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The effectiveness of online learning by EdPuzzle in polymer materials on students' problem-solving skills

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Abstract. This study aims to produce EdPuzzle content in polymer materials and examine its effectiveness on students' problem-solving skills. The method used in this research is experimental research, employing a pre-test post-test one-group design through online learning. The subject of this study is 70 tenth grade students. Data were collected using students' problem-solving skills tests and analysis of the learning process to determine the effectiveness of online learning. The data obtained were then analyzed using quantitative descriptive. The results showed that learning using EdPuzzle is statistically very significant in improving students' problem-solving skills and is quite effective in online learning. The study concludes that EdPuzzle is quite effective to improve students' problem-solving skills which are characterized by an increase in the score of pre-test to post-test, with an N-gain of 63%. The implementation of online learning EdPuzzle is quite effective with an effectiveness score reaching 91%.

1. Introduction

In this digital era, there are learning trends that are increasingly developing. One such trend is that learning can be taken place anytime anywhere. Previously, learning was identical to face-to-face in class and was limited to certain hours, now learning can be done anywhere and anytime. Various applications are available that allow learning to be carried out not only in schools. Students can learn anywhere and anytime using the applications found on their mobile phones. Some applications provide two-way learning features, which allows direct interaction between teachers and students. Learning trends like this continue to develop as the digital world grows rapidly. This learning trend is characterized by e-learning and other applications related to learning [1, 2, 3].

Flipped Learning is one of the learning trends that makes students learn independently at home before entering class in the form of presentation slides, videos, or e-modules provided by the teacher. Nowadays, many countries have implemented the flipped learning method as a method to make the learning process more enjoyable. By student-centered learning, the activities in learning by flipped learning involve active student participation and make students enjoy the learning process. Flipped Learning requires students to watch videos or read the material before entering class. Students can access videos from the internet, so this concept can also be used for distance learning processes that do not require certain space and time. By watching videos related to the lesson, students gain prior knowledge before starting lessons in the class, both conventional and online classes.

One of the flipped learning types is the use of EdPuzzle applications. EdPuzzle is a platform that can help teachers carry out interactive video learning between teachers and students. One of EdPuzzle's strengths is that it helps students learn through video following their respective learning speed and ability [4, 5, 6]. By using EdPuzzle, the teacher can collect data related to student interactions with the video, for example, the number of times that students watch, answer questions, or provide responses. The video can be edited directly with the video clipping feature to take just the part that is needed. Besides, the teacher can also insert their voice into the video and also slip the questions between the videos that students will watch to test their understanding of the video they watch [7]. This is what makes learning with video more interactive. Thus, EdPuzzle can be used as alternative learning in the digital age.

In the digital age where problems are increasingly complex now, problem-solving skills for students become very important. This is because every human being is inseparable from problems. These problems range from personality problems, learning problems, and popular problems to the attention of the world. Plastic waste is one of the problems that are currently a serious problem in the world and especially in Indonesia. In Chemistry subject, material about plastics is studied in the topic of polymer chemistry. Learning chemistry in polymer material is expected to be able to develop students' problem-solving skills so that the impact of plastic waste problems can be reduced.

The students' problem-solving skills in various schools are still low. It is found that students have difficulty in determining the form of the solution of a problem. This was revealed by the low number of students in waste management both in schools and the surrounding environment. Based on the Focus Group Discussion (FGD) conducted by MGMP chemistry teachers in Sukabumi Regency, students are still ignorant of waste segregation and care in disposing of garbage, especially plastic waste. This condition is alarming, considering that students have received material about polymers in which there is material about plastic polymers and their impact on the environment. Learning about polymers should lead students to have an awareness of the environment and be able to develop their problem-solving skills.

Current learning must be able to encourage students to develop their problem-solving skills as research conducted by Wang [8], Gwo-Jen & Pei-Ying [9], and D'Agostino [10] and follow the trends of 21st-century learning. Problem-solving skills are needed so that students can face all problems when engaging in society. The 21st-century learning trends in the form of learning based on flipped learning are needed today with various advantages such as increased creativity and critical thinking [11, 12] as well as independence and achievement [5, 13, 14]. Learning can be done online based on existing applications, such as gamification of learning with Kahoot, e-module, quizzes, EdPuzzle, and others [15, 16].

