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The development of mathematics learning tools through the bridge games based on lesson study for learning community and its relationship with the higherorder thinking skills in probability theory

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Abstract. This research purposes to develop a mathematical learning tool through the Bridge games based Lesson Study for Learning Community and find out its relationship with the process of high-level thinking on opportunity material. This study uses a mixed method that combines developmental research and when testing the development process is used experimental research to find the relationship between learning devices and the high-level thinking process of students. The research subjects were students of the eleventh grade of the high school. The sample consisted of two classes taken randomly. Class selection was done by using the cluster random sampling method. This sampling technique is used to determine the sample if the object under study is quite large. The class given treatment is called the experimental class and the untreated class is called the control class. The next stage, both experimental and control classes are taught by the same teacher but with different treatments. In the experimental class, the researchers used a bridge games based on Lesson Study for Learning Community and a control class using conventional learning. Data obtained from pre-test and post-test to solve the problem sheet and also from the results of interviews. In the homogeneity test, the Levene's test shows the results of the sig value. 0.671 in pre-test and 0.450 in post-test so that it can be concluded that the assumption of homogeneity of variance is fulfilled. Based on the results of validity, effectiveness, and practicality tests, the researcher has concluded that the learning platform through a bridge game and LSLC is a valid, effective and practical device. At the time of the field trial experimental research was also conducted. From the results of the test of differences in the increase in high-level thinking skills in both classes using the Mann Whitney Test showed the sig value. 0,000 ($p < 0.05$), so it was concluded that there was a difference in the increase in high-level thinking skills between control classes that used conventional Instruction and experimental classes that used learning through LSLC-based bridge games with results that showed a significant high-level thinking skills of students so that when compared with conventional methods these devices get higher results than students using conventional methods.

1. Introduction

The learning process in the 21st century wants to make student can improve their critical thinking skills and be able to solve problems, be creative, innovative, and be able to communicate and collaborat[5;15]. To make realizing the development of mathematics learning, learning tools are needed that are in line with the era, so that real development results from mathematics learning done by someone. According to [17], one way to make students more high-level and innovative thinking is to make learning media more complex by linking the material to mathematics with contextuall problem. Learning devices are a set of learning resources that allow students and teachers to carry out learning activities [8]. Learning tools needed in managing the teaching and

learning process can be in the form of; Learning Implementation Plan, Student Worksheet and Learning Outcomes Test. With group discussions students are more free and active and can develop their knowledge independently. Lesson Study for Learning Community or what is often called LSLC which changes with collaborative and learning community based. The characteristics of LSLC are students making groups with four students whose seats are close together (collaborative learning), caring community, and giving jumping tasks [1].

The game has the potential to improve student relations, motivation, stimulate high-level thinking, replicate real phenomena, and accelerate students' ability to solve real problems [2;6;13;20]. One game that is suitable for making a learning media is Bridge. Bridge is a game that uses a set of playing cards based on communication skills between players in one partner or opponent. With the Contract determined at the initial stage during the bidding process. After that, in the second stage is playing all the cards based on the information obtained and the distribution (factor of division) of the card. The beginning of playing bridge begins with offering until a contract is obtained [18]. Based on the results of observation, it was found that the bridge game with the model was related.

This research is different from previous research. The research conducted by [1]. Aims to describe the activities of students using LSLC-based Problem-Based Learning (PBL), with a special emphasis on the nature of social justice, especially on critics of the neo-liberal reform agenda. The research conducted by [8]. Aims to develop learning devices with LSLC-based Contextual Teaching and Learning (CTL) learning instruments with the subject of Class X Vocational Rows and Series as well as to find out the effect on HOTS thinking skills. Then, research conducted by [10] aims to see the relationship between collaborative learning and motivation.The research conducted by [9] aims to collaborate between Civil Servant Teachers and Internship Students in Lesson Study in Thailand The research conducted by [14] and [3]. Aims to determine the percentage of mathematical creative thinking skills of junior high school students in PBM.

Based on the results of observations, we can find a problem regarding decision making related to opportunities, namely when all players make a short calculation to make an appropriate decision, therefore it is necessary to conduct a study of bridge games so that it is expected to be used to show the relationship between opportunity theory and the bridge game itself. It is also hoped that from the bridge game it can be used as a learning media in opportunity material so that it can improve the higher order thinking skills process of students based on Lesson Study for Learning Community and with this research can make students think higher and innovative, improve critical thinking skills and the courage to take risks so that they can give birth to a deeper understanding of mathematics.

2. Methods

2.1Research Scope

The method used in this research is a mixed method. By combining 2 research method, development research and experiments. Development of learning devices is a series of processes or activities carried out to produce a learning device based on existing development theories [8]. The development model that will be used in this research is modifying the Thiagarajan model known as the Four-D Model. The four stages are the defining stage, the design phase, the development stage and the dissemination stage. The research that will be carried out is intended to develop an opportunity learning tool through a game of Bridge-based Lesson Study for Learning Community and to know its relationship by high-level thinking of students. This research presents a device in the form of Silabus, Learning Implementation Plan, Student Worksheets, through bridge play and will be shown there is an effect with higher order thinking skills of students. The research steps presented in the research flow diagram.

2.2Sample

The subjects of the research were the eleventh grade of class 1 and 2, mathematics and science study program, SMAN 2 Jember. Class 1 used as the experimental class, in which the number of students in class 1 werw 36 students, while the class 2 used as the control class with 36 students.

2.3Instrument and Procedure

The research instruments used in this study include: device validation sheets, readability questionnaires of student worksheets and learning outcomes, observation sheets namely observation sheets of educator activities, observation of students activities, observation sheets for development of higher order thinking skills, students response questionnaire sheets, worksheets students, and test results.

The experimental design used was quasi-experimental research (Quasi Experimental Design) using two classes, experimental class and control class. The experimental class is a class that learns to use a bridge games based Lesson Study for Learning Community. The control class is a class that learns to use conventional learning

models that are commonly applied in schools, direct learning models (DI). This study provides an overview of the comparison between higher order thinking students in the experimental class with the control class.
The design of this study uses Nonequivalent Control Group Design with a scheme such as table 1.

Table 1. Research Design [19]

Group	**Pre-Test**	**Treatment**	**Post-Test**
Control Class	O_1	Conventional	O_2
Experimental Class	O_3	LSLC	O_4

To know the students higher order thingking skills level based on their cognitive style and to find out the improvement of the students higher order thinking skills level, the researchers analyzed the results of the pre-test and post-tes.

2.4Data Collection and Data Analysis

Both classes, experimental and control classes were given the same pre-test and post-test. Qualitative data gained from the process of interview and was analyzed from the ordinal data.

This study involves one independent variable and one dependent variable. The independent variables tested in this study is a learning devices with bridge games based LSLC while the dependent variable is a higher order thinking skills. Data analysis techniques used are t-test if the data is normally distributed and homogeneous. If the data is not normally distributed or not homogeneous, then use the non-parametric test, the Mann-Whitney test. The data resulted were going to be analyzed by using SPSS 22.0 program.

The analysis of the students answers in the scope higher order thingking skills consisted of students worksheets and learning outcomes. The assessment of higher order thinking skills for each sub-indicator was scored as “good” with 3 points, “average” with 2 points and “poor” with 1 points. The points would be change in the form of scale 1-100. The processing of the students answers, as follows: The answers in the scope of higher order thinking skilss for each dimension is categorized based on assessment scale that consists of high higher order thingking skills, mediumhigher order thingking skills, and low higher order thinking skills. In this research, the range scores og high higher order thingking skills was $87.5 \leq x < 100$, medium higher order thingking skills was $69.64 \leq x < 87.5$, and low higher order thingking skills was $51.79 \leq x < 69.64$.

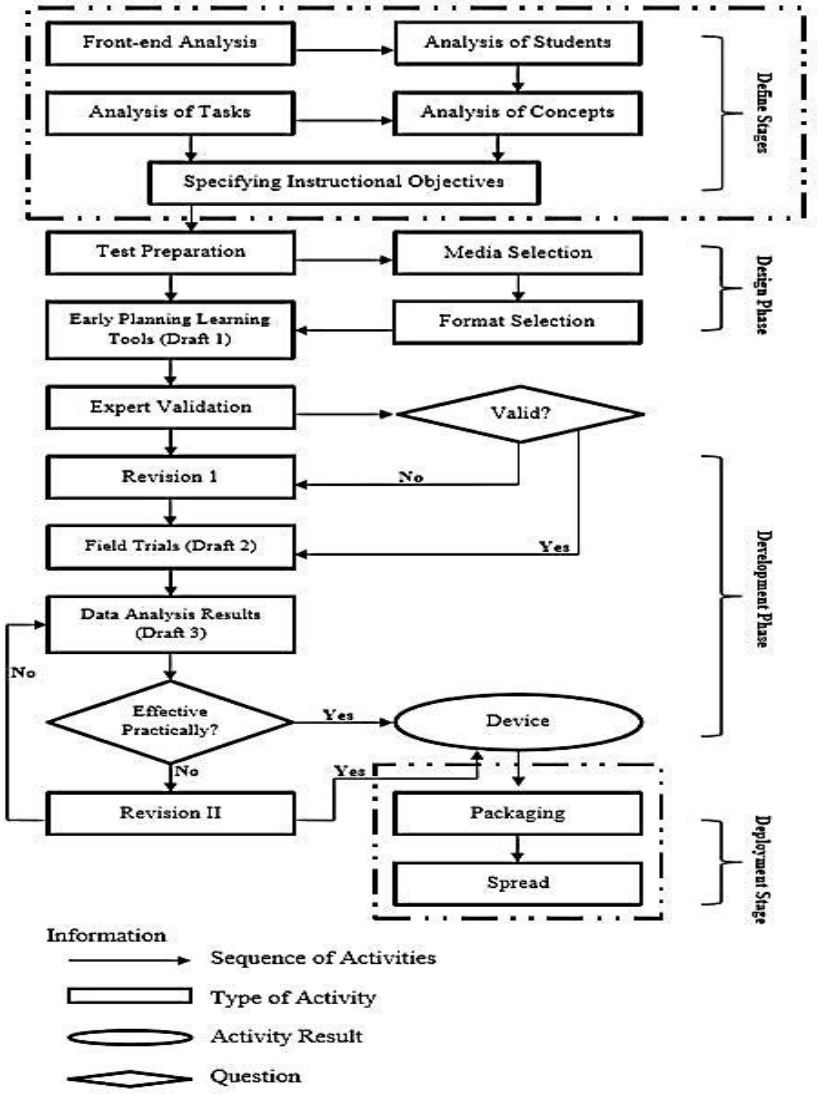


Figure 1. Development Research Chart

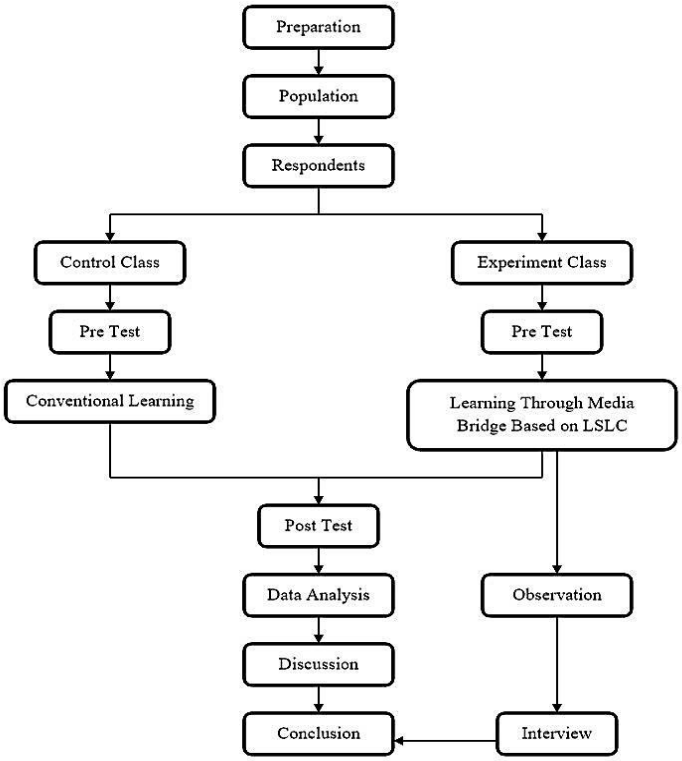


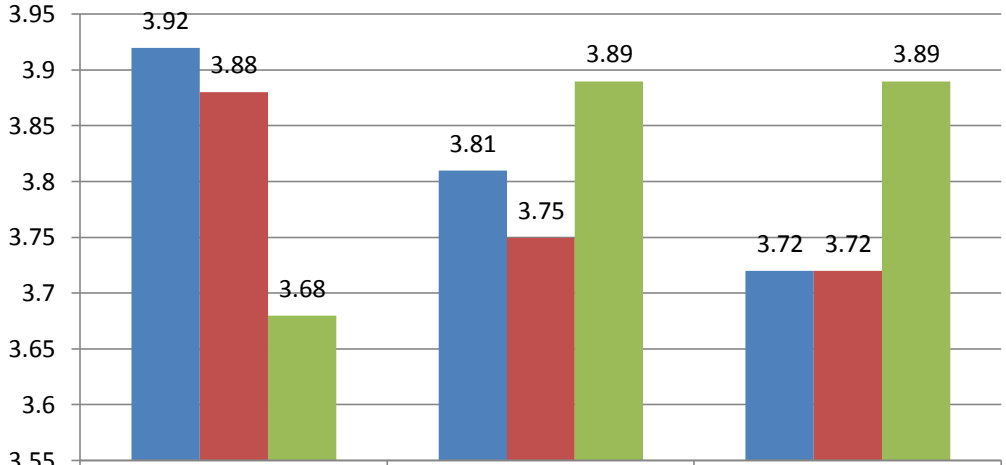
Figure 2. Experimental Research Chart

3. Research Findings

The initial research done the qualitative method that based on interviews conducted by researchers with mathematic teacher SMAN 2 Jember, information was obtained that students had difficulty in solving contextual problem on the subject Probability Theory. Students find it difficult to understand and express the problem of story in Probability Theory. This shows that students do not understand correctly about the concept of probability theory.

From the results of observations and interviews conducted by researchers at the mathematics teacher of SMAN 2 Jember, the caracteristic of students in the learning groups as follows: 1) students with high abilities tend to help friends who have difficulty learning by directly showing the results of their work without giving an explanation of how the steps are resolved. In other word, low-ability students are neglected and lack of mutual care to help friends who do not understand to become understanding. 2) low-ability students are less active in asking friends who already understand. Students reluctance to ask questions is caused by the presence of shame or lack of confidence or due to reluctance and resignation because self-conviction will not be able to understand the mathematical material. Therefore, students need to be given a variety of teaching and learning processes where collaborative learning is created and a growing sense of mutual care so that no students are neglected (caring community).

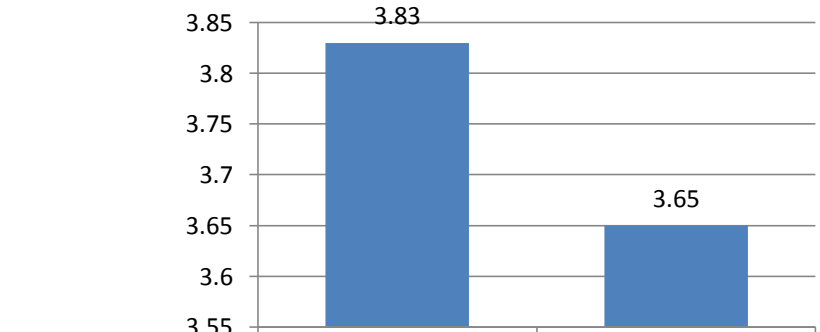
Furthermore, from the quantitative method that were validity and reliability tests in the learning devices. The aim of validity and reliability was to know how far the validity of the assessment instrument to do its measurement function. The following were the results of validity and reliability tests had been conducted in the research subject.



	LIP	SW	LOT
Validator 1	3.92	3.81	3.72
Validator 2	3.88	3.75	3.72
Validator 3	3.68	3.89	3.89

Figure 3. The Results of The Learning Device Validation

3.1 Implementation of Learning Devices with Bridge Games based on Lesson Study for Learning Community
During learning the observer observes the implementation of the learning tools carried out by the model teacher. The aspects assessed are the stages of learning, the social system, and the principles of reaction and management. The results of observations on the implementation of learning devices are presented in the following figure.



	Meeting 1	Meeting 2
Observation Results	3.83	3.65

Figure 4. Implementation of Learning Devices

The learning tool is well implemented if the average value of the learning device implementation $(\bar{V})$ at each meeting is at an interval of $3 \leq \bar{V} < 4$. From the diagram above shows that the value of the implementation of learning devices at each meeting is in good criteria with the average value of the implementation of learning devices $(\bar{V})$ in the implementation of this study amounting to 3.74.

Decrease in the value of the average implementation of learning at the 2nd meeting was caused by a class situation that had not been controlled by the teacher. This is because, the material at the second meeting is a conditional opportunity material that is considered more difficult than the previous material. So that many groups experience difficulties because group discussions do not produce the right solution. Therefore many groups then raise their hands to the teacher to ask. When the teacher gives scaffolding to a group, the other group cannot wait for an explanation from the teacher so that some group members call or come to other groups who

have solved the problem first. This resulted in the class atmosphere being crowded and chaotic. But then the teacher tried to control the condition by giving a warning to some students who made noise.

3.2 Student Activities

Student activities observed during the learning process take place, namely the activity of students paying attention to the explanation of the teacher or friend, asking/arguing and collaborating, working on and finding answers, and presenting or responding to the results of group discussions. From the results of observations made by observers during the learning process on student activities, the results are presented in Figure 5 below:

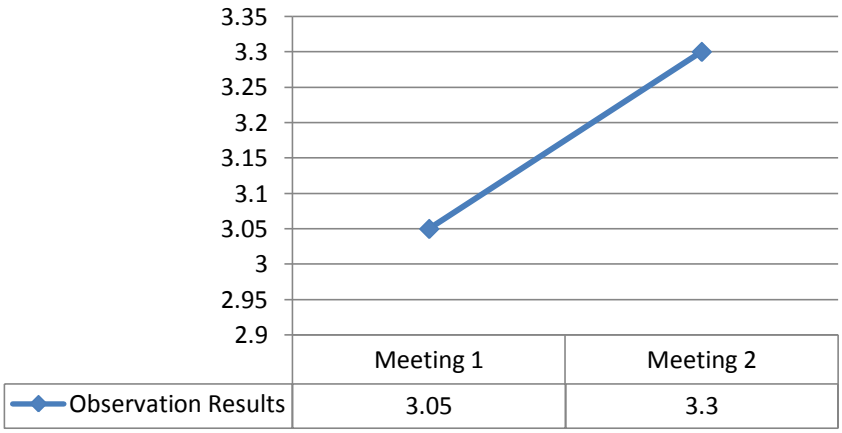


Figure 5. Student Activities

Student activities meet good criteria if the average value of student activity ($\bar{V}$) at each meeting is at an interval of$3 \leq \bar{V} < 4$. Figure 5shows the results of student activities at the first meeting to the 2nd meeting at intervals of$3 \leq \bar{V} < 4$. Thus the activities of students during the learning process are at high criteria.

The increase in student activity occurs because the material is perceived as more difficult so that students want to ask questions and try to solve problems that occur in Student Worksheets that have been shared.

3.3 Learning Outcomes Test

Learning outcomes tests are conducted at the 3rd meeting by giving 5 essay questions. Learning outcomes test results on Opportunity material are presented in the following table:

Table 2. Learning Outcomes Test

The highest score	100
Lowes value	50
Class average	80
Number of students completing	30
Number of students not completed	6
Completion percentage	83.33%

Based on learning outcomes test results, the percentage of completeness exceeds 75%, which is 83.33%. Thus the learning outcomes of Class 1 mathematics and science students using learning tools through Lesson Study based Learning Community bridge games have met classical completeness criteria. For 6 students who have not fulfilled the full criteria given questions and remedial training. The questions contained in the Learning Outcomes Test are high-level thinking questions. Based on the test results that show the achievement of classical completeness or in other words the criteria are good, then a hypothesis can be drawn that is the learning device used influences the higher order thinking of students. This hypothesis will be tested at the deployment stage with quantitative methods using quasi-experiments.

