

LEARNING PROSESS OF POLYHEDRON USING COLLABORATIVE LEARNING THROUGH LSLC

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Abstract

The difficulty of learning to build polyhedron for middle students makes experts lecturers collaboratively create learning trajectories through the Lesson Study for Learning Community (LSLC). This study aims to produce a learning trajectory that can assist students in learning polyhedron using collaborative learning through LSLC. The research method used was design research with the first stage, preparing for experiment, experimental design, and retrospective analysis. This learning approach uses collaborative LSLC is used in the process of making teaching materials and along with research methods. This study involved 47 lecturers and 24 mathematics education students. Data collection was carried out through observing student activities, recording video events in class, collecting student work results, and student test results. The collected data were then analyzed retrospectively with the results showing that collaborative and LSLC used in the acquired learning paths can help students in learning flat-sided shapes. The learning trajectory includes (1) students can collaboratively understand the surface area of the cube (2) collaboratively, students can understand the space diagonal of a block. With the existence of LSLC, researchers can form learning communities with research subjects, collaborate in making learning designs and teaching materials, and produce multilevel effective learning through sharing tasks and jumping tasks

Keywords: Collaborative learning; Learning trajectory; LSLC; polyhedron; Learning process

Abstrak

Sulitnya pembelajaran bangun polihedron bagi mahasiswa menengah membuat dosen ahli secara berkolaborasi membuat lintasan pembelajaran melalui Lesson Study for Learning Community (LSLC). Penelitian ini bertujuan untuk menghasilkan learning trajectory yang dapat membantu siswa dalam belajar polihedron dengan menggunakan pembelajaran kolaboratif melalui LSLC. Metode penelitian yang digunakan adalah design research dengan tahap pertama, yaitu preparing for experiment, design experiment, dan retrospective analysis. Pendekatan pembelajaran ini menggunakan pembelajaran kolaboratif. LSLC digunakan dalam proses pembuatan bahan ajar beserta metode penelitian. Penelitian ini melibatkan 47 dosen dan 24 mahasiswa pendidikan matematika. Pengumpulan data dilakukan melalui observasi aktivitas siswa, perekaman video kejadian di kelas, mengumpulkan hasil kerja siswa, dan hasil tes siswa. Data yang terkumpul kemudian dianalisis secara retrospektif dengan hasil menunjukkan bahwa collaborative dan LSLC yang digunakan pada jalur pembelajaran yang diperoleh dapat membantu siswa dalam mempelajari bangun polihedron. Lintasan belajar meliputi (1) mahasiswa secara berkolaborasi dapat memahami luas permukaan kubus (2) secara berkolaborasi mahasiswa dapat memahami diagonal ruang dari suatu balok. penggunaan LSLC dan kolaboratif dalam jalur pembelajaran yang diperoleh dapat membantu siswa dalam mempelajari bangun datar. Lintasan pembelajaran meliputi (1) siswa dapat secara kolaboratif memahami luas permukaan kubus (2) secara kolaboratif, siswa dapat

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memahami diagonal ruang suatu balok. Dengan adanya LSLC, peneliti dapat membentuk komunitas belajar bersama subjek penelitian, berkolaborasi dalam pembuatan desain pembelajaran dan bahan ajar, serta menghasilkan pembelajaran efektif berjenjang melalui sharing task dan jumping task

Kata kunci: Collaborative learning; lintasan belajar; LSLC ; polihedron; proses pembelajaran



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INTRODUCTION

Polyhedron is a very important material in learning mathematics. Polyhedron is included in important geometry material that can help students understand to understanding and reasoning (Cao, 2018). Polyhedron is one of the important materials in the Indonesian curriculum and teach students from elementary school to university level (Jelatu et al., 2018). Polyhedron is one of the many concepts in geometry taught in junior high schools in Indonesia. Studying polyhedron are attractive to the visual, intuitive, and ice senses, which are closely related to the development of mathematics so that they are suitable for improving one's mathematical abilities (Rodr & Romero, 2021)..