The teacher must quickly adapt to various digital learning media through various applications. In this COVID-19 pandemic condition, there is a considerable gap between learning in various schools with the ideal conditions of learning following the demands of 21st-century learning. There are still relatively few teachers who use flipped learning in learning. If this condition is not immediately resolved by implementing and testing the effectiveness of learning with a digital platform (such as EdPuzzle), it will have a wide impact on the low quality of education. So, it is very important to immediately carry out digital-based innovative learning following the conditions and needs of students.

The purpose of this research is to create EdPuzzle content and examine EdPuzzle online learning on students' problem-solving skills. The topic of learning is limited to polymer chemistry. Analysis of students' problem-solving skills is limited to a video file about the problem of plastic waste in Indonesia published by the Indonesian Institute of Sciences (LIPI). Also, this study measures the effectiveness of online learning by using EdPuzzle that has been produced as an impact of the learning process due to the COVID-19 pandemic.

2. Methods
This study was designed using an experimental research method that refers to Sugiyono [17]. The experiment aims to examine the impact of using EdPuzzle on students' problem-solving skills. Student

selection is done by purposive sampling referring to Arikunto [18]. Data is collected through tests to measure students' problem-solving skills. The test of problem-solving skills is in the form of 10 essay questions, by giving score 10 for each question, thus, the maximum score is 100. The test questions are tested with a one-group pretest-posttest design technique that refers to Fraenkel *et al.* [19]. The schematic is shown in table 1.

Table 1. The scheme of the group pretest-postest design.

Pretest	Treatment	Posttest
T_1	X	T_2

T1 as a pretest is done before students are treated (Treatment); X as a treatment is given through EdPuzzle learning, and T2 as a posttest is done after the sample is given treatment. Through this pretest-posttest, students' problem-solving skills are measured before and after treatment.

The subject of the study was 70 students in grade 10. Tests are carried out online using Google Form by accommodating 5 aspects of problem-solving skills indicators based on categories from Rahman [20] and Polya [21], namely aspects of defining a problem, examining a problem, planning a solution, implementing a solution made and evaluating. Problem-solving skills data in the form of grades are then analyzed by determining the N-Gain based on the Hake [22] category, as shown in table 2.

Table 2. The N-Gain category.

N-Gain (%)	Interpretation
$(g) \geq 70$	high
$70 > (g) \geq 30$	medium
$(g) < 30$	low

The effectiveness of EdPuzzle online learning is calculated based on feedback from the number of students who watched the video and completed the assignment compared to the total number of students. The data obtained were then analyzed using quantitative descriptive.

The research procedure includes the planning stage, the implementation stage, and the final stage. The planning stage is curriculum analysis (analysis of core competencies, basic competencies, learning indicators, and learning objectives), preparing the completeness of learning instruments and research instruments. The implementation stage includes the pretest, the implementation of learning using EdPuzzle, then ends with a post-test to measure students' problem-solving skills. While the final stage is by conducting data analysis, discussion, and drawing research conclusions.

Before testing the significant difference between the pretest and posttest, it is necessary to do a data normality test. In statistics, this is important because it is the main requirement in parametric statistics. The data normality was tested through the Kolmogorov Smirnov test with SPSS version 20. The normality test with the Kolmogorov Smirnov test was chosen because the number of samples was more than 50. The normality test aims to find out whether the residual score (not on each research variable) is normally distributed or not. The interpretation of the Kolmogorov Smirnov normality test is as follows. If the significance score is in the column of Asymp. Sig (2-tailed) or probability > 0.05, so the data is said to be normally distributed. If the residual score is normally distributed then it is followed by a paired sample t-test, but if the residual score is not normally distributed, the significant difference test is performed on a non-parametric statistical test, namely Wilcoxon test [23].

To find out whether there is a significant difference in the average between the results of the pretest and posttest of problem-solving skills, it will be tested through paired sample t-test. This test is used for two sample/paired data. A paired sample t-test was processed using SPSS version 20. The basis of the research decision is if the score of Sig. (2-tailed) $p < 0.05$, then there is a significant difference between

the score of problem-solving skills in the pretest and posttest data. If the Sig. (2-tailed) p > 0.05, there is no significant difference between the scores in the pretest and posttest data. A paired sample t-test is part of parametric statistics. Therefore, as a rule in parametric statistics, the research data must be normally distributed.

3. Result and discussion

EdPuzzle content that has been created contains learning videos and questions that have been inserted in it to ensure that students have watched and understood the contents of the video. The front page of EdPuzzle is shown in figure 1. The EdPuzzle link can be accessed at https://EdPuzzle.com/media/5eb647ea124f433ee8f6e619.

Figure 1. EdPuzzle homepage.

The results of the study in the form of data analysis show an increase in the pretest to posttest with an N-Gain of 63%, and the mean increasing from 31 to 74 after learning using EdPuzzle, as shown in table 3.

Before the t-test is performed, the data normality test is first tested, based on the SPSS data output. It is known that the significance score of Asymp. Sig. (2-tailed) of 0.923 is greater than 0.05, then according to the basis of decision making in the Kolmogorov-Smirnov normality test, it can be concluded that the data are normally distributed. The significance test of the difference between pre-test and post-test with paired test t-test using SPSS version 20 software shows the number of 0,000, which means it is very significant, as shown in table 4.

Table 3. Result of the pre-postest analysis of problem-solving skills.

EdPuzzle data	*Pretest*	*Posttest*
Number of students	70	70
Lowest score	10	50
Highest score	70	100
Mean (average score)	31	74
% N-Gain	63 % (medium)	

Table 4. The result of the normality test and t-test

Data	Sig. score	Interpretation
Pre-Posttest	Normality test = 0.923	Data distributed normally
	Paired sample t-test = 0.00	Very significant

Table 5. The result of pre-posttest and posttest analysis on problem solving skills.

Indicators of problem-solving skills	% N-Gain	Criteria
Defining problems	70	High
Checking problems	72	High
Planning solution	53	Medium
Implementing solution	60	Medium
Evaluating	66	Medium

As for the results of the pre-test–post-test analysis of each indicator, it was found that the problem-solving skills in the aspects of defining and checking problems with an N-Gain of 70% and 72% (high category), while the aspect of planning a solution got the lowest score with an N-gain of 53% (medium category), as presented in table 5.

From the research conducted, it was found that an increase in the pre-posttest score with an N-gain of 63% (medium category). This proves that learning with flipped learning with EdPuzzle can improve students' problem-solving skills. This finding is strengthened by t-test = 0.000 that this learning is very significant in improving students' problem-solving skills in polymer materials. Increased problem-solving skills are caused by the learning video content that is displayed, so it can stimulate students to think at a higher level. In this polymer chemistry learning, a video about the problem of waste in Indonesia which is so severe. The video presents facts about the number and constraints in waste management. This condition causes students to feel challenged to participate in solving these problems starting from the lowest level and themselves. Some research conducted by Lewis [24] and Sarmantayev *et al.* [25] stated that stimulation in the form of videos, narratives, and presentation slides plays an important role in generating students' metacognition skills.

The increase in the score of problem-solving skills that is very significant is also caused by this learning carried out personally. In face-to-face learning that is carried out in class, the teacher faces many students, so in this digital age, students can carry out their learning process personally through gadgets by utilizing online learning. This personal learning has the advantage of providing opportunities for students to be able to focus on learning without any distractions from others or in other words this learning can increase students' learning independence [16, 26, 27]. For this reason, learning with EdPuzzle can be used as alternative learning in the Covid-19 pandemic. Although learning is personal, it does not close the space for discussion among students online.

The high N-gain in the aspect of defining and checking problems (high category) shows that students master problems. This is due to the interactive activities of watching videos and answering questions on the sidelines of the video that make students truly understand the concepts discussed. The video also presented facts and problems that are following the conditions of their surroundings/contextual. So, EdPuzzle can improve students' concept mastery. This finding is supported by many researchers [5, 9, 13, 14] that flipped learning can improve students' concept mastery and achievements. This ability is the main asset for the skills to plan problem-solving.

This study also found the fact that among the five indicators of problem-solving skills, the aspect of planning problem-solving got the smallest N-Gain score (53%). This is supported by data during the learning process. When students answer questions on the sidelines of the video, students are not quite right in ranking the priority scale for handling plastic waste. Students answer only with short answers, without breaking down into systematic solution plans. An example of students' answers that are not systematic in explaining is shown in figure 2.

However, the following processes make students more familiar with the context of the problem. This is indicated by the relatively higher N-Gain score in the aspect of implementing the solution (60%) and evaluating the solution (66%). The high score in both aspects is caused during learning, students are led to think critically, so they can implement and evaluate the solutions offered [8, 10, 28].

