Journal of Primary Education
10 (4) (2021) : 485–496

https://journal.unnes.ac.id/sju/index.php/jpe

Students' Mathematical Critical Thinking Ability with Project Based Learning (PjBL) Model Based on Local Culture

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Article Info

History Articles
Received:
12 September 2021
Accepted:
13 October 2021
Published:
30 December 2021

Keywords:
Critical Thinking Ability, Local Culture, Project Based Learning

Abstract

Students' mathematical critical thinking skills are still low, this is because the learning is still monotonous. Therefore, it is necessary to implement student-based learning. The purpose of this study was to analyze the effectiveness of the local culture-based Project Based Learning model in improving the critical thinking skills of class VIII students. This study uses a quantitative research approach. This design involved two groups of subjects, the experimental class was given treatment in the form of giving a Project Based Learning model with ethnomathematical nuances based on local wisdom, while the control class was taught using conventional learning. The sample in this study were 30 students in the experimental class and 30 students in the control class. The results of this study are the effectiveness of learning using the PjBL model with an ethnomathematical nuance based on local culture in improving the critical thinking skills of eighth grade students. Value of Sig. in the experimental class, the results of 0.05 it means that H_0 is rejected, in other words that the average posttest result of students' critical thinking skills classically has reached the minimum criteria completeness so that it can be said to be effective. The mean of the experimental class showed a result of 82.50, while the control class showed a result of 71.09. This shows that the average critical thinking ability of students in the experimental class is higher than the average critical thinking ability of students in the control class. The conclusion of this research is that the Project Based Learning (PjBL) Model Based on Local Culture is effective in improving the critical thinking skills of eighth grade students.

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p-ISSN 2252-6404
e-ISSN 2502-4515

INTRODUCTION

Mathematics is an important subject and gets special attention to meet needs in various fields, such as economics, science, technology, industry and so on. Therefore, mathematics is a compulsory subject at every level of education. This is as contained in Law no. 23 of 2003 concerning the National Education System Article 37 paragraph 1 states that "primary and secondary education curricula must contain mathematics". Mathematics is even one of the subjects that gets the highest percentage of lesson hours compared to other subjects. The purpose of learning mathematics as conveyed by Haryani (2012), is to improve critical thinking skills. This is because mathematics lessons use rules that can develop consistent and accurate reasoning so that it can be used as an effective thinking tool to solve a problem. Therefore, students who successfully learn mathematics are expected to have good critical thinking skills.

Initial research was conducted at SMPN 1 Wonotungga, initial observations showed that in the field reality related to learning mathematics was still found in the delivery of learning in conventional ways and tended to only prioritize results, without paying attention to the learning process and what happened to students. The results of the initial observations showed that students' thinking skills were still minimal. This is recognized by the teacher because students only receive the learning provided without ever asking questions outside the handbook or those that arise from their critical minds after getting learning.

The classroom teacher stated that most teachers still use the direct explanation method as the mainstay method that is often used in everyday learning, because they assume that if it is not explained, the material will not be complete. This kind of reality will more or less interfere with the process and results of receiving learning materials for students, such as students' critical thinking skills that are not optimal.

The researcher also conducted a question-and-answer session with one of the students at SMPN 1 Wonotunggal who stated that the interesting learning for him was learning that was appropriate to everyday life. Learning that comes from books is very irrelevant to everyday life that is nuanced in the local culture. Therefore, he considers that learning is difficult to accept.

The difficulties experienced by students are not necessarily due to their abilities, but the factor in delivering learning from the teacher is very fundamental. If the teacher is reluctant to pour his creations into learning, then boredom is something that is definitely felt by students, as a result, students' critical thinking skills are also not optimal.

Critical thinking is an attitude of thinking deeply about problems and things that are within the range of one's experience. Critical thinking requires students to make reasonable or logical decisions. Critical thinking will also help students in sorting out relevant information or not (Cottrel, 2011). This is especially useful for solving problems and working on larger tasks. Critical thinking is a must in solving problems, making decisions and analyzing assumptions. Critical thinking is applied to learn to solve problems systematically, innovatively and to design appropriate solutions. In this case, students are required to analyze the information and conclude it.

Therefore, to encourage students' thinking potential, the implementation of learning and evaluation must be managed in a planned manner to empower students' conceptual understanding and critical thinking skills. Armed with this, the researchers provided a solution to use the Project Based Learning (PjBL) learning model. PjBL is a teaching and learning model that involves students to work on a useful project to solve problems in society or the environment. This model provides broad opportunities for students to make decisions in choosing topics, conducting research, solving problems and creating a product. Students are required to work for real and as if they exist in the real world that can produce products realistically.

This research was conducted relevant to the research conducted by Suhatini & Martyanti (2017) entitled "Improving Critical Thinking

Ability in Ethnomathematical-Based Geometry Learning" providing the conclusion that students' mathematical critical thinking skills can be improved using ethnomathematical-based geometry materials in the learning process. Ethnomathematical learning related to culture in ethnomathematics-based geometry learning trains students to think critically. Research conducted by Kristianto (2020) entitled increasing critical thinking skills and mathematics learning outcomes with the project based learning (PJBL) model concluded that there was a better improvement from the implementation of project based learning (PJBL), namely critical thinking skills in the pre-cycle of 10%, the first cycle is 63% and the second cycle is 84%. So it is said that the implementation of the project based learning (PJBL) model is effective in improving students' mathematical critical thinking skills.

Learning is an activity or a process to acquire knowledge, improve skills, improve behavior, attitudes, and strengthen personality. So that children at elementary school age are also at a critical age for the process of character building based on local wisdom.

Sagung (2014) states that learning carried out in schools also needs to be adapted to all developments that occur in society so that students are able to remain competitive in this era of globalization. However, the learning that is carried out cannot be separated from the culture that exists in each region in Indonesia.

The local wisdom-based learning model is one of the learning models oriented to the integration of the local wisdom values of a community into learning materials. According to Wibowo (2015) local cultural wisdom is very appropriate to build student character values which are an accompaniment effect in learning at school. Local wisdom-based learning can bridge students to rediscover their hopes. The purpose of learning based on local wisdom is a learning strategy that utilizes the environment as a learning target, learning resource, and learning tool. This can be used to solve environmental problems and to instill an attitude of loving the environment. Local wisdom is the local wealth of ancestral heritage in the values of life that are integrated in the form of religion, culture and customs (Anwar, 2017).

The purpose of this study was to analyze the effectiveness of the Project Based Learning model based on local culture in improving the critical thinking skills of eighth grade students of SMP 1 Wonotunggal.

METHODS

The applied method was the experimental method with a pretest-posttest group control design. The research population consisted of 135 children of the Muslimat Nurul Huda Early Childhood Education Program, Karangtalok, Pemalang. The sampling technique was purposive sampling by considering the children aged 5-6 years old. They were also in the transition period from preschool into preliminary school. Sixty childrens participated in this research. Each group of class B1 and B2, consisted of 30 childrens. The group B1 as the control group and B2 as the experimental group.

This research was carried out in eight sessions. The first session consisted of a pretest as the replacement of intervention for both groups, experimental and control groups. The pretest was given with the most frequently used application media, the non-media model. The second until the sixth sessions consisted of intervention for an experimental group with the cooperative learning method mediated by snake-ladder media. On the other hand, the control group was taught without a non-media learning model. The posttest was given on each session for both groups. The experimental group was intervened by snake-ladder while the control group was taught by a non-media learning model.

The data collection technique was a mathematics skill observation sheet in the form of a checklist with a 1-4 Liker scale. The observation sheet validity test used expert validation to test the content or construct validity. The instrument was arranged based on the measured aspects in a certain theory. Then,

the instrument was consulted with the experts, the lecturer of early childhood education.

The result showed the instrument was valid. It was taken from the early childhood development achievement level standards for 5-6 years old children as applied by the Ministerial Regulation of Education and Culture of Republic of Indonesia, Number 137 the Year 2014. The instrument consisted of eleven items about of recognizing the surrounding objects and mentioning the surrounding objects.

During the observation, the obtained checklist scores were used as observation guidance. The data of this research were analyzed statistically with a t-test. Before examining the hypotheses, the classical assumption test was done, consisting of normality and homogeneity tests. Before conducting the normality test, the obtained scores of each class were $\alpha > 0.05$. The homogeneity test was $\alpha > 0.05$ for each group, both the experimental and control groups.

Table 1 consists of early childhood mathematics skill indicators. Based on Table 1, the mathematics indicator measured are about recognizing the learner surrounding objects and named them to investigate their understanding about their environment as well as their basic mathematics skills. It is in line with Berkowitz et al. (2016), that learning mathematics immediately required the same development as children learn basic mathematics vocabularies, how they recognize the surrounding world of mathematics, and how they express the more complex mathematics concept, such as measurement, geometry, and reasoning.

Early childhood children must have frequent access and interaction. Thus, they will have an algebra concept to develop, including classifying, ordering, comparing, contradicting, arranging objects, and identifying patterns. Yuliantina et al. (2017), argued that basic geometry is a part of the mathematics curriculum in the early years, including identifying various objects and communicating the spatial directions.

RESULTS AND DISCUSSION

The results of the research that will be described in this chapter are oriented to the research objectives that have been described in the background of the problem, namely to analyze the effectiveness of the Project Based Learning model based on local culture in improving the critical thinking skills of eighth grade students of SMP 1 Wonotunggal. The research data that will be presented are in the form of analysis prerequisite test data and research data.

1. Prerequisite Test

a) Normality Test

The first stage after the data from the pretest results of the experimental class and control class students are collected, then a normality test of the data is carried out using the normality test formula through the Liliefors test (Kolmogorov-Smirnov) using SPSS version 21, this is done to find out whether the pretest data comes from of the data are normally distributed or not. The form of the hypothesis for the normality test is as follows. H0: data comes from a sample that is normally distributed. H1: data does not come from a sample that is normally distributed.

The criteria used to reject or not reject H0 based on the P-value are as follows. If P-value < 0.05, then H0 is rejected. If the P-value > 0.05, then H0 is accepted. The results of the normality test for the control class and the experimental class can be seen in Table 1.

Table 1. Normality Test of Students' Critical Thinking Skills Pretest

Normality Test	Experiment Class	Control Class
Sig. Kolmogorov-Smirnov	0.148	0.200
α	0.05	0.05
Description	Normal Distribution	Normal Distribution

Based on Table 1, it can be seen that the results of the pretest of critical thinking skills of experimental class students have a Sig value of the normality test of 0.148 which is greater than the value of = 0.05. This shows that the experimental group's pretest data came from data that were normally distributed or H0 was accepted. In the control class after the normality test has a Sig value of 0.200, which is greater than the value of = 0.05, this indicates that the pretest data in the control group is normally distributed or H0 is accepted. Therefore, it can be said that the experimental class and control class data are normally distributed.

b) Homogeneity Test

Homogeneity test was carried out to investigate whether or not the homogeneity of the variance or group was met or not. The hypotheses for the homogeneity test are as follows. H0: Both variances are the same. H1: The two variances are different. The criteria used to determine the homogeneity of the pretest are as follows. H0 is accepted if the significance is 0.05. H1 is rejected if the significance is < 0.05. Following are the results of the homogeneity test in Table 2.

Table 2 Homogeneity Test of Students' Thinking Skills Pretest

		Levene's Test for equality of Variances	
		F	Sig.
Pretest	*Equal variances assumed* *Equal variances not assumed*	0.445	0.822

Based on Table 2, the homogeneity test of the experimental group and control group has a Sig value of 0.445, this shows that H0 is accepted because Sig > 0.05, meaning that the experimental group and control group come from the same variance.

2.Hypothesis Test

a) Sample t-Test

The results of the sample t-test of students' mathematical critical thinking skills that the value of Sig. shows the results of 0.05 0.05,

meaning that H0 is rejected, in other words that the average posttest result of students' critical thinking skills classically has reached the criteria minimum so that it can be said to be effective.

b) Independent Sampe t-Test

The difference in the effectiveness of learning with the PjBL model with ethnomathematical nuances based on local wisdom can be known by conducting a t-test. The t-test used is the independent sample t-test, which is an average difference test by comparing the results of the posttest control class and the experimental class. The results of the calculation of the independent sample t-test of students' critical thinking skills between the experimental class and the class can be seen in Table 4 as follows.

Table 4 Test Independent Sample t-Test

Sig. 2 Tailed	α	Mean Experiment	Mean Control	Description
0.00	0.05	82.50	71.09	There is a difference in the average critical thinking ability

ased on the posttest t-test table above, it can be seen that the significance value shows the number 0.00 <0.05. This proves that there is a difference in the average value of critical thinking skills in students in the experimental class and the control class after learning. In the mean box, it can be seen that the mean of the experimental class shows a result of 82.50, while in the control class it shows a result of 71.09. This shows that the average critical thinking ability of students in the experimental class is higher than the average critical thinking ability of students in the control class.

c) Learning Outcome Improvement Test

The following is a graph of the acquisition of score 1 for each indicator of the pretest-posttest results of critical thinking skills in Figure 1.

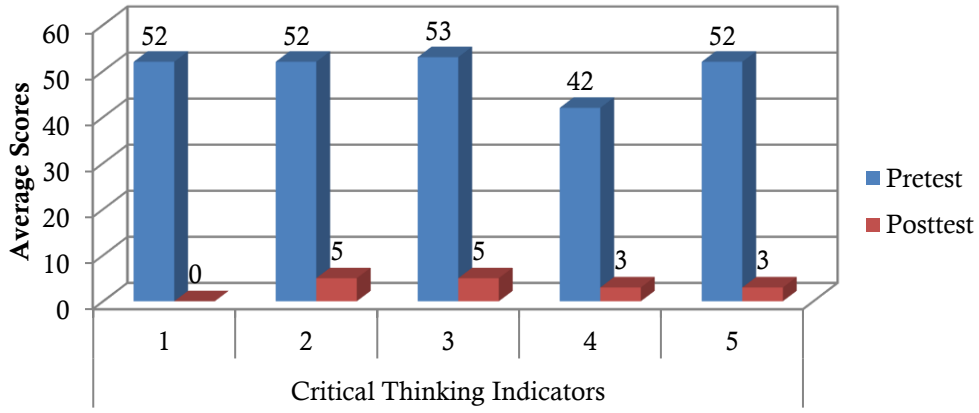

Figure 1 score 1 Each Critical Thinking Indicator

Based on the results of Figure 1, the researchers gave treatment to the research subjects in the form of learning using the PjBL model with ethnomathematical nuances based on local culture. In students who get a score of 1 in learning, it appears that students still do not understand the direction of learning so that they do not actively participate in the learning that is carried out. Next, a graph of score acquisition is presented 2 each indicator of the results of the pretest-posttest of critical thinking skills is shown in Figure 2.

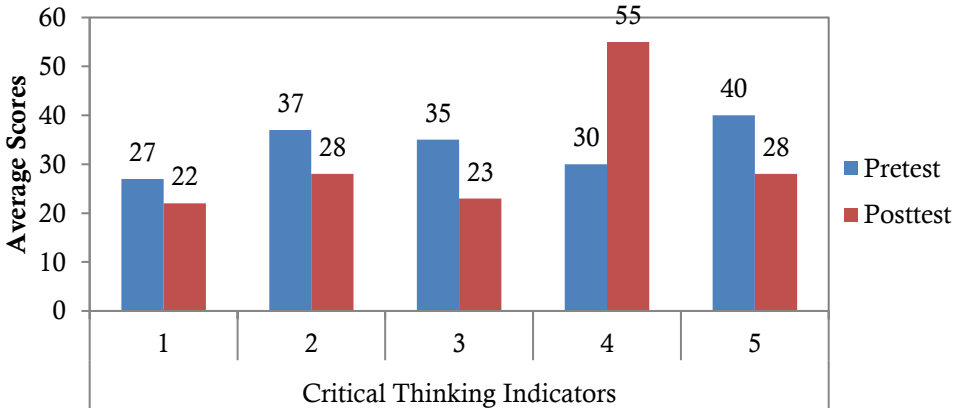

Figure 2 Obtaining a Score of 3 Critical Thinking Indicators

Based on the picture above, students who get a score of 2 in learning show their enthusiasm in participating in learning with the PjBL model with ethnomathematical nuances based on local culture. Students follow the planning of making projects enthusiastically but are unable to follow in making it, this is because students have not been able to follow the making of projects to the fullest.

Futhermore, a graph of the acquisition of scores of 3 for each indicator of the pretest-posttest results of critical thinking skills is presented in Figure 3.

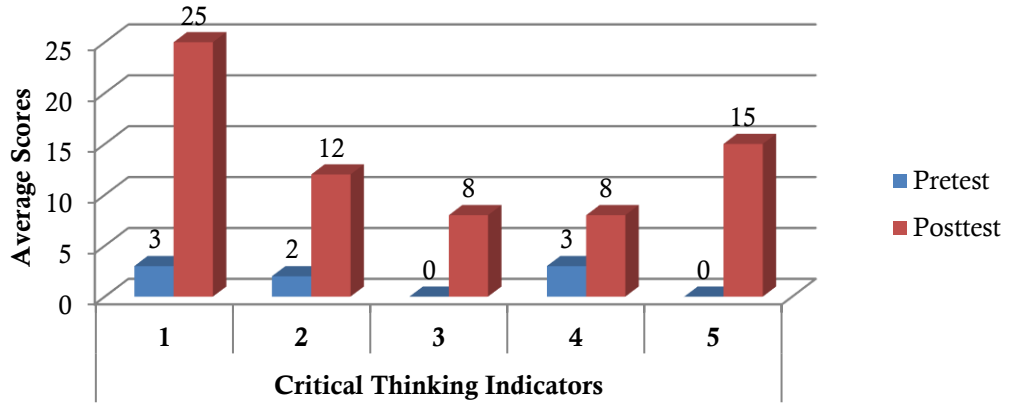

Figure 3 Obtaining a Score of 3 Critical Thinking Indicators

Based on the picture above, students who get a score of 3 are caused because students are active in learning, students who get a score of 3 are able to plan and make projects optimally, then students are able to demonstrate it well so as to obtain maximum student critical thinking skills.

Furthermore, a graph of the acquisition of scores of 4 for each indicator of the pretest-posttest results of critical thinking skills is presented in Figure 4.

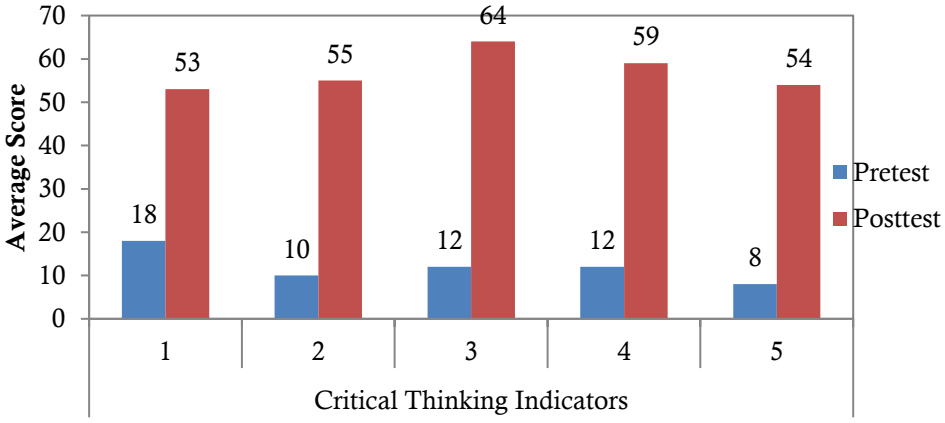

Figure 4 Obtaining a Score of 4 Critical Thinking Indicators

Based on the data, students who get a score of 4 are students who have high mathematical critical thinking skills. Students are able to solve problems and are able to make projects according to the number pattern material correctly and are able to demonstrate it well so as to make other students understand. In addition, students who get a score of 4 are also enthusiastic in carrying out projects with good progress. Students with a score of 4 in critical thinking skills are able to solve problems

correctly and in accordance with the systematic work of complete mathematical problems.

d) n-Gain Test

Gain test was conducted to determine the difference in the improvement of students' critical thinking skills from pretest to posttest. The results of the N-Gain test can be seen in Table 5.

Table 5 Calculation Results of N-Gain Test

Aspect	Score	Average	Category
Critical Thinking Ability	11.142	0.45	Medium

Based on the data in Table 5, it can be seen that the average N-Gain of students' critical thinking skills shows a result of 0.45 which is in the moderate category. The results of the N-Gain calculation for each student can be seen in Figure 5

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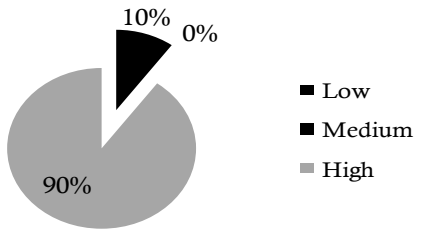

Figure 5 N-Gain Critical Thinking Skills

Based on Figure 5, it can be seen that in terms of critical thinking skills, there are no students who achieve high gain scores, students who achieve moderate gain scores have a percentage of 90%, and students who achieve low gain scores have a percentage of 10%.

The PjBL learning model with ethnomathematical nuances based on local culture is considered more effective than conventional learning using the lecture method. This can be seen from the results of the t test used to analyze the data. Based on the results of the t test, it was found that there was an effectiveness of the PjBL learning model with an ethnomathematical nuance based on local culture. During learning using the PjBL learning model with ethnomathematical nuances based on local culture, students seem enthusiastic in participating in learning. As the opinion of Glynn & Winter (2004) states that contextual learning such as PjBL requires students to answer questions from the phenomena they find in their environment. PjBL is learning with learning concepts that are taught in real-world situations and encourage evidence that will show the level of students' abilities in achieving learning objectives.

During learning by using the PjBL learning model based on local culture, students express a lot of opinions and ask questions related to the local culture around their place of residence. So, with the application of learning based on local culture, students can better recognize the potential that exists in the area where they live. For example, in learning the number pattern material, students are introduced to one of the parks in Batang district. The shape of the park is a rectangle then students are asked to show the number pattern of the park. Learning by applying ethnomathematics will make students understand more deeply about the culture around them and be able to understand the material more concretely. As stated by Nursahadah (2019) that local culture-based learning is mathematics learning that is associated with cultural outcomes that exist in society, both in the form of artifacts and customs.

In addition, students also appear to be more active, creative, and interactive in learning based on local wisdom. This shows that there is a sense of student interest in participating in learning activities as stated by Marzoan & Hamidi (2017) learning activities will be successful when students are interested in participating in learning activities. Through the implementation of local wisdom-based learning, it is hoped that students have a better understanding of Mathematics, as well as an understanding of culture which will make it easier to instill these cultural values in everyday life (Sunandar, Zaenuri & Dwidayati, 2018).

Ethnomathematics-based learning will benefit students at the same time, namely understanding the concept of mathematics and getting to know the culture.

Daniel (2016) in his research obtained the results that students' critical thinking skills with the implementation of the project based learning (PJBL) model were better than without using the project based learning (PJBL) model. The score of students' mathematical critical thinking skills using the project based learning (PJBL) model based on high, medium, low categories is better than the control class that does not use the project based learning (PJBL) model.

According to Falahudin (2016) critical thinking is a reflective thinking ability that focuses on decision-making patterns about what to believe and what to do. Practicing critical thinking means that students will naturally build arguments using reliable evidence and reasonable logic. According to Haryadi et al. (2015) critical thinking is a directed thinking process in solving problems, making decisions, and analyzing before acting. Critical thinking is a very vital ability in all aspects of life because it is one of the determinants of student success in life (Masfuah et al. 2016).

Learning mathematics is not actually memorizing words, but is the result of an association from an experience gained from learning. Learning will be more meaningful if children experience what they learn, not just know it. When children get experience from the learning process, then children will be able to understand math material more deeply and can be remembered in a relatively long period of time. Therefore, there is a need for the teacher's role in determining appropriate and effective learning models and methods in achieving students' critical thinking skills in learning mathematics. As stated by Ekoningtyas (2013) that students' critical thinking skills will develop well if done intentionally. Similar to the opinion of Rahayuni (2016) that critical thinking skills can be trained through mathematics lessons or other disciplines with learner-centered learning.

The Project Based Learning (PjBL) learning model is different from traditional learning models which are generally characterized by short, isolated classroom practices and teacher-centred teaching and learning activities. PjBL places more emphasis on long-term, holistic, student-centered learning activities that are integrated with practice and real-world problems. PjBL fosters abstractions and intellectual tasks to explore complex issues. Therefore students explore, make research, interpret, synthesize information in a meaningful way (Maudi, 2016). This is a manifestation of the ability to think critically in solving a problem.

Learning using the PjBL model requires students to learn independently and be actively involved in problem solving and investigation. The essence of the learning model (Nurfitriyanti, 2016). PjBL is project work. Project work is a form of work that contains complex tasks based on very challenging problems and leads students to design, solve problems, make decisions, carry out investigative activities, and provide opportunities for students to work independently. The final result of this learning model is the creation of a useful product to solve a problem. The products delivered in PjBL learning can be in the form of electronic media, print media, appropriate technology, written works and so on. Product delivery can be done through online media, exhibitions or other activities (Effendy, 2018).

The advantages of implementing the project based learning model according to Kurniasih (2014) are: "(1) increasing students' motivation to learn to encourage their ability to do important work, and they need to be appreciated; (2) improve problem solving ability; (3) making students more active and successful in solving complex problems; (4) enhance collaboration: (5) encourage students to develop and practice communication skills; (6) improve students' skills in managing resources; (7) providing students with learning and practical experience in organizing projects and making allocations of time and other resources such as equipment to complete assignments; (8) provide a learning experience that involves students in a complex manner and is designed to develop

according to the real world; (9) involving students to learn to take information and demonstrate their knowledge, then implement it in the real world; (10) make the learning atmosphere fun, so that students and educators enjoy the learning process.

According to Widyatini (2014), the advantages of using a project-based learning model are as follows: 1) increase student motivation 2) improve problem solving skills 3) increase collaboration 4) improve resource management skills 5) increase student activity 6) improve student skills in finding information 7) encourage students to develop communication skills 8) provide students with experience in organizing projects 9) provide experience in making time allocations to complete assignments.

This is in line with research from Sari (2017) which concludes that there is a difference in mathematical critical thinking ability shown by tcount greater than ttable, which is 2.49 greater than 1.66. There is an effect of the project based learning (PJBL) model on students' mathematical critical thinking skills. The difference between the research that has been carried out and the research to be carried out is the research method used, in previous studies using quantitative methods, while the research to be carried out was using mixed methods. Meanwhile, the similarities are that they both use the PjBL learning model on students' critical thinking skills.

Meanwhile, the control class did not show effectiveness in conventional learning in improving students' critical thinking skills. What appears when students discuss is that in each group there must be students who don't want to help and just sit, play alone, even disturb friends in one group or another group. This happens because the student pays less attention to learning, he is reluctant to discuss because his group friends do not invite him to discuss. When reprimanded by the teacher, he kept quiet and tried to join his group of friends, but after a while he returned to his original attitude. In accordance with what was stated by Dunlosky (2013), namely the limited opportunity for student participation and the less than optimal teacher in explaining the material with various variations, it can create boredom and the forum situation is less orderly so that learning becomes less meaningful. So, it can be concluded that conventional learning is less effective in improving students' critical thinking skills. As stated by Hendracipta, Syachruroji & Hermawilda (2017) that the results of conventional learning are less effective in improving student outcomes.

CONCLUSION

The conclusion of this research is that the Project Based Learning (PjBL) Model Based on Local Culture is effective in improving the critical thinking skills of eighth grade students of SMP 1 Wonotunggal. This can be seen from the t test with the Sig result of 0.00 < 0.05, meaning that H0 is rejected. Based on research that applies the PjBL model with ethnomathematical nuances based on local culture, it has the advantage of being able to activate students in this study, they also plan projects and make them so that their critical thinking skills increase. However, there are shortcomings in this study, namely there are still students who get a critical thinking ability score of 1 because these students still cannot be conditioned properly.

ACKNOWLEDGMENT

The researcher would like to thank all those who helped in writing this article. the principal of SMPN 1 Wonotunggal and all teachers at SMPN 1 Wonotunggal and students as research subjects who helped carry out this research.

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