Jurnal Elemen, 9(1), 49-64, January 2023
https:/doi.org/10.29408/jel.v9i1.6587

e- ISSN: 2442 - 4226

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The impact of polyhedron learning assisted by *Edpuzzle* in improving students' mathematical representation

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Abstract

The ability that students must have is the ability of mathematical representation. This research aims to determine if eighth-grade students at Al-Qona'ah Islamic Junior High School improve their mathematical representation skills after using the *Edpuzzle* application to learn how to construct polyhedrons. It was a quantitative research design using the Quasi Experiment research method with control and experimental classes. This research's population comprised 60 students (23 males and 37 females). After conducting research, it was determined that students' mathematical representation abilities did not improve with the aid of the *Edpuzzle* application on the polyhedron due to the need for more learning support facilities when utilizing the *Edpuzzle* application. This research is supported by the t-test, which yielded t-count < t-table or -29.2936 < -1.67155 so that H0 is accepted. The results of the n-gain calculation yielded a total n-gain score of 0.03, or the n-gain was low, indicating was no progress in learning using the *Edpuzzle* application on the polyhedron. This study did not have an impact on increasing students' mathematical representation.

Keywords: *Edpuzzle* application; polyhedron; students' mathematical representation

How to cite: Sartika, N. S., Kusumah, Y. S., Martadiputra, B. A. P., Sutihat, & Rosdianwinata, E. (2023). The impact of polyhedron learning assisted by *Edpuzzle* in improving students' mathematical representation. *Jurnal Elemen*, *9*(1), 49-64. https://doi.org/10.29408/jel.v9i1.6587

Received: 26 September 2022 | Revised: 28 September 2022
Accepted: 11 October 2022 | Published: 2 January 2023

Introduction

The main thing that students must have in learning mathematics is mathematical ability. According to Herdiman et al. (2018), students' mathematical understanding ability is one part that plays an essential role in the learning process. One of the abilities that can develop abilities students mathematical representation, namely students' mathematical representation abilities. According to Villegas et al. (Mulyaningsih et al., 2020), mathematical representation skills can be divided into three categories: verbal, graphical, and symbolic. The form of verbal representation, in the form of a statement, describes the supplied difficulties vocally or in writing. The type of visual representation may be tables, diagrams, graphs, or photographs. While symbolic representation takes the shape of mathematical symbols and models or mathematical equations created by these symbols, linguistic representation takes the form of words.

Jupri et al. (2020) stated that mathematical representation is a form of interpretation of one's thoughts on problem situations, which can be integrated into materials and processes mathematics learning includes verbal representation, numerical representation, symbolic representations, and visual representations in the form of graphs, diagrams, or forms geometric. Lesh et al. (Pratiwi, 2021) split the ability to represent mathematics learning into five categories: representation of real-world things, tangible representations, representation of arithmetic symbols, representation of spoken or spoken language, and representation of images or graphics.

Aisyah and Madio (2021) stated that the ability to represent mathematically is one of the skills needed to learn mathematics. Representation is converting an issue or concept into a new form, such as symbols, phrases, or sentences from images or physical models. Students must possess the skill of mathematical representation in order to solve story problems, including reasoning in the process (Salma & Sumartini, 2022). Representations in mathematics learning in various formats are used by someone to communicate mathematical concepts that are understood.

According to Muhammad (Puspitasari et al., 2021), representation is a model or alternative form of a problem circumstance used to identify a solution. For instance, an issue may be represented by objects, drawings, phrases, or mathematical symbols. Representations are mathematical expressions exhibited by pupils instead of a problem circumstance that tries to solve a difficulty they face due to the interpretation of their ideas.

Lestari et al. (2017), mathematical representation ability is the capacity to translate notations, symbols, tables, images, graphs, diagrams, and other mathematical expressions into other forms. According to Goldin (Mulyaningsih et al., 2020), representation is one of the configurations or forms, characters, symbols, or objects which can describe, represent or symbolize the other forms. Therefore, a representation is a configuration, sign, character, symbol, or object that can describe, represent, or indicate anything else. According to Jones and Knuth (Huda et al., 2019), representation is an alternative method for communicating issue conditions, such as in the form of objects, phrases, images, or mathematical symbols. It may be deduced from the preceding definition that mathematical representation is a stage in

solving mathematical issues by reflecting words in various forms, such as drawings, graphs, tables, and mathematical symbols, that make it easier for pupils to answer these difficulties.

Mathematical representation ability is also influenced by student attitudes (Silverajah & Govindaraj, 2018). Students can use representations with appropriate learning models accompanied by tenacity and a confident attitude. Attitudes can be seen as the result of emotional reactions that have been internalized in students' feelings; in other words, attitudes reflect emotional reactions (Agustina & Sumartini, 2021). Previous research carried out by Mulyaningsih et al. (2020) resulted in the results of data analysis obtained the conclusion that low mathematical representation abilities can affect how students understand the mathematical problems they face and affect how to solve these problems. Based on the research results of (Ribkyansyah et al., 2018), many students still have low mathematical representation abilities, and students still need to be able to use mathematical models to solve mathematical problems.

Students' low mathematical representation ability requires teachers to change their learning system into more innovative, creative, and exciting learning. For that, teachers can take advantage of one of the learning support applications, namely Web-based *Edpuzzle*, which can also be accessed via Android. Moreover, in this study, the material discussed is the polyhedron.

The *Edpuzzle* program is the supporting tool or media in this research. According to Afach et al. (2018), *Edpuzzle* is a web-based application that enables teachers to select videos for their students to watch and study based on their schedules and availability. According to the subject matter covered in class, this program provides students with engaging videos for learning. *Edpuzzle* is a platform for editing and sharing web-based interactive videos with embedded quizzes. Content can be customized to prohibit students from speeding up shared videos and set due dates. The reason for using the *Edpuzzle* application in this research is because the *Edpuzzle* application is a new-sounding application that contains learning videos that can be made as attractive as possible so that it can attract students' interest in learning mathematics.

According to Achmad et al. (2021), *Edpuzzle* is an interactive video-based learning medium that enables instructors to customize learning videos for students. Suherman (Sugondo & Bernard, 2021) stated that mathematics is both the queen and the servant of science; mathematics is autonomous and serves as a hub for developing other disciplines. According to Sartika and Rifa'i (2018), mathematics is a discipline of science that necessitates every student's ability to think to meet the demands of the current era and technological progress. The difficulty level in discussing the polyhedron needs to be higher. In contrast, spatial material has a high level of difficulty and abstraction because in studying, students are required to have high imagination power to pour three-dimensional shapes into two-dimensional images (Pramuditya et al., 2022).

According to Latuconsina (2021), a polyhedron is a wake with a polyhedron (not a curved side). A polyhedron is discussed as a planar shape. A *beam* is a geometric object composed of six polyhedrons, either a square and a rectangle or a rectangle and a rectangle.

Math problems are given as integers and as diagrams, tables, graphs, drawings, and even stories.

Some previous researchers researched polyhedron construction with other learning media, including the following. This research and development of learning media have succeeded in developing interactive media learning on the material for polyhedron at eighth-grade junior high school students packaged in the form of a video. Learning Media developed with procedural stages starting with the preliminary, development, and validation. Learning media that has been developed made with Macromedia Software Flash8, which contains video components, animations, text, graphics, practice questions, and evaluations, as well as instructions on how to use learning media so that they can be used as independent learning media by students student (Meilinda et al., 2019).

Based on the research results, flipped learning Classroom with assisted ethnomathematics *Edpuzzle* is effective because it meets the requirements for effective learning in this study (Alsalamah et al., 2022). *Edpuzzle* is one of the ICT-based learning media that has been widely used by teachers and lecturers, especially during this pandemic. Edpuzzle is an application that is very easy to access its use is also relatively easy, and children can quickly learn to use *Edpuzzle*. Besides puzzles, WhatsApp is also a supporting medium for this activity. As for The benefits obtained from this research, the activity is increasing the learning motivation of children during this pandemic, adding knowledge and insight to society (Bili & Surat, 2022). Based on the data analysis that has been done, the learning module assisted by the GeoGebra software is effective in learning mathematics. It can be seen from the results of the percentage of student activities during learning using the GeoGebra software-assisted learning module on the polyhedron geometry material of more than 90% there is an increase in formative tests, on average more than 50% of students give positive responses, and observers also gave a positive response to the use of the GeoGebra software-assisted learning module for polyhedron geometry (Rhilmanidar et al., 2020).

The difference between this research and previous research lies in the *Edpuzzle* application, which is used as a tool or learning media in this study to measure students' mathematical representation abilities. The research was conducted by collecting data on student test results and supported by the results of interviews and documentation at the time of conducting the research. The use of the *Edpuzzle* application is still rare for researchers to use the *Edpuzzle* application in researching the polyhedron. The results of previous research show that GeoGebra and several other applications are used.

This research was conducted on junior high school students in class VIII with the help of the *Edpuzzle* application, which contains videos that have been made as good and exciting as possible so that students can watch and want to learn mathematics with fun. This research was conducted on a polyhedron material, often considered complex by students.

This study aimed to determine whether the use of media or learning support applications in the form of *Edpuzzle* affected learning mathematics, especially on polyhedrons. This *Edpuzzle* learning support application is expected to significantly impact student learning

because the interactive videos presented can arouse student interest in learning, especially about polyhedrons, which students often consider challenging.

Methods

This research was quantitative, so it uses the Quasi Experiment method with the Non-Equivalent Control Group Design type, which has control and experimental classes. The pre-test was given to both classes before the experimental class, and the control class received different treatments. Then a post-test was conducted on both classes to determine the magnitude of the changes caused by the intervention. The experimental class was given the *Edpuzzle* treatment, where learning was done through the *Edpuzzle* application, which contained videos made by the researcher. In contrast, the control class was given standard treatment through direct teacher-student interaction in the classroom.

This research was conducted in Al-Qona'ah Islamic Junior High School with a sample of eighth-grade students. Each experimental and control class consisted of thirty students. Simple random sampling is the taking of samples from the population that is carried out randomly without regard to the strata that exist in the population (Sugiyono, 2016). The sample of this study consisted of two classes, namely class VIII A, which consisted of 30 students. It was used as an experimental class using the *Edpuzzle* program and class VIII B, which consisted of 30 students, and was used as a control class with a traditional learning approach.

The test research instrument was prepared by considering the indicators of students' mathematical representation abilities, namely visual, verbal, and symbolic representations. Then the instrument was tested in class IX to determine its validity and reliability. There are five valid questions with a reliability result of 0.44 and from the six questions tested.

The procedure of this research started with preparing the test instrument following the indicators of the ability of mathematical representations in the discussion of the polyhedron. A pre-test was carried out before implementing different learning, and a post-test was carried out. After that, in the experimental class, an interview is conducted regarding using the *Edpuzzle* application. The end was with documentation as the final step in data collection.

The data collection technique was carried out by conducting tests: pre-test and post-test. The results of the tests were analyzed through testing for normality, homogeneity, hypothetical test (t-test), n-gain test (for the experimental class), interviews, and documentation.

Results

The research instrument was a test of students' mathematical representation abilities with the polyhedron. Tests were administered before and after learning treatment with the *Edpuzzle* application for the experimental class and conventional learning for the control class. In addition, to a pre-test and post-test, this research is backed by the findings of interviews with students whose learning is facilitated by the *Edpuzzle* program.

Students' mathematical representation ability in conventional learning

In the control class, learning is conducted conventionally, i.e., through direct teacher-student interactions in class. Students are given a pre-assessment of their mathematical representation abilities before learning. The examination questions are essay questions that assess students' mathematical representation skills. Visual, verbal, and symbolic categories are used to classify mathematical representation abilities (Mulyaningsih et al., 2020).

After administering the pre-test, class VIII B students received conventional instruction on the materials for creating polyhedrons, studying directly in class for four sessions. Then, a Post-test with similar questions was administered to determine how much students' mathematical representation skills had improved. Below in Table 1 is the outcomes of mathematical representation ability tests administered to students in the control group.

Table 1. Control class instrument test results

	Pre-test	**Post-test**
Average score	7.73	9.3
Standard Deviation	1.39	3.0

Students' mathematical representation ability in *Edpuzzle* application assisted learning

Edpuzzle application is a learning tool that includes interactive videos the teacher has created for the benefit of the pupils. With the use of the *Edpuzzle* learning application, it is envisaged that students will be able to re-learn uncomprehensive content at home by repeating the video provided by the teacher within the application.

After the pre-test was administered and the findings were known, learning in the experimental class was applied to learning using the *Edpuzzle* learning media, which consisted of learning films that had been made as entertaining as possible for students to study for four meetings. Next, a post-test was conducted to measure the extent to which students' ability to understand the learning that had been carried out, especially the students' mathematical representation skills on the polyhedron. The following are the average results of the experimental class students' mathematical representation ability tests, which are presented in Table 2 below.

Table 2. Experimental class instrument test results

	Pre-test	**Post-test**
Average score	7.67	8.87
Standard Deviation	2.60	2.40

The results of the pre-test conducted in two different classes show that the initial abilities of the two classes are heterogeneous or with the same initial ability. However, after the post-test, it was seen that there was a different increase in the two classes. In the experimental class, the post-test value was similar to the control class, which caused the use of the *Edpuzzle* application in the experimental class not to have a good effect on improving

students' mathematical representation abilities. Figure 1 is a figure of learning using the *Edpuzzle* application.

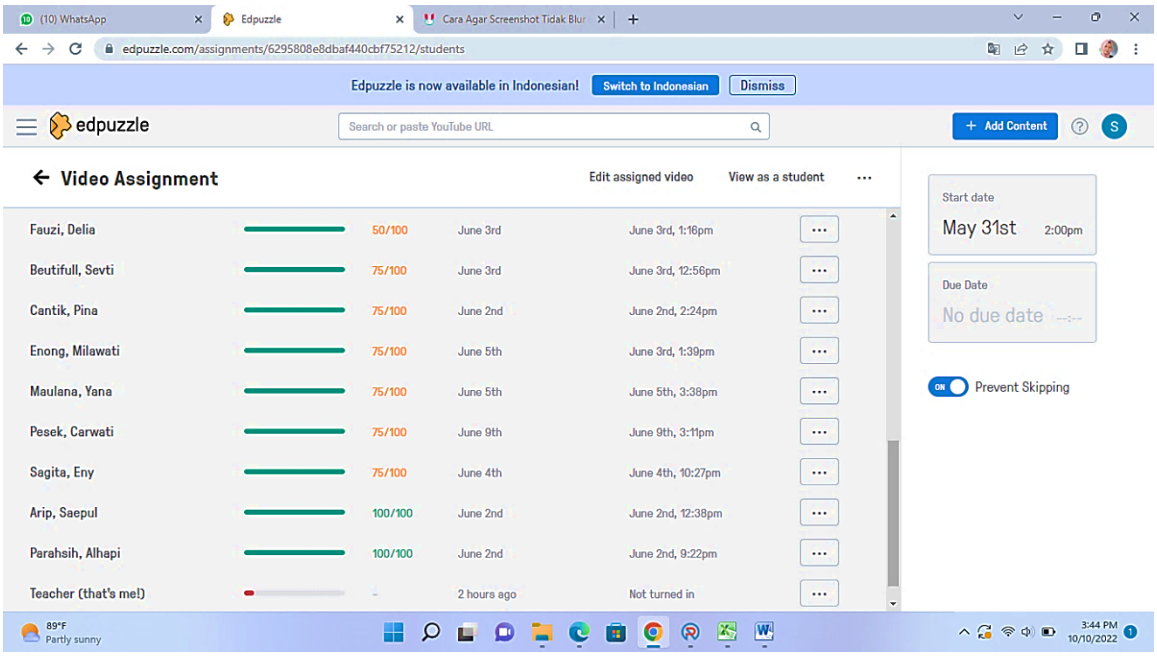

Figure 1. Student quiz results

They were learning in the *Edpuzzle* form to explore student information about the material being taught. Teachers can also provide notes for students in the *Edpuzzle* application. It cannot only upload interactive videos but can also provide small quizzes as the notes section in the *Edpuzzle* application that has been provided. In this application, learning can be given a time limit. Students can watch videos uploaded by the teacher anytime and anywhere during the time limit determined by the teacher who provides the material. If the time is over, students cannot watch the video given by the teacher again. Teachers can see students who have entered the class in the *Edpuzzle* application.

In the *Edpuzzle* application, learning can also be done directly. Learning is carried out according to a predetermined schedule, and students can only participate in direct learning as long as learning is still active, and the teacher provides access.

Students can join the ongoing learning by activating the live mode in the *Edpuzzle* app. Previously, students already had an *Edpuzzle* account and entered the code the teacher gave in class in this lesson. When in the middle of the video, students are given a question that must be answered, and students can only continue watching the video if the question has been answered. Then the learning was look like in Figure 2.

In this study, a prerequisite test was conducted to determine whether this study was fulfilled and under the hypothesis. Prerequisite tests include the normality test to see the normality of the data in this study and the homogeneity test by comparing the largest and smallest variances because they have the same amount of variance. Previously, the validity and reliability of the test instrument used had been calculated. The results of the validity test showed that the instrument questions were valid and could be used, and from the results of the reliability test calculations obtained, a value of 0.44 and the instrument questions were

reliable. Normality and homogeneity tests were carried out in this study's experimental and control classes.

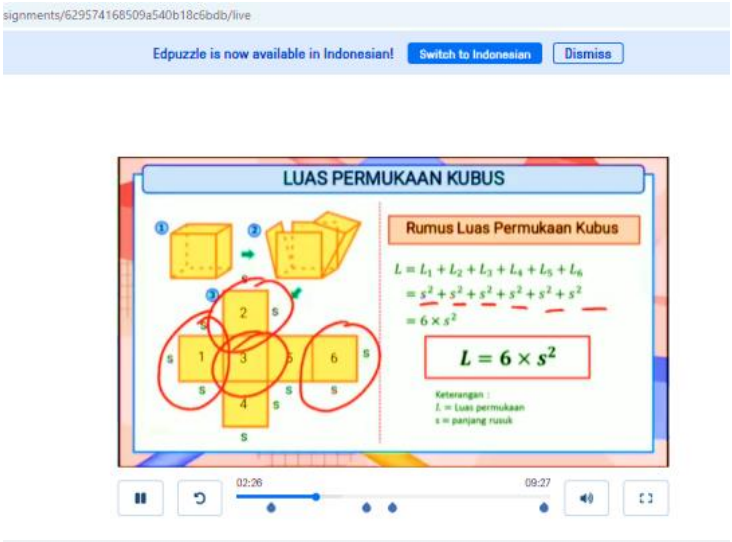

Figure 2. Learning material

The condition for the data to be normally distributed is that if L-count < L-table, then the distribution is normally distributed. However, the data distribution is irregular if L-count > L-table. The calculation of the normality test of the results of the student's mathematical representation ability on the polyhedron in the experimental class is as Table 3 below.

Table 3. Experimental class normality results

	Pre-test	**Post-test**
Average	5.87	8.87
Standard Deviation	2.28	2.40
L-count	0.13	0.11
L-table (n=30; alpha=0.05)	0.16	0.16

Normality calculation using Microsoft Excel. From the data above, it can be seen in the table that the L-count is 0.13, and L-table is 0.16. While in the post-test, it can be seen that the l count is 0.11 and the t table is 0.16, which means t-count < t-table. So the data is normally distributed. Similar to the experimental class, the normality of the control class was also calculated using Microsoft Excel from the results of calculations with the number of n as much as 30 and a significance level or alpha of 0.05 and obtained an L count of 0.157 and an L table of 0.161. Because L-count < L-table, it can be concluded that the data is normally distributed. At the post-test, the normality test calculation obtained an L-count of 0.09 and an L-table of 0.161, so the data is said to be not normally distributed. In addition to the normality test, data obtained were then tested for homogeneity, with the condition that they accept H0 if F-count < F-table and reject H0 if F-count > F-table. With the formula $F = \frac{largest\ variance}{smalest\ variance}$. Homogeneity test calculations using Microsoft Excel, here are the results of the homogeneity test.

The homogeneity test was calculated using Microsoft Excel. From the results of the calculation of the experimental class, the calculated F is 1.14 the F-table is 1.86. Following

the criteria of the homogeneity test, H0 is accepted if F-count < F-table. It can be concluded that the data is homogeneous because F-count < F-table. Likewise, in the control class, the calculation results obtained F-count 0.28 and F-table 0.54 so that F-count < F-table, and it can be concluded that the data is homogeneous. From the results of the normality and homogeneity tests carried out, the experimental class did not experience a significant increase after learning using the *Edpuzzle* application, so the purpose of this study was not fulfilled.

Discussion

Students' mathematical representation abilities were assessed before the deployment of learning using the *Edpuzzle* learning application and conventional learning, and the results of these assessments reveal the material's conclusions. The initial examination was designed to assess students' comprehension of their mathematical representation abilities on the polyhedron.

In the initial display in the *Edpuzzle* application, many recommendations for video suggestions can be taken or can be directly connected to YouTube. Class VIII A was implemented as an experimental class utilizing the *Edpuzzle* learning program.

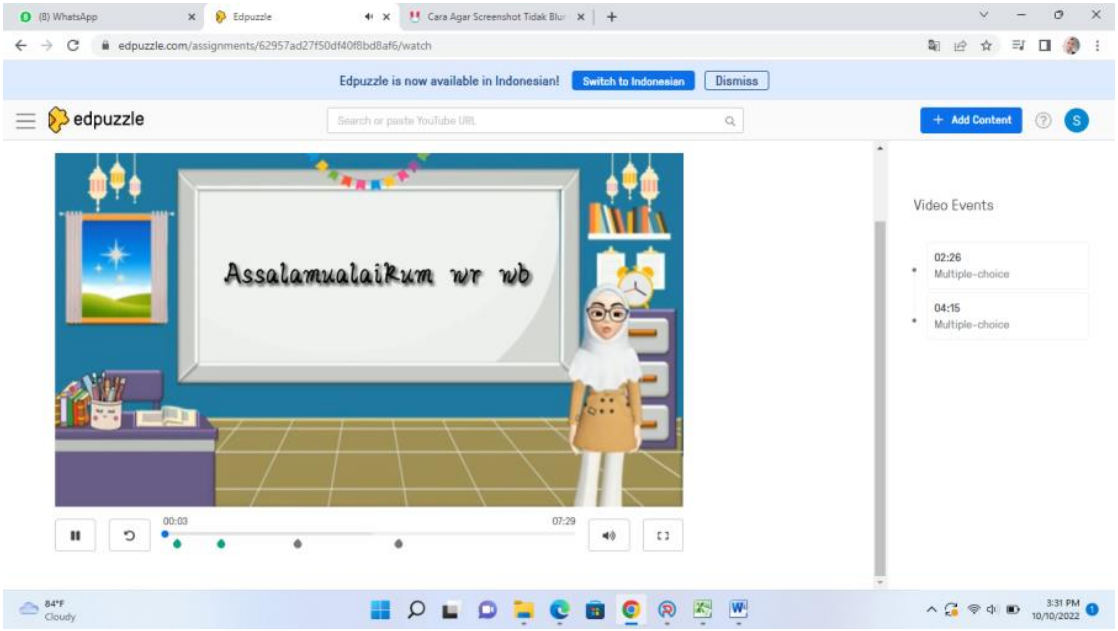

Figure 3. Learning with *Edpuzzle*

Students may replay videos at home or elsewhere if they need more comprehension of the studied information. Students must have sufficient internet quota and a steady network to access the videos in the *Edpuzzle* application. Otherwise, the videos will only play partially. Giyanto et al. (2020) research revealed that learning using *Edpuzzle* was statistically very significant in improving students' problem-solving abilities and quite effective in online learning.

Students like to use *Edpuzzle* to learn mathematics. However, many things must be considered carefully before using this media, especially in online learning, including

supporting facilities and infrastructure, students' mental readiness to receive learning, and of course, careful preparation from educators, starting from the planning stage, making learning videos, editing, and up to the evaluation stage (Sirri & Lestari, 2020). The importance of mathematical representation skills and needed by students to understand the material provided and solve problems; if mathematical representation skills are lacking, it causes a lack of understanding of students in the material provided so that students find it challenging to understand and work on the questions provided (Fitrianingrum & Basir, 2020).

In addition to learning how to utilize the *Edpuzzle* program in the experimental class, students in the control class apply conventional learning, where students and teachers engage face-to-face in the classroom. The material covered is identical to that covered in the experimental class.

In this research, in addition to administering tests with question instruments, students were asked a series of questions or participated in interviews discussing the *Edpuzzle* application's challenges and hurdles and their comments on the application. Although various hurdles frequently arise when attempting to access instructional videos, such as unstable networks, insufficient internet quotas, and insufficient mobile memory owing to a complete phone, you cannot download the application.

In research, in addition to using the prerequisite test, a hypothesis test or t-test was also carried out to determine whether the hypothesis in research was successful or not. The hypothesis test is carried out with the condition that H0 is accepted if t-count < t-table. T-test calculations were carried out using Microsoft Excel; the average result before using the *Edpuzzle* application was 5.70, and the average after using *Eddpuzzle* was 8.87. Then a t-test was performed with the results obtained t-count -29.29 and t-table -1.67. From the results of these calculations, it can be seen that if t-count < t-table so that H0 is accepted, it means that there is no influence on students' mathematical representation abilities with the help of the *Edpuzzle* application.

In addition to conducting a t-test to determine whether or not *Edpuzzle* application-assisted learning has an effect, an n-gain test is conducted on the experimental class to determine whether there is an increase in the experimental class after the implementation of *Edpuzzle* application-assisted learning. Gain is the difference between the pre-test and post-test results. It indicates an improvement in students' mathematical representation skills due to using the *Edpuzzle* application to learn. The n-gain score is 0.03, which indicates that the n-gain is of a low level and that there is no progress in learning using the *Edpuzzle* program on the polyhedron, according to the calculation results.

Research conducted by Sugestiana and Soebagyo (2022), learning media in the form of the *Edpuzzle* application is one of the innovations in learning mathematics in the new normal era. *Edpuzzle* is an interactive video-based learning media so teachers or educators can modify their learning videos for students. Based on the study results, it was concluded that students liked to use the *Edpuzzle* application in learning mathematics. Moreover, students hope that the *Edpuzzle* application will be used in the following material because it can increase students' interest and motivation in online learning during COVID-19. However, in

utilizing the *Edpuzzle* application in learning, there are things that the teacher must pay attention to. These include the network students have in accessing *Edpuzzle* and the limitations of gadgets used because the thing that must be considered when we use the *Edpuzzle* application is a stable network.

In previous studies regarding the material of polyhedrons, they did not use tools in conducting their research and only used learning methods in analyzing students' mathematical representation abilities. In this study, researchers used the *Edpuzzle* application to determine the effect of polyhedron learning in improving students' mathematical reorientation abilities.

From the research results, the students' mathematical representation ability after using the *Edpuzzle* application is low. As the results of research by Ainunnisa et al. (2021), it was found that not all subjects had good representation abilities. Many factors cause the subject to have difficulty solving problems with mathematical representation indicators on the polyhedron material. Sapitri and Ramlah (2019) stated that the mathematical representation ability of 20 junior high school students in one of the Karawang districts in solving polyhedron problems is quite sufficient. Sabirin (Mauliza et al., 2021) said that mathematical representation skills are essential for students because representation is a form of student thinking about a problem in the form of words, writing, pictures, tables, graphs, concrete objects, symbols, and so on. Other things help make it easier for students to understand and find solutions to problems.

It is supported by the cognitive development of students based on Bruner's learning theory starting from the enactive stage, namely the stage where students learn from concrete objects related to the real world. In addition, in the iconic stage, knowledge is presented as visual images or images that depict and describe concrete activities. Finally, the enactive stage is the symbolic stage, where students are invited to represent images in mathematical symbols. *Enactive representation* is a sensorimotor representation that is formed through action or movement. Iconic representation is related to image or perception, and symbolic representation is related to mathematical language and symbols. In Bruner's view, enactive, iconic, and symbolic relationship to a person's mental development and each representational development influences each other. *Enactive representation* is a sensorimotor representation formed through action or movement. Iconic representation is related to image or perception; symbolic representation is related to mathematical language and symbols. In Bruner's view, enactive, iconic, and symbolic relationship to a person's mental development, and each representational development influences the other (Tussa'diyah et al., 2019). It is also supported by Vygotsky's theory that students have different levels of development (Azizah & Purwaningrum, 2021). These developments are divided into two, namely the level of potential development and the level of actual development, the occurrence of an actual level of development where students independently use their cognitive abilities functionally.

Meanwhile, the level of cognitive development that students can achieve with the help of a more competent or mature person is called the level of potential development. To bridge the internalization process, Vygotsky relies on an area between potential and actual development, called the Zone of Proximal Development or zone of proximal development (ZPD). Noviandini (2021) revealed that the closest developmental zone or ZPD is the distance

between students' ability to perform tasks under adult guidance and with peer collaboration and problem-solving independently according to students' abilities. Learning mathematics implies that ZPD can help bridge concrete thinking and abstract thinking. Students generally have difficulty understanding abstract mathematics; this ability can be encouraged through social interaction through ZPD.

Halimi et al. (2021) stated that the constructivism learning model is a learning model that places students as active agents in a meaningful learning process. Students not only receive the material but also interpret the material. Using this constructivism model requires students to be active while the teacher acts as a facilitator. Applying an environment-based constructivism learning model can improve mathematics learning outcomes. It is because of constructivism theory; in the learning process, students must emphasize and be active in developing their knowledge, not the teacher.

Therefore, the results of calculating the t-test and n-gain test do not state that the hypothesis in this study is not fulfilled. It occurs due to the need for more supporting facilities in learning using the *Edpuzzle* application, both from the availability of Wi-Fi, good cellphones, and quotas. Internet and the research time should be longer. It is not optimal to use the *Edpuzzle* application at Al-Qona'ah Islamic Junior High School because of the differences in the level of ability possessed by each student.

Conclusion

The learning media for a polyhedron with the help of the *Edpuzzle* application does not affect the mathematical representation ability of students at Al-Qona'ah Islamic Junior High School. Based on the results of the t-test obtained, t-count data with a total (-29.293) and t-table with a total (-1.67155) so that t-count < t-table. Based on the n-gain test, the n-gain test value is 0.03 with a low category, so there is no increase in n-gain when using the *Edpuzzle* program to study the polyhedron. The limitations of this study are the lack of supporting facilities in the AL-Qona'ah Islamic Junior High School environment to study with the *Edpuzzle* application and the lack of research time. So this resulted in failing to achieve the objectives of this study.

Acknowledgment

The authors thank those who have helped, including the school that became the research site, the supervisor from the Indonesian Education University (UPI), and the mathematics education lecturer at Mathla'ul Anwar University (UNMA) Banten.

Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript.

Funding Statement

This work received no specific grant from any public, commercial, or not-for-profit funding agency.

Author Contributions

Nenden Suciyati Sartika: Conceptualization, writing - original draft; **Yaya S. Kusumah:** Formal analysis, and methodology; **Bambang Avip Priatna:** Validation and supervision; **Sutihat:** Writing - review & editing; **Eka Rosdianwinata:** Editing, and visualization.

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