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Analysis of Students' Mathematical Reasoning Ability in the Context of Globalization and Sustainability Using the Project Based Learning Model

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Abstract: The purpose of this study is to describe the steps for planning a project-based learning (PjBL) model in teaching Mathematics in grade X in the global context of Globalization and Sustainability and describe how students' mathematical reasoning abilities are after experiencing learning using the PjBL model. The type of research used in this research is design research. In this study, researchers designed a hypothetical learning trajectory (HLT) to teach Mathematics using the PjBL model in the context of planning to build a house. The stages of the research carried out were making the initial design, conducting design trials, and conducting retrospective analysis. The research subjects were six grade X students of private high schools in Yogyakarta who used the IB (International Baccalaureate) curriculum. The data collection instruments used by the researcher were field note sheets, written test sheets in the form of worksheets containing project questions, and structured interview sheets. From this study, the results obtained were that five students were able to use mathematical reasoning to complete the construction planning project of a house. Four students have been able to check the correctness of the solution and make conclusions.

Keywords: globalization and sustainability, project-based learning, mathematical reasoning, project-based learning, house building projects.

Abstrak: *Tujuan dari penelitian ini adalah untuk mendeskripsikan langkah-langkah merencanakan model pembelajaran berbasis proyek dalam pembelajaran Matematika di kelas X pada konteks global Globalization and Sustainability dan mendeskripsikan bagaimana kemampuan penalaran matematis siswa setelah mengalami pembelajaran dengan menggunakan model PjBL. Jenis penelitian yang digunakan dalam penelitian ini adalah penelitian desain (design research). Dalam penelitian ini, peneliti mendesain hypothetical learning trajectory (HLT) untuk membelajarkan Matematika menggunakan model PjBL dengan konteks merencanakan pembangunan sebuah rumah. Tahap-tahap penelitian yang dilakukan adalah membuat desain awal, melakukan uji coba desain serta melakukan analisis retrospektif. Subjek penelitian adalah enam siswa kelas X SMA swasta di Yogyakarta yang menggunakan kurikulum IB (International Baccalaureate). Instrumen pengumpulan data yang digunakan peneliti adalah lembar catatan lapangan, lembar tes tertulis yang berupa lembar kerja yang berisi pertanyaan proyek, dan lembar wawancara terstruktur. Dari penelitian ini, diperoleh hasil bahwa lima siswa sudah mampu menggunakan penalaran matematis untuk menyelesaikan pembuatan proyek perencanaan pembangunan sebuah rumah. Empat siswa sudah mampu untuk memeriksa kebenaran solusi dan membuat kesimpulan.*

Kata kunci: *globalization and sustainability, pembelajaran berbasis proyek, penalaran matematis, projet-based learning, proyek pembangunan rumah.*

▪ INTRODUCTION

Mathematics is useful to help humans solve many problems in everyday life. Mathematics is a universal knowledge that underlies the development of modern technology, has an important role in various disciplines and advances human thinking.

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Mathematics is a living subject that seeks to understand the patterns that permeate both the world around us and the thoughts within us (Schoenfeld, 2016). Mathematics is related to concepts and the way a person thinks critically and communicates them to solve problems.

Mathematics learning is the process of providing learning experiences to students through a series of planned activities so that students gain competence regarding the mathematical material being studied. Mathematics learning includes five basic mathematical abilities which are five process standards according to NCTM (2000) in (Putri, et al., 2019), namely problem-solving, reasoning, communication, connection. and representation. One of the goals of learning Mathematics is have the ability to use reasoning on patterns and properties, carry out mathematical manipulations in making generalizations, compiling evidence or explaining mathematical ideas and statements.

One aspect that is very important to develop in students in mathematics education is mathematical reasoning abilities (Aprisal & Abadi, 2018). Mathematical reasoning skills are important to build in mathematics learning to help students solve mathematical problems. Apart from that, good reasoning skills can help them make clear decisions, think systematically and logically in responding to things in their lives. Therefore, students need to have structured mathematical reasoning abilities when solving a mathematics problem. This also needs to be done by researchers because the curriculum in force at IB (International Baccalaureate) schools requires students to have experience in solving problems by reasoning and providing logical reasons complete with justification and communicating them into clear and structured arguments.