However, learning polyhedron are still difficult for students. Students have difficulty imagining objects and construction prior knowledge so that the polyhedron has high difficulties and abstractness, especially to find the surface area cubes and cuboids (Charitas & Prahmana, 2020). Lesson Study is a learning approach that involves students actively discussing, because in the learning process the teacher exchanges ideas and collaborates with students (Mewald & Mürwald, 2019). Stated that conducting Lesson Study activities during learning can make teachers collaborate in solving problems, besides that it makes students more active in solving shared problems (Sutopo et al., 2020). Paying

attention to this, the Lesson Study approach can overcome the problems of students who find it difficult to understand polyhedron material because it is material with a high level of difficulty, so collaboration is needed in understanding the material (Zhang et al., 2019). As expressed by (Lewis & Perry, 2014; Putri & Zulkardi, 2019). Students can work on questions that have a high level of difficulty using a collaborative approach. In line with this, the research results of (Rahmi et al., 2020).

Currently, the 2013 revised curriculum in Indonesia applies 21st century learning skills known as 4C (Communication, Collaboration, Critical Thinking, and Creativity) (Putri, 2018). Education in the 21st century has logical consequences for the professional development of educators to develop skills. Professional educators must have four key skills, which are: 1) pedagogical capacity; 2) professional competence; 3) personality competence and 4) social competence (Icela & Ramírez-Montoya, 2022). One of the problems is about how to improve the teacher's ability to teach, which is inseparable from the problem of practical learning activities (Putri & Zulkardi, 2019).

Lesson study is educational model that develops careers through collaborative and sustainable learning studies based on the principle of collective and mutual learning to build a learning community (Rusiyanti et al., 2022; Hidajat et al., 2018; Zhang et al., 2019).

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The lesson study excellence according to Hidajat et al. (2018), the use of lesson study creates inquiry more collaboratively between prospective teachers and provides information based on experience on how to create learning enhancements for the student. Consequently, students are not motivated to provide maximum performance in learning (Octriana et al., 2019).

Other efforts are made by using a lesson study where it is an effort to improve the quality of collaborative and continuous learning by a group of teachers based on the principles of collegiality, mutual learning, and building learning communities (Zulkardi et al., 2020); (Putri & Zulkardi, 2019). In the LSLC, the teacher focused on discussions on planning, observations in implementation activities, and reflections on learning practices (Saskiyah & Putri, 2019); (Agus et al., 2021).

However, the current practice of lesson study continues to be developed, which is not only limited to basic education, even, there is also a tendency to apply to secondary education and higher education. This research is to produce a learning trajectory that can help students learn polyhedrons by using collaborative learning through LSLC so as to help teachers design meaningful learning for students. With the existence of LSLC, researchers can form learning communities with research subjects, collaborate in making learning designs and teaching materials, and produce multilevel effective learning through sharing tasks and jumping tasks.

RESEARCH METHODS

Subject of the Research

This research involved 47 lecturers and 24 students from STKIP PGRI, West Sumatra, Indonesia. 10 out

47 lecturers collaborated to make teaching instruments and materials, one of the lecturers became a model teacher, and 46 lecturers during the teaching experiment became observers. Design research used as a theory of this research method with the aim of proving the learning and development of Local Instructional Theory (LIT) and to see the development of the quality of learning according to Gravemejer & Cob, (2006) in (Utari et al., 2015) describe three stages in the research design, including (1) experimental preparation, (2) experimental design, and (3) retrospective analysis.

In the first stage, namely preparing the experiment, the researcher prepares lecturers and students that will be the subject of the research, prepares study literature such as the national curriculum, instrument of learning, and deepens the material of polyhedron. After that, several lecturers collaborated to make learning instruments and questions that would be tested on the students through a focus group discussion (FGD). Together with lecturers, the researchers discussed who would be the model teacher during class activities, and make a learning planned who would be the observer and adjust the schedule. The result of the research were used by researchers as materials in designing student activities which were translated into hypothetical learning trajectory (HLT).

In the third stage, namely retrospective analysis. The data obtained from the teaching experiment were analyzed to compile designs for further learning. HLT will be compared with actual learning activities or learning trajectory to answer the formulation of research problems. The purpose of retrospective analysis is to develop local instructional theory (LIT).

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Relation Between Design Research and Lesson Study

In lesson studies, teachers collaboratively design lessons that they test in their classrooms. In many cases, researchers are involved to guide this process or help in the plan step. While one teacher conducts the lesson, the other teachers observe. When the

teachers are satisfied, the lessons can be taught by other teachers too. In this way, schools can improve their education step by step and contribute to the professional development of their teachers. Characteristics of lesson study and design research can be seen in Table 1.

Table 1. The characteristic of lesson study and design research

Numb	Feature	Lesson study	Design research
	Main aim	Professional development of teachers and teams	Design and research
	Drive	Education driven	Research driven
	Unit	One lesson	Can be series of lessons, course, tool, environment.
	Role of theory	Only input	Input and output
	Iterative	Yes	Yes, though not always
	Concern	Optimization	Innovation
	Sharing	Lesson, local	Publications, design
	Prior predictions/ plans	Anticipations	Hypothetical learning trajectories, scenarios, conjecture maps, design principles

Technique of Collecting the Data

Data collection was carried out through observation by recording learning in the class and the results of student group work as evidenced by video recorder by the observer. The final results of the HLT design will be compared with the actual learning trajectory in the teaching experiment for retrospective analysis.

Technique of Analysis the Data

Data analysis was carried out jointly by researchers and lecturers to increase validity and reliability. Validity is useful for seeing the quality of the research which will affect the conclusion. Reliability is described with a clear description of the data taken so that conclusions can be drawn.

RESULT AND DISCUSSION

Plan

In the plan stage, the researchers carried out the experimental preparation and pilot experiment stage. Experimental preparation was carried out on 26th-27th April 2019 and attended by 10 lecturers of STKIP PGRI West Sumatra. Initially, lecturers were conditioned to form the letter of U as well as learning in LSLC, then it discusses some important points among them: LSLC, learning communities, collaborative learning in learning activities, observing class and then analyzing it which can be seen in figure 1.

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Figure 1. LSLC Workshop Atmosphere

In the experimental preparation stage at Figure 1, the researchers with 10 lecturers plan to design learning tools matched to RPS and SAP, design learning activities in the form of sharing assignments and jumping tasks that enable students to actively participate in

the learning process. At this stage, all lecturers formulated the learning problem, compiled the goals and targets of the learning outcomes, made guesses about the answers to the problems given together and agreed on the lecturers who becomes a model during the open class. Based on the collaboration results of 10 lecturers, there are two planned activities: (1) students can collaboratively understand the surface area of the cube, (2) collaboratively, students can understand the space diagonal of a cuboids. Result of Plan Phase from Lecturer Team can be seen in Table 2.

Table 2: Result of plan phase from lecturer team

Numb	Stages															
1	<p>Plan</p> <ol style="list-style-type: none"> a. Students are told to sit in the letter U shape b. The teacher conveys the learning objectives c. The teacher devides students into sitting groups consisting of 4 students with heterogeneous abilities (medium and medium high abilities) d. The teacher distributes discussion sheet to students <p>Examples of LKPD that will be given to students: LKPD on the material for the description test and development of the description test. Learning indicators: Students are able to analyze essay tests, create assessment scores to questions that have been developed</p> <p>Instructions for using LKPD:</p> <ol style="list-style-type: none"> 1. Analyze the questions below by determining the cognitive aspects contained in these questions and the reasons 2. Make a completion an assessment rubric for each of these queations and reasons 3. Determine the score of each question and the reason 															
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">No</th> <th style="text-align: left;">Question</th> <th style="text-align: left;">Cognitif aspect</th> <th style="text-align: left;">Completion and assessment rubric</th> <th style="text-align: left;">score</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>A cube has a volume 343 cm^3. Determine the surface area</td> <td></td> <td></td> <td></td> </tr> <tr> <td>2</td> <td>A block ABCD.EFGH has a total of 36 cm. if the surface area of the block is 32 cm^2. Determine the length of the space diagonal HB</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	No	Question	Cognitif aspect	Completion and assessment rubric	score	1	A cube has a volume 343 cm^3 . Determine the surface area				2	A block ABCD.EFGH has a total of 36 cm. if the surface area of the block is 32 cm^2 . Determine the length of the space diagonal HB			
No	Question	Cognitif aspect	Completion and assessment rubric	score												
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2	A block ABCD.EFGH has a total of 36 cm. if the surface area of the block is 32 cm^2 . Determine the length of the space diagonal HB															
	<ol style="list-style-type: none"> e. Students discuss LKPD and the teacher guides who experience difficulties f. Evaluation stage: the teacher aska students to present the result of grup work and other students and the teacher listen and respond to the result of the group's work. 															

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At table 2, After preparing the experiment and got the first HLT, the researchers and the lecturers conducted a pilot experiment to testing the questions that had been made on 6 students, consisting of 2 high ability students, 2 medium ability students, and 2 students that have a low ability. From the results of the pilot experiment, it was found that students understood better because of collaborative activities with their peers so that in the learning process, students felt helped by the collaborative learning (Putri & Zulkardi, 2019). However, there is an improvement in the sentence in the second question, the word “ruas” becomes “luas”. So, the HLT in the pilot experiment is: (1) students can collaboratively understand the surface area of the cube, (2) collaboratively, students can understand the space diagonal of a cuboids.

Do

In the do stage, the the researchers carried out the teaching experiment in method. Theres 24 Students from STKIP PGRI West Sumatra, 1 lecturers as teacher model, and 46 lecturers as observer. The existence of observers in the classroom was not only to gather information but it was also intended to learn from ongoing learning, but it was definitely not to evaluate the teachers. Therefore, there were several things that observers needed to pay attention for example: did not interfere with the activities of the teacher and students during the implementation of the open class; focused of observation was the students and it was not the model teacher implementing the open class; the observer must stand in a position where he/she could see the faces and expressions of the students because LSLC was learning from the reality of student learning this can be seen in the Figure 2.



Figure 2. Student seat position on the class

At figure 2, The student's sitting position began with forming U letter or horseshoe in the preliminary activity. It was to make it easier for the observers to determine the focus of students observed. During the main activity, students were asked to form groups of 4

students (2 men and 2 women) by cross-sitting. This cross-sitting system was implemented to anticipate excessive communication that was not related to learning this can be seen in the Figure 3.



Figure 3. Student asked favor from his / her group

At Figure 3, When working on activities, the teacher always reminded the students who did not understand to ask "please teach me" and directs them to ask a group of friends who had already understood (Putri & Zulkardi, 2019). However, if none of the students understood in the group, the teacher-

directed students to ask other groups who understood the problem(Charitas & Prahmana, 2020). It is seen in the figure 4 where male and female students asking for a from a group of friends to solve the problems given this can be seen in the Figure 4.



Figure 4. Change of student face expression

Based on the Figure 4 picture above, it is shown that a student is asking for a favor from students who have already understood and solved the problems by

themselves. At that situation, they tried hard solved the problem until they are find one problem and then asking he/her friend this can be seen in Figure 5 .



Figure 5. Presentation of student work result

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At Figure 5, The teacher appointed students who asked for help to present the results that they got in front of the class. The student that in call was understood by the problem had solve in the group and also explain to the other group. At the end of the lesson, the model teacher and the students reflected and concluded the learning material about the material learned.

See and Re- Design

The researchers carried out the retrospective analysis in the stage. In reflection stage with observer and model teacher, the teacher and the observer must immediately implement it after the learning process is complete. It was to maintain accuracy in every event observed during the learning process. The model teacher began by conveying impressions in carrying out learning. Furthermore, the observer was asked to provide comments and what is learned from the learning, which was mainly related to student activities. During the reflection, the observer must avoid criticism and intervention on the model teacher. The results of the reflection show that the model teacher is not advised to give instructions directly to students who are experiencing difficulties. However, the model teacher must encourage and direct students who

have difficulty asking for a favor from their peers in the group. Conversely, if none of them can solve the problem, the teacher guides the student to ask for a favor from other groups this can be seen in the Figure 6.



Figure 6. Learning reflection by observer

Based on Figure 6, In retrospective analysis, the researchers correction the answer of students . The correct and incorrect table students can be seen in Table 3.

Table 3. Analysis of student answer

No	Correct Answer Students	Incorrect Answer Students
1	24	0
2	5	19

The description of students in solving the first math problem can be seen in the Figure 7 and Figure 8.

1. A cube has a volume of 343 cm^3 . Find the surface area of the cube.

$$\begin{aligned}
 &\text{Volume} = 343 \text{ cm}^3 \\
 &\text{LP (surface area)} \dots ? \\
 &\text{Answer:} \\
 &\cdot) \text{Volume} = a \times a \times a \\
 &\quad a^3 = 343 \text{ cm}^3 \\
 &\quad a = \sqrt[3]{343 \text{ cm}^3} \\
 &\quad a = 7 \\
 &\text{LP} = 6a^2 \\
 &\quad = 6(7)^2 \\
 &\quad = 6 \cdot 49 \\
 &\quad = \underline{\underline{294 \text{ cm}^2}}
 \end{aligned}$$

Figure 7. An answer from the high ability student of question number 1

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1. A cube has a volume of 343 cm^3 . Find the surface area of the cube.

$$\begin{aligned}
 V &= 343 \text{ cm}^3 \\
 V &= a^3 \\
 343 &= a^3 \\
 a &= \sqrt[3]{343} \\
 &= 7 \\
 LP &= 6 \times a^2 \\
 &= 6 \times 7^2 \\
 &= 6 \times 49 \\
 &= 294 \text{ cm}^2
 \end{aligned}$$

Figure 8. An answer from low ability student of question number 1

Based on the Figure 7 and 8, it is shown that students with high ability and low ability can identify problems well and solve problems correctly. The student observes the side of the cube through the given volume of the cube,

then substitutes the value of the side into the cube's surface area. From the 24 students, all of them answer correctly for question number 1. For the next, Student answers to problem number 2 can be seen in Figures 9 and 10

2. A cuboid of ABCD.EFGH has a total of edges 36 cm . If the area of surface of the cuboid is 32 cm^2 . Find the length of diagonal of HB space.

$$\begin{aligned}
 4l + 4w + 4h &= 36 \text{ cm} \\
 l + w + h &= 9 \text{ cm} \\
 lw + wh &= 32 \text{ cm}^2 \\
 wh &= 2lw + 2lh + 2wh \\
 32 \text{ cm}^2 &= 2lw + 2lh + 2wh \\
 16 \text{ cm}^2 &= lw + lh + wh
 \end{aligned}$$

Figure 9. An answer from high ability student of question number 2

2. A cuboid of ABCD.EFGH has a total of edges 36 cm . If the area of surface of the cuboid is 32 cm^2 . Find the length of diagonal of HB space.

$$\begin{aligned}
 \text{Total of edges} &= 36 \text{ cm} \\
 \text{area surface} &= 32 \text{ cm}^2 \\
 \text{HB} &= \dots ? \\
 \text{Answer :} \\
 \text{Total of edges} &= 4(l+w+h) = 36 \\
 l+w+h &= \frac{36}{4} = 9 \\
 \text{Surface area} &= 2(lw+wh+lh) = 32 \\
 lw+wh+lh &= \frac{32}{2} = 16 \\
 \text{length of diagonal HB} &= l^2 + w^2 + h^2 = (l+w+h)^2 - 2(lw+wh+lh) \\
 &= 9^2 - 2(16) \\
 &= 81 - 32 \\
 &= 49 //
 \end{aligned}$$

Figure 10. An answer from low ability student of question number 2

Based on the Figure 9 and 10, it is shown that students with high ability can identify problems well and solve problems correctly. Students can

understand the concept of algebraic multiplication operations associated with the Pythagorean theorem, so that they can find the space diagonal of the

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block. Meanwhile, students, who are low of ability, get errors when calculating the diagonal of space because they have not been able to link the concept of algebraic multiplication operations with the theoretic Pythagoras. This is because student with low abilities do not want to ask for help from friends who are able to solve these problems. In the implementation of LSLC the impact of cooperation, collegiality and communication between students and lectured is formed

CONCLUSION AND SUGGESTION

Conclusion

Based on the result of research and discussion, it can be concluded that the learning trajectory obtained that consisted of two activities as follow. First, students can collaboratively understand the surface area of the cube. Second, collaboratively, students can understand the space diagonal of a cuboids. Learning using a collaborative approach makes students understand in doing questions. With the existence of LSLC, researchers can form learning communities with research subjects, collaborate in making learning designs and teaching materials, and produce multilevel effective learning through sharing tasks and jumping tasks. it is recommended for educators to use lesson study in learning so that learning is more meaningful

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