Figure 2. An example of students' responses (not systematic).

Figure 3. Students' activities monitored through grade book.

Students' activities are monitored through the grade book, EdPuzzle feature that contains scores, videos that have been watched, and questions that have been answered, as shown in figure 3. Analysis of the data in the grade book found that many students answered not according to what was wanted in the video show. Students answer according to their perceptions, relating to the solutions they offer. This shows that learning with EdPuzzle can develop students' critical and creative thinking [11, 12].

From the grade book data, the effectiveness of EdPuzzle can be determined in online learning by 91% which shows that students are enthusiastic about implementing the learning process, conducting feedback, and evaluating themselves in the form of tests. The high effectiveness cannot be separated from the advantages of choosing EdPuzzle in learning for students, namely user friendly, which is proven at the time of installation that the teacher only shares video tutorials through the WhatsApp group and students can carry out this process themselves. Another advantage is that this application is relatively lightweight which does not require a lot of android memory. So that even students with low android specifications do not experience problems.

For the teacher, as an administrator, EdPuzzle has some advantages: 1) this application is free; 2) this application can change any video to flip according to learning needs; 3) the video used can be from resources from others who have posted to YouTube, etc.; 4) we can upload our video. Besides, the teacher can see the progress of the percentage of completion, so it is known who has finished watching the video and embed questions throughout the video. The video will stop automatically and move forward after someone responds. The teacher can provide feedback to be displayed after the response is sent so that the sender receives immediate feedback. This makes learning more interactive [15, 29, 30].

Strengthening the last aspect of problem-solving, namely evaluating solutions, is carried out with online face-to-face activities with the zoom meeting application, as shown in figure 4.
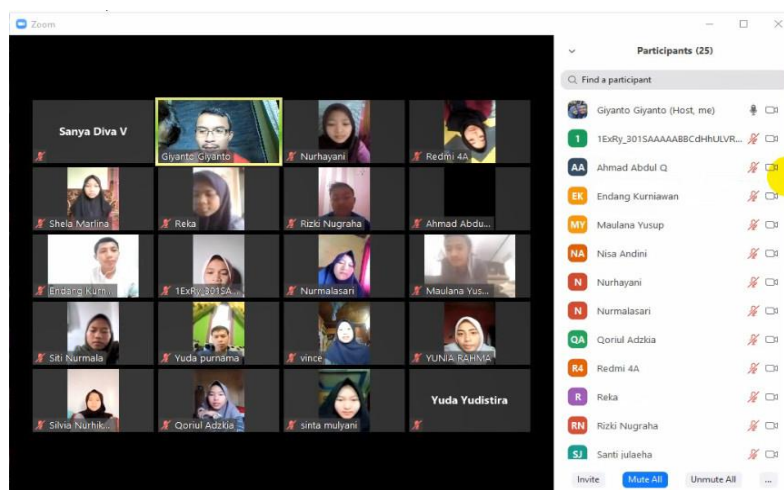

Figure 4. Strengthening activities; aspect of evaluating solutions.

At this stage, students brainstorm among other students and the teacher roles as the facilitator. Some students convey ideas related to problems, plan solutions, and implement them. The obstacles encountered were revealed, then other students responded trying to solve various obstacles that were conveyed by other students. This results in a discussion among students. This is done to reduce the disadvantages of using EdPuzzle, namely the lack of discussion during learning so that some studies show the ineffectiveness of flipped learning in learning as research by Geist [31].

From the explanation given, it is clear that the use of EdPuzzle can significantly improve students' problem-solving skills in polymer chemistry. This is confirmed by the findings of Wang [8] and Gwo-Jen and Pei-Ying [9]. EdPuzzle is also quite effective in online learning with various advantages and disadvantages. In the condition of the COVID-19 pandemic and the rapid development of information technology, EdPuzzle can be chosen as an alternative learning media that is effective and efficient.

4. Conclusions

Flipped learning using EdPuzzle media effectively improves students' problem-solving skills. The five aspects of problem-solving skills have an N-Gain percentage in the medium-high category. Overall, the N-Gain pretest-posttest achievement was 63% and in the medium category. The level of significance statistically with the Sig. (2-tailed) = 0.00 less than 0.05 which means that learning using EdPuzzle can increase the ability of the problem, is very significant. Online learning with EdPuzzle media is also quite effective, based on students' feedback in doing assignments by 91%.

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