Constructivism experts hold that meaningful learning is learning that can make students find their own concepts, this is in accordance with the opinions of Glaserfeld and Matthews (Abidin, et al., 2020). In current Mathematics learning, there are still many students who find Mathematics less interesting, difficult and boring. This happens due to many factors, such as: less interesting learning, monotonous learning methods, or other factors. As a result, students are less interested in studying Mathematics so that the abilities they should have in Mathematics are less developed. In solving mathematical problems, students still tend to have difficulty conveying logical reasons for thinking and communicating them using mathematical evidence.

Based on the condition in school from interview, it was found that students still need to improve their mathematical reasoning to solve math problems carrying out mathematical manipulations in making generalizations, compiling evidence or explaining mathematical ideas and statements, especially in the context of everyday life problems, for example when solving problems about surface area of composite shape like a mask. Therefore, to train and improve mathematical reasoning abilities, a method or step is needed that can be carried out systematically as an effort to help students achieve their mathematical reasoning abilities.

Considering the importance of mathematical reasoning ability in learning mathematics, the teacher has to develop innovation in teaching (Aprisal and Abadi, 2018). Researchers see that the learning approach with Project-Based Learning (PjBL) is one of the right ways to achieve this goal. The connected Mathematics Project is designed to investigate important mathematical ideas in developing students' understanding and reasoning (Wafirah & Asih, 2019). This is supported by the results of research conducted by Endriana et al. (2020), which aims to develop a Project Based Learning model to

improve students' mathematical reasoning and motivation by meeting valid, practical and effective criteria. The development model in this research uses ADDIE which consists of 5 stages, namely Analysis, Design, Development, Implementation and Evaluation. The research results from the pretest data showed that students' mathematical reasoning increased from a score percentage of 38.96% to 77.12% using the posttest average. Utami's research (2018), which examined improving the mathematical reasoning abilities and independence of junior high school students through the Project Based Learning model. The research results show that there is an increase in the mathematical reasoning abilities of students who use the Project Based Learning model and the improvement is better than students who use conventional learning models.

According to the Ministry of Education and Culture (2014:45), the Project Based Learning model is a learning model that uses problems as the first step in collecting and integrating new knowledge based on experience in real activities. According to Babtist et al. (2020), the Project Based Learning model is a learning model where students must build their own content knowledge, and demonstrate new understanding through various forms of representation. In contrast to conventional learning models, project based learning emphasizes mathematics application into interdisciplinary, holistic, student-centred, and integrated with practice and real-world issues by giving complex problems in which students must be able to conduct an investigation to understand and oriented to the product that made by students (Widakdo, 2017). Students' thinking patterns have been trained from the beginning to the end of the lesson. The PjBL learning provides various options in the problem-solving process and can drive students' challenge (Yunita, et al., 2021). Project-based learning is an active student-centred form of instruction which is characterised by students' autonomy, constructive investigations, goal-setting, collaboration, communication and reflection within real-world practices. It has been explored in various contexts and in different phases of schooling, from primary to higher education (Kokotsaki, et al., 2016). Mathematical projects also give students the opportunity to collaborate, where one person is in charge. In project-based learning activities, students with different abilities have a chance to contribute to the solution (Lazic, et al., 2021).

PjBL can be viewed as a model with a constructivist approach based on project tasks in optimizing problem solving (Ashari, 2021). Project-based learning is an instructional strategy to strengthen the teaching and learning process of knowledge and demonstrate new understanding with various methods (Prabawa and Zaenuri, 2017). According to Wulandari, et al. (2019), the PjBL model has six components, namely determining fundamental questions; designing the project; preparing a schedule; monitor project progress; presenting results and evaluation. Project-based learning (PjBL) steps consist of several stages. These stages are: starting with important questions; designing a project plan; make a schedule; teacher collects students and project progress; assess results; and going around in circles (Ismail, 2018).