3.4 Student Response Questionnaire

Student responses are measured using a questionnaire consisting of 8 questions. The question contains student responses to learning with LSLC-based bridge games and student responses to the student worksheet used. The "yes" answer shows a positive response and vice versa the "no" answer shows a negative response. The results of the student response questionnaire are presented in the following table:

Table 3. The Results Of The Student Response Questionnaire

Question Number	Percentage Of Student Answers	
	Yes	No
1	94.40%	5.40%
2	83.33%	16.70%
3	100.00%	0.00%
4	91.70%	8.30%
5	94.40%	5.60%
6	91.70%	8.30%
7	100.00%	0.00%

Based on the table above, students responses to the questions given give the results of a positive "yes" answer of more than 80% for all questions asked. Thus, it can be concluded that students respond positively to learning and worksheets with bridge games based LSLC.

3.5 Description of Experimental Research Data

Data obtained from the results of experimental studies conducted in the experimental class and the control class were the results of a high-level thinking ability test based on the pre-test and post-test. The test results are described as follows.

3.6 Pre-Test Results

Table 4. Pre Test Result

Class	The Number Of Students	The Highest Score	Lowest Value	Average	Standard Deviation
Control	36	13	7	10.05	1.33
Experimental	36	13	8	9.67	1.39

The number of students with high-level thinking skills in the low, medium and high categories in the experimental class and the control class was the same. The number of students in the low category is 35 students, the moderate category is 1 student, and there are no students who have high thinking ability.

3.7 Post-Test Results

At the last meeting a post-test was conducted to determine the students' high-level thinking skills after following the learning process. Data from the post-test results in the experimental class and control class are presented in the following table:

Table 5. Post Test Result

Class	The Number Of Students	The Highest Score	Lowest Value	Average	Standard Deviation
Control	36	17	9	12.61	1.78
Experimental	36	17	8	14.25	2.35

From the data it can be obtained that the difference in average is quite far with a range of 1.64 and also the difference in the standard deviation of 0.54.

3.8 Experiments on the influence of learning devices using LSLC-based bridge games on Higher Order Thinking Skills

The first step is done before the hypothesis test which includes the normality test and homogeneity test. The normality test uses the Kolmogorov-Smirnov statistic summarized in the table below:

Table 6. Normality Test

	Class	Kolmogorov-Smirnov		
		Statistic	Df.	Sig.
Pre-Test	Control	.175	36	.007
Post-Test	Experimental	.150	36	.039
Pre-Test	Control	.212	36	.000
Post-Test	Experimental	.163	36	.016

Data comes from populations that are normally distributed if the probability value (p-value) is greater than the significance value of 0.05. From table 6 shows that the data on the significance value of high-level pre-test

thinking ability in both classes is sig = 0,000 while the post-test significance value in the experimental class is sig = 0.016 and the sig = 0,000 control class. Therefore it can be concluded that the pre-test and post-test data in both classes are not normally distributed.

Table 7. Homogeneity Test Results

	Levene Statistic	Df1	Df2	Sig.
Pre Test	0.182	1	70	0.671
Post Test	0.221	1	70	0.450

The homogeneity test of Levene's test shows the results of the sig value. for HOTS is 0.671 in the pre test and 0.450 in the post test so it can be concluded that the assumption of homogeneity of variance is fulfilled. Because the significance value obtained is more than 0.05, the data on high-level thinking ability (pre-test and post-test) in both classes have the same or homogeneous variance. Thus it can be assumed that the differences that occur in this study are really caused by the treatment given, namely the implementation of learning devices through LSLC-based bridge games. Based on the prerequisite test, the pre-test and post-test data obtained are not normally distributed but have the same or homogeneous variance. Therefore the data analysis uses the non-parametric test, the Mann-Whitney test. The results of data analysis are shown in the following table.

Table 8. The Results of The Mann-Whitney Analysis

Increased Thinking Ability in High Levels	
Mann-Whitney U.	389.500
Wicoxon W	1055.500
X	-2.953
Asymp. Sig. (2-tailed)	0.003

From the results of the test of differences in the increase in high-level thinking skills in the two classes using the Mann Whitney Test showed the sig value. 0,003 p <0,05) so it was concluded that there were differences in the increase in high-level thinking skills between control classes that used conventional learning (Direct Instruction) and experimental classes that used learning through bridge games based LSLC. The average increase in each aspect of high-level thinking skills in the experimental class and control class is presented in the following figure.

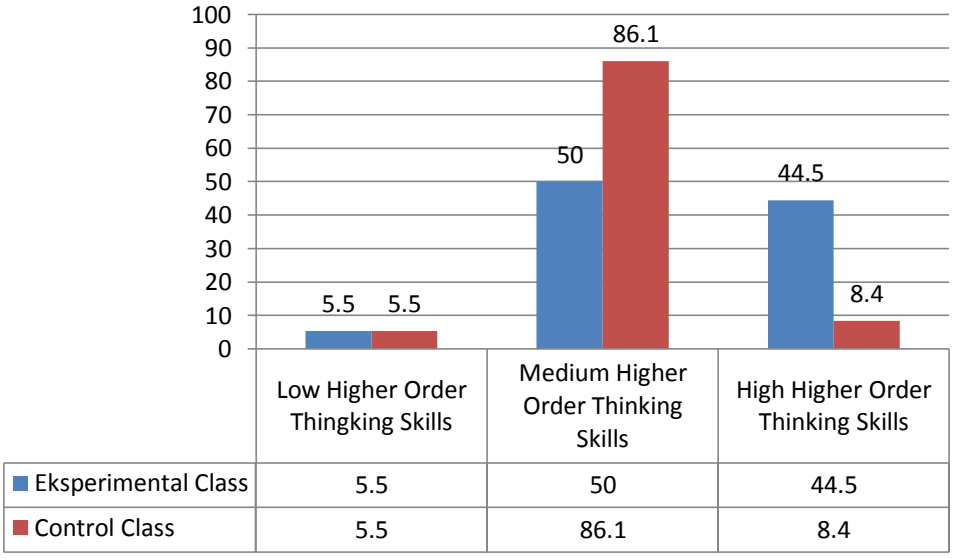


Figure 6. Average Aspect Increase

4. Discussion

This research was conducted to analyze the effect of bridge games based Lesson Study for Learning Community based on their higher order thinking skills. The findings of this study indicated that the implementation of bridge games based LSLC had a significant effect on the students higher order thinking skills in the experimental class.

The students in the experimental class showed that their higher order thingking skills were higher compared to the control class. The results showed that the improvement on the learning outcomes and students higher order thingking skills were seen in the post-test. Experimental class scores were significantly better as bridge games based LSLC was implemented in the experimental class to improve higher order thinking skills. The students in the experimental class were taught by using bridge games based LSLC, in which they had an understanding of the concept to help each other, therefore, bridge games based LSLC was great in improving the students higher order thinking skills.

The results of this study, that Learning Implementation Plan developed has components and principles in accordance with [11]. Students Worksheet made has met the indicators in the Students Worksheet validation process stated by [7], and Students Worksheet developed has met didactic requirements, construction requirements, and technical requirements [4]. Likewise the Learning Outcomes Test has fulfilled material aspects and construction (content), as well as language and writing [7]

The results of the observation on the implementation of the study also showed that the learning tools were well implemented according to the bridge games based on LSLC. Teachers who see learning are inspired to apply the same learning model to field of study being taught. This is in libe with Kitada's opinion in [16] which states that through LSLC the teacher can improve their understanding of how students learn through collaboration so as to foster inspiration and new insight for teachers regarding the learning process.

Based on the value of the average student activity, the percentage of completeness of students, and the positive response of students, it can be concluded that the learning device used has met the effective criteria. These results are in line with the results of the development of learning tools carried out by [12] who developed learning devices for the Problem Based Learning model to improve high-level thinking skills. Bridge games based Lesson Study for Learning Community must be applied in many class to expand the researches in all institutions, and to apply the researches in education, the relationship between the research and teaching.

5. Conclusion

Based on the research that was conducted, it shows that the application of bridge games based Lesson Study for Learning Community had a significat effect on the students higher order thinking skills in the experimental class. The students higher order thinking skills in the experimental class were compared to the control class. The results showed that the improvement on the learning outcomes and students higher order thinking skilss were seen from the post-test. The experimental class cores were better since it is supported by bridge games based Lesson Study for Learning Community in improving higher order thinking skills. Hence, bridge games based Lesson Study for Learning Community was great to improve the students higher order thinking skills.

Learning tools developed can be used even though the teacher does not understand bridge games because they are made with simple language according to the results of device validation.It is better to do further research on games related to mathematics, to make students happy and love to learn mathematics, not just textbooks.

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References

[1] Andini S. A. 2017. *Students Activity in Problem-Based Learning (PBL) Math Classroom Be Oriented Lesson Study for Learning Community (LSLC)*. International Journal Of Advanced Research **5** 9 pp 1395-1400

[2] Alessi M. S. and Trollip S. R. 2001. *Multimedia for learning: Methods and development (3rd ed.)* Boston : Allyn and Bacon

[3] Arifani N. H. et all. 2015. *Level of Mathematical Creative Thinking Ability of Grade VIII Middle School Students in Jember 6 Public Middle School Al Furqon 1 Middle School Rambipuji 1 Junior High School and 1 PGRI Middle School Rambipuji*. Kadigma **6** pp 159-172

[4] Darmojo, H. and Kaligis, J. R. E. 1992. *Science Education II*. Jakarta : Depdikbud

[5] Fitriyah H. and Hariani S. 2015. *Effect of Creative Problem Solving Learning Model with Mind Mapping on Ability of Creative Thinking and Science Biology Learning Achievement) (Grade VII students of 11 Jember Junior High School in the Even Semester Academic Year 2014/2015*. Student Scientific Articles, II (**1**) pp 1-8

[6] Gee J. P. 2003. *What video games have to teach us about learning and literacy*. New York : Palgrave MacMillan
[7] Hobri. 2009a. *Development Research Methodology*. Jember : Center for Society Studies
[8] Hobri, et all. 2010. *High-order thinking skills in contextual teaching and learning of mathematics based on lesson study for learning community*.International Journal of Engineering & Technology (IJET). **7** (3) 1576-1580.
[9] Kanauan W. and Narumol Inprasitha. 2014. *Collaboration between Inservice Teachers and Student Intern in Thai Lesson Study*. Procedia-Social and Behavioral Science**116** (2) pp 28-32
[10] Keihaniyan M. 2013. *Collaborative Learning and Motivation.* International Journal of Advanced Research (IJAR). **1** 10 pp 613-621
[11] Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia nomor 22 Tahun 2016. *Standard Process of Primary and Secondary Education*. June 28, 2016. Berita Negara Republik Indonesia Tahun 2016 nomor 955. Jakarta
[12] Qohar, M.A. 2017. *Development of Learning Tools for Problem Based Learning Models to Improve Hogh-Level Thinking Skills*. Thesis. Jember : Faculty of Theacher Training and Education Jember University
[13] Rieber L. P. et all. 1998. *The value of serious play*. Educational Technology**38** (6) pp 29–37
[14] Santoso F. G. I. 2012. *Mathematical Creative Thinking Skills in Problem Based Learning (PBM) in Middle School Students*. Proceedings of the Mathematics National Seminar pp 453-459
[15] Sato M. 2012. *Reform Learning with Learning Community and School Development Creation Model 21st Century*. Jakarta : International Lesson Study Conference
[16] Saito, E. and Atencio M. 2014. *Lesson Satudy for Learning Community (LSLC) : conceptualising teachers practise within a social justice perspprestive.* Discourse : Studies in The Cultural Politics of Education, DOI : 10.1080/01596306.2014.968095
[17] Seifert K. 1983. *Learning Guidelines and Educational Instruction*. Jogjakarta: PT IRCISoD
[18] Siregar R. 1992. *Let's Play the Basic Bridge Theory Becomes a Declaration*. Jakarta: PT Pustakakarya Grafikatama
[19] Sugiyono. 2017. *Combination Research Method(Mixed Methods)*. Bandung: Alfabeta
[20] Van Eck R. 2006. *Building intelligent learning games. In D. Gibson, C. Aldrich, & M. Prensky (Eds.) Games and simulations in online learning research & development frameworks*. Hershey PA: Idea Group