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Effectiveness of Problem-Based Learning Assisted by Digital Comic Media on Students' Critical Thinking

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Abstract

This research aims to evaluate the effectiveness of problem-based learning (PBL) learning models, which use digital comics to develop the students' ability to think critically. Critical thinking is an important aspect of education that equips students to solve problems and make rational decisions. PBL uses a problem-centered learning approach that is expected to improve this ability, and the use of digital comics is expected to increase students' motivation and critical thinking skills in the learning process. The methods applied in this study are quasi-experimental with a nonequivalent control group design. The research sample consists of 282 students from class XI who chose an interest in economics at SMA Negeri 1 Jogonalan, which is divided in a random way into two groups: an experiment group using PBL with the help of digital comics and a control group that only uses the conventional learning model. The study showed that there was a significant difference in the improvement of critical thinking skills between the experimental group and the control group, with the experimental group showing a higher improvement. This finding indicates that the implementation of PBL assisted by digital comics is effective in encouraging students to analyze, conclude, and understand the connections between ideas, improving students' critical thinking skills. Therefore, this learning model can be considered an innovative alternative for improving the quality of learning and developing students' critical thinking skills in schools.

Keywords

problem-based learning; digital comics; innovative learning

I. Introduction

The quality of education greatly influences the development of a country. Education is a process of a person developing their abilities and being able to find solutions to improve the advantages of individuals or society (Asbari et al., 2020). Planning for improving education must always be carried out at every level. Such work needs to be done to prepare and produce quality human resources who are able to compete on the world stage (Putri, 2023). The current educational problems in Indonesia are the lack of skills in science, mathematics, and reading. The fact has been proven by a scientific study by the OECD (Organization for Economic Cooperation and Development) carried out through evaluation and testing that Indonesia is ranked 70 out of 78 countries in the world (Rizkianti et al., 2024).

The government in Indonesia has made efforts to overcome these problems through a new curriculum, namely *Kurikulum Merdeka* (Damiati et al., 2024). The concept of independence in *Kurikulum Merdeka* is in line with the ideas of Ki Hajar Dewantara, who prioritizes liberating learning participants and educating them so that they can study in an independent way and develop their creativity (Ilmawan, 2024). This idea is in line with research from Glasersfeld (1992) on the theory of constructivism put forward by Piaget in 1977, which emphasizes the role of an individual's internal construction in building their understanding (Voon & Amran, 2021). Constructivism theory looks at study as an active process in which students, in a way, independently build knowledge, seek the material studied, and implement and update understanding with the knowledge that has been owned (Firdaus et al., 2023). The role of the teacher is only as a facilitator who submits problems through the question igniter. In the approach to learning constructivism, it is expected that teachers convey materials and provide means to develop the ability of students to understand the material through a deep thinking process (Tishana et al., 2023). Students grow creatively by creating new, valuable ideas for self-development based on their knowledge.

This research was conducted at State High School 1 Jogonalan to address the observed difficulties experienced by Class XI students in responding to higher-order thinking questions, specifically those categorized at level C4 and above within Bloom's revised taxonomy. Bloom's taxonomy consists of six cognitive processes that range from the lowest to the highest levels of thinking: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). There are two levels of thinking for students, namely low-order thinking (C1-C3) and high-order thinking (C4-C6) (Practice & Bloom, 2008). An interview was conducted with the economics teacher, Mrs. Yeni Surya Ningsih, S.Pd., to gain insights into students' critical thinking abilities, particularly those whose performance remains below the minimum mastery criterion (KKTP 71), especially in responding to higher-order questions at the C4 to C6 levels of Bloom's revised taxonomy. Participants are students of State High School 1 Jogonalan who entered the interest economy program. There are 3 classes: XI 6, XI 7, and XI 8. In the research, the researcher chose two classes with the lowest achievement marks, namely class XI 7 as the experimental group and class XI 8 as the control group.

The ability to think critically refers to high-level thinking that enables an individual to solve problems and develop their potential for thoughtful reasoning (Ma'rifah & Mawardi, 2022). Based on the results of the interview on February 13, 2025, Mrs. Yeni Surya Ningsih, S.Pd., explained the methods often used in the learning process, namely the lecture and discussion methods, while during the material, they usually use textbooks provided by the school as a guide for students. Therefore, the use of less captivating learning models can result in low motivation for students during the learning process as well as hinder the development of the ability to think critically and optimally. (Iswanto et al., 2024) . Critical thinking is a process that aims to conclude beliefs and convictions in oneself or about what we will do (Mahanal et al., 2019). The primary focus should not only be on obtaining answers or grades but also on questioning the answers, facts, and existing information (Bugg, 1997). The learning model used by the teacher must be in accordance with the learning objectives and the material to be taught (Wijayanto, 2021). Problem-based learning (PBL) is a viable learning model for economics subjects.

Howard Barrows introduced the problem-based learning (PBL) model, which was then further developed by various education practitioners because, through PBL, students can identify learning problems that are the focus of individual and group problem-solving (Kenny & Beagan, 2004). PBL can help the learning process for students to develop their thinking skills and direct students to be able to solve a problem (Fitriyanti & Ahmad, 2020). Students can apply problems to the PBL model to enhance their critical thinking skills. The PBL model expects students to solve real problems (Nurrohma & Adistana, 2021). Problem-solving can spur students' creative thinking because they are able to find and solve problems with new ideas. The PBL learning model also encourages students to increase collaboration (Ramadhani et al., 2019). Along with the development of learning models in the era of globalization, learning media has also changed to become digital-based (Damopolii et al., 2021). These efforts need to be made to ensure learning media is still captivating, attention-grabbing, and appropriate to the needs as well as interests of participants.

Learning media acts as a facilitator in the teaching and learning process, namely, all forms of materials or tools that can stimulate students' cognition, emotions, focus, and abilities, which will ultimately foster the learning process. (Prianggita & Meliyawati, 2022). Digital media offers various benefits, including cost savings and convenient access, as well as its use, which makes it increasingly popular (Kistofer et al., 2019). The development of modern technology significantly contributes to the sector of education because of its ability to facilitate and enhance the effectiveness of the learning process (Utami, 2022). The use of technology can be carried out by schools through the provision of information technology facilities (Suri et al., 2021). In addition, teachers must also utilize technology that continues to develop. Among various digital learning media that have emerged as means of conveying material, digital comics are one of the most popular (Darmayanti et al., 2022). Comics consist of composite images arranged in a regular format, featuring figures with easily recognizable characteristics (Narestuti et al., 2021). Comic media will facilitate the learning process, especially in realizing concepts learned through more real examples in everyday life with character

values (Rina et al., 2020). Although PBL has been widely used to increase the ability to think critically, the use of digital comics as complementary media in learning models is a relatively new thing (Hafizah et al., 2024). In general, the purpose of this study is to determine the level of effectiveness of the digital comic media-assisted learning model on students' critical thinking skills.

This research is in line with research conducted by Indriani et al. (2022), which showed results analysis of the use of learning models in the process of lectures in the class experiment found that the PBL learning model has more influence in increasing the ability to think critically in students compared to conventional learning models applied in class control, which is proven with each student's score. The study is also in line with Oktaviana & Ramadhani (2023), which found that the digital science comic media has been proven to have changed the learning outcomes of fifth-grade students at SDN Kalideres 12 Pagi, West Jakarta, with an average increase in *N-Gain Score* of 61.51%. From the analysis, it can be concluded that the use of science-based learning media, digital comics, provides enough impact to improve the results of students' cognitive aspects. The novelty of this research lies in PBL assisted by digital comics designed using Canva Design containing illustrations of everyday life that present real situations in a learning context. This digital comic conveys a visual story and contains elements of analysis, evaluation, and synthesis by following the stages of critical thinking in the PBL learning model. Students can also explore and solve a problem actively and reflect on the learning process. Thus, this research provides a practical learning experience by developing students' critical thinking skills.

II. Method

This study was conducted using a quantitative approach. It adopted a quasi-experimental method, a study design that aims to measure the effects of an intervention without involving a random process in determining the comparison group (Isnawan et al., 2020). Specifically, the design used is *a nonequivalent control group*. The *nonequivalent control group design* is a form of quasi-experiment in which the selection of the experimental class and control class is not done randomly (Sugiyono, 2019).

This research was conducted in class XI of SMA Negeri 1 Jogonalan. The population of class XI consisted of 282 students, and samples were taken using *purposive sampling,* where researchers were free to choose respondents based on the purpose of the study. The sample of the study was class XI students, where class XI 7 was the experimental group that received *the Problem-Based Learning* (PBL) model treatment with digital comic media, and class XI 8 was the control group that used conventional learning. The selection of these two classes was based on the criteria of the lowest class average score. The selection of these two classes was based on the lowest average score. The research instruments included 10 multiple-choice questions and 5 essay questions using *Higher Order Thinking Skills* (HOTS). Critical

thinking ability data were collected through pretests and posttests, then analyzed using descriptive statistics, prerequisite tests, *paired sample t-test hypothesis tests,* and *n-gain score tests* through IBM SPSS version 26.

III. Result and Discussion

This study involved students of grade XI at SMA Negeri 1 Jogonalan in the 2024/2025 academic year. Grade XI 7 was designated as the experimental group, and grade XI 8 as the control group. The classes were designated based on the average value of the economics interest class, where both classes had the lowest average values. The experimental group received treatment in two meetings, with the duration of the first meeting being 2 teaching hours and the duration of the second meeting being 3 teaching hours. Furthermore, the control group also received treatment in two sessions, with the duration of the first meeting being 3 teaching hours and the duration of the second meeting being 2 teaching hours for each meeting. Before and after the learning process, both classes were given *a pretest* and *a posttest*. The questions given were the same, consisting of 10 multiple-choice questions and 5 essay questions using the same *Higher Order Thinking Skills (HOTS) inquiries. Based on the pretest and posttest data, both groups were analyzed statistically to test the improvement and effectiveness of the PBL learning model assisted by* digital comic learning media in improving students' critical thinking skills. The results of the descriptive statistical analysis are presented in Table 1.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Sum	Std. Deviation
Pretest Eksperimen	33	37	67	52.21	1.232	7.079
Post Eksperimen	33	65	93	79.55	1.211	6.956
Pretest Kontrol	33	37	54	44.64	858	4.930
Postest Kontrol	33	65	91	75.67	1.237	7.105

Figure 1. Statistics of Pretest and Posttest Learning Outcomes

Figure 1 shows that the average pretest score for class XI 7 is 52.21, while *the pretest* for class XI 8 is 44.64. The average *posttest score* shows a significant increase in both classes. Class XI 7 recorded an average posttest score of 79.55, while class XI 8 reached 75.67. Thus, there is a significant difference in the average of the two classes. The experimental class showed a greater increase compared to the control class because it used a *problem-based learning model* assisted by digital comic media.

Table 1. Recapitulation of Posttest Value Normality Test

Test of Normality						
	Kolmogorov- Smirnov [a]			Shapiro-Wik		
	Statistics	Df	Sig.	Statistics	Df	Sig.
Posttest Experiment	.087	33	.200	.974	33	.588
Posttest Control	.138	33	.111	.945	33	.095

Table 1 presents the posttest results. The experimental group yielded a significance value of 0.588 ($p > 0.05$), indicating that the data are normally distributed. Similarly, the control group produced a significance value of 0.200 ($p > 0.05$), confirming that its data are also normally distributed. As both datasets meet the assumption of normality, the next step involves testing for homogeneity of variance.

A homogeneity test on posttest data is done to ensure that the data are homogeneous. Following the analysis of posttest data from both the experimental and control groups, the resulting significance value of 0.129 ($p > 0.05$) indicates that the assumption of homogeneity of variance is met. This result suggests that the posttest scores between the two groups are statistically homogeneous. *Posttest* data that has been distributed normally and homogeneously is then continued with the final data test, namely the independent sample t-test. The results of the posttest data mean similarity test are presented below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Hasil Berpikir Kritis	Equal variances assumed	.129	.720	2.241	64	.029	3.879	1.731	.421	7.337
	Equal variances not assumed			2.241	63.971	.029	3.879	1.731	.421	7.337

Figure 2. Results of the Independent Sample t-test

Figure 2 shows that the independent sample t-test in Figure 2 shows mark significance (2-tailed) $0.029 < 0.05$, which means Ho is rejected and Ha is accepted. Based on these data, experimental classes and control classes have average differences in their ability to think critically at the moment *of the posttest*. Afterwards, we conducted a hypothesis test. We conducted the hypothesis test using *a paired sample t-test*. A paired *sample t-test* is a test used to determine the average difference between two groups based on the independent variables. The following results are from the *paired sample test.*

Paired Samples Test								
	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pretest Postest Eksperimen	31.030	9.187	1.843	34.288	27.773	19.403	32	.000
Pair 2 Pretest Postest Kontrol	27.333	10.588	1.599	31.088	23.579	14.830	32	.000

Figure 3. Paired Sample T-Test Recapitulation

The results of the test in Figure 3 show that the results of the *paired sample t-test* have a significant value in the experimental class, namely 0.000 < 0.05, while the control class also has a significant value of 0.000 < 0.05. The data shows that Ho is rejected and Ha is accepted; the difference means that the application of the *problem-based learning* (PBL) learning model assisted by digital comics in improving students' critical thinking skills. Furthermore, the effectiveness of *the problem-based learning* model assisted by digital comic media in enhancing students' critical thinking skills can also be demonstrated through the *N-gain score* test—the following results of N-gain score testing on both classes.

Table 2. N-gain score test results

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Standard Deviation
Gain	66	.10	.85	.5728	.16518
Valid N (listwise)	66				

Table 2 presents the N-gain score results for the experimental class, revealing an average score of 0.5728. This result suggests that the implementation of the problem-based learning (PBL) model, integrated with digital comic media, is effective in enhancing students' critical thinking abilities.

This research demonstrates that students in class XI-7, who participated in learning using the problem-based learning model supported by digital comics, achieved higher scores compared to students in class XI-8, who were taught using conventional learning models. This is evidenced by the higher average posttest score of the experimental group (79.55) compared to that of the control group (75.67). The findings suggest that the integration of creative and contextually relevant learning models, along with effective use of media, can enhance students' critical thinking skills.

Students who were initially less interested in learning become more interested and understand the material taught by the teacher. One way to make students more active in learning is to create a pleasant classroom atmosphere. Learning that involves students directly helps students to be able to manage learning independently, not depend on teachers, and be

able to implement their learning (Nguyen & Habók, 2021). *Problem-based learning* supported by digital comic media is proven not only to deepen the understanding of students but also to hone their ability to think critically as well as practice solving real-world problems (Dawood et al., 2021). This result is in line with research conducted by Marpaung et al. (2022), which shows that the problem-based learning model using digital comic media is effective in improving students' science literacy skills. The use of digital comic media enhances the effectiveness of learning for teachers and increases students' enthusiasm, as it allows them to not only read but also view images of cartoon characters.

This methodology is different from the research conducted by Isa (2020), which used a quasi-experimental research type. This study concluded that there was a significant difference in economic learning outcomes between the use of the problem-based learning (PBL) learning model and the conventional or lecture learning model in class X students of MAN 1 Tebo Regency. The control class's average learning outcomes exceeded those of the experimental class. The average posttest score in the control class was 81.14, and the experimental class was 76.98. This finding means that classes using the PBL learning model are less effective in improving student learning outcomes compared to conventional learning models.

The use of digital comic media has been proven effective in increasing students' ability to think critically, as supported by research from Nelvianti (2021). Her research showed that the application of the problem-based learning model supported by digital comic learning media has a positive impact on improving the critical thinking ability of students in class V of public elementary school education units in Bandung City in the form of mastery of concepts and critical thinking skills of students in phase C in class V with the material of human digestive organs. The results of the study showed that students' critical thinking increased significantly by 25, with a significance value of $0.000 < 0.05$, an average pretest of 39.57, and an average posttest of 64.57.

The results of this study are also supported by research conducted by Dewi et al. (2024), showing that the use of the PBL learning model with digital comic media has a significant effect on the critical thinking skills of grade IV students in public elementary schools in photosynthesis material. In this study, PBL has been proven to be very effective in improving students' critical thinking skills and encouraging their active participation in the learning process. This study shows that the application of the PBL model has a positive impact on students' critical thinking skills, which are reflected in the achievement of critical thinking syntax indicators such as student competence in giving simple explanations, making observations, making conclusions, giving further explanations, and planning strategies and tactics.

In another study conducted by Zarvianti and Sahida (2020), there was an increase in the competency scores of knowledge, attitudes, and skills of students at each meeting; this result shows that the physics comics for SMA/MA that were developed were effective in learning. This result is also in line with research conducted by Nurchurifiani & Zulianti (2021), which concluded that the use of PBL-based comics is very effective in overcoming

learning limitations, for example, student learning difficulties, low learning motivation, critical thinking skills, and low student learning achievement. With the use of PBL-based digital comic media, students will be more interested in reading material and motivated to learn because it is presented with a sequential storyline and taken from everyday life. Educators need to further develop creative and innovative learning through learning models and learning media in accordance with existing technological developments.

IV. Conclusion

The conclusion of this study is the results of the research described above: the effectiveness of the problem-based learning model assisted by digital comics significantly influences students' critical thinking skills, as proven by the pretest and posttest results. The problem-based learning model is effective in improving students' critical thinking skills. Additionally, digital comic media can serve as a tool for teachers to engage students' attention, enabling them to participate effectively in the learning process.

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