According to Gardner (in Eka & Mokhammad, 2015: 82), revealed that mathematical reasoning ability is the ability to analyze, generalize, synthesize/integrate, provide appropriate reasons and resolve non-routine problems. Reasoning ability in mathematics is an ability to use rules, properties or mathematical logic to get a correct conclusion (Zilda & Padang, 2022). Donaldson (1978) in (Dahlan &Wibisono, 2021) divides reasoning into three, namely: Intuitive Reasoning that requires a knowledge ready

or guessing. Inductive Reasoning, includes understanding or regularity. Inductive reasoning requires the observation of specific and sharp examples of patterns or rules; Deductive Reasoning, simple reasoning in describing the conclusions that need to be followed from what we know. Reasoning is a process or activity of thinking to draw a conclusion or make a new statement that is truly based on several statements whose truth has been previously proven or promised (Sumartini, 2015). According to Lithner (in Jonas, 2016), the definition of mathematical reasoning ability refers to the concept of "reasoning" which is a thinking process carried out to produce statements and reach conclusions in solving certain problems. Reasoning is not always based on formal logic, which means that the thought process does not always produce valid evidence or be proven scientifically correct. However, this statement emphasizes that the reasons used in the thinking process must make sense to the giver of the reason. So, it can be concluded that mathematical reasoning ability is a person's ability to draw conclusions obtained from the process of analyzing, generalizing, integrating existing concepts, providing appropriate reasons where the conclusion is a valid or justifiable conclusion.

Based on Rokhima, Kusmayadi and Fitriana (2019) mathematical reasoning indicators are as follows: Analyzing the problem explained by: looking for hidden structures, looking for patterns and relationships, making connections with previous work; Starting a strategy by selecting mathematical concepts, representations or procedures that are possible to use and utilizing the procedures; Looking for and using relationships in terms of connecting seemingly different mathematical domains, connecting seemingly different contexts, and connecting differences in representation; Reflecting on the solution to a problem by: interpreting the solution and how it answers the problem, checking the truth or reasons for a solution.

Based on the Middle Years Program (MYP): From Principles into Practice (2020) book, in the IB curriculum, learning is based on a global context (Global Context) consisting of six materials, namely: Identity and relationships; Orientation in space and time; Personal and cultural expression; Scientific and technical innovation; Globalization and sustainability; Fairness and development

Students will learn mathematical concepts to plan a project and produce a product. In this way, students can understand the importance of Mathematics in life so that learning Mathematics will be more meaningful and of interest to students. The novelty in this research is that researchers will look at the analysis of the use of the Project-Based Learning approach on the mathematical reasoning abilities of class X students in context Globalization and Sustainability with exploration in the field of development planning. Researchers will provide project-based assignments related to scale and floor plan drawings, surface area, volume, measurements, measurements and cost calculations in building a house. At the end of project learning, students will produce a product from the assignment given by the teacher in the form of a project report. The objectives of this research are as follows: To describe the steps for planning and implementing the Project Based Learning model in Mathematics learning in class X in the context of globalization and sustainability; To describe the mathematical reasoning abilities of class X students in the context of globalization and sustainability after experiencing learning using the Project Based Learning model. Researchers hope that this research can be useful for readers, especially Mathematics teachers so that they can teach Mathematics using

context so that students can be more interested and aware of the usefulness of Mathematics in their lives.

▪ METHOD

Participants

The population of this research were 6 grade X students at a private high school in Yogyakarta that uses IB curriculum. This class is just small class, so the researcher takes all students as participants.

Research Design and Procedures

This type of research is design research. According to Plomp (in Rudhito, 2019: 11), design research is systematic research about designing, developing and implementing educational interventions (such as programs, strategies and learning materials, products and systems) as solutions to solