisfactory solution. Students regularly document the steps, decisions, and changes they make throughout the process. This documentation includes their understanding of the problem and the reasoning behind each model change. They share their models with peers and provide constructive feedback. Peer review stimulates discussion and allows students to see a problem from multiple perspectives.

Collaborative activities are integrated, allowing students to work together to improve understanding by combining different ideas for a better solution (Al Ayyubi et al., 2018; Al Ayyubi, Dzikri, et al., 2024; Al Ayyubi, Murharyana, et al., 2024; Al Ayyubi, Rohaendi, et al., 2024; Al Ayyubi, Rohmatulloh, et al., 2024; Al Ayyubi & Rohmatulloh, 2023). Students reach a final solution after a series of iterations, tests, and updates. This solution may reflect the student's understanding of the problem and the model representation that is arguably the most effective. The MEAs learning model often ends with a class discussion in which students share their final solutions, insights gained, and experiences throughout the process. This discussion reinforces understanding of the concept and presents an opportunity to reflect together. Through these stages, the MEAs learning model can create an active learning environment, promote critical thinking, and engage students in a more genuine model development process.

High Order Thinking Skills (HOTS) refer to the understanding and application of higher-order thinking skills in thought processes and problem-solving (Niswah, 2022; Rumain, 2020; Sulistyarini, 2022). (HOTS) involves analysing, evaluating, synthesising, and making complex decisions. It is crucial for developing students' independent and analytical thinking in preparing for more complex intellectual challenges in real-world life and future careers. In addition, training in higher-order thinking skills can also help students become lifelong learners and more effective problem solvers.

The development of HOTS has various benefits, including improving problem-solving and decision-making skills, developing critical analysis and evaluation skills, enabling individuals to connect information and understand concepts in depth, encouraging creative thinking, and the ability to think broadly (Yusuf & Ma'rufi, 2022). It is essential to improve critical and analytical thinking, vital skills in education and daily life. The development of HOTS is also considered necessary in the education curriculum because it can help students develop HOTS, which is needed in facing future challenges by applying several contexts in learning, such as (1) Encouraging Critical and Creative Thinking, (2) Improving Analysis and Evaluation Skills; (3) Deepening Concept Understanding; and (4) Encouraging Issue Tackling.

HOTS allows students to be able to think critically and creatively, such as by posing open-ended questions or questions that ask students to make connections between information, develop their ability to think out of the box, generate new ideas, and express themselves creatively, as well as develop problem-solving skills, and think critically through solving problems which are relevant to daily life. By developing HOTS, they can learn to deeply analyse information and evaluate various concepts, which are essential skills in learning (Rumain, 2020; R. et al., 2020; Widayanti, 2021).

By using HOTS, students can make connections between information, understand concepts deeply, and see the big picture of a topic, which can improve their understanding. Next, it helps students solve problems and develop problem-solving skills in various learning contexts. Thus, HOTS development, integrated into learning, can help students develop skills in understanding, analysing, and critically evaluating information. Moreover, one way to encourage them in order to develop HOTS, especially in critical and creative thinking, is by using strategies that include (1) Encouraging students to ask questions, (2) Using problem-based learning models, and (3)Using HOTS-based questions.

Educators can encourage students to actively ask questions because students who ask questions tend to be ready to explore and find answers. This can help construct students' ability to think critically and creatively (Indiyanti et al., 2023; Risdiana et al., 2022). This learning model allows them todevelop problem-solving and critical thinking skills by solving problems relevant to daily life. HOTS-based questions in learning are used to measure students'ability to think critically and creatively. The questions encourage them to exchange concepts, process and apply information, find links from various information, use information to solve problems, and critically examine ideas and information. By applying these strategies, students are expected to have critical and creative thinking skills, essential for facing future challenges.

## CONCLUSION

It can be concluded that there are differences in students' learning outcomes by applying MEAs learning based on HOTS between students in classes VIII A, B, C, D, E, and F at SMPN 1 Wanayasa, with an average value of 54.06,51.38, 53.63, 38.75, 48.06, and 49.75 and standard deviations of 20.471, 17.659, 20.967, 13.984, 20.525, and 16.317 in the six classes. However, the difference only occurs between class VIII A and VIII D and between class VIII C and VIII D, whereas between class VIII A and classes VIII B, C, E, F; class VIII B and classes VIII C, E, F; class VIII C and classes VIII E, F; class VIII D and classes VIII E, F; and between class VIII E and class VIII F there is no significant difference. Thus, for further research, it is suggested that the MEAs learning model based on HOTS be tested in a two-way ANOVA by classifying students' learning outcomes based on gender in order to see further differences in students' learning outcomes that are more elementary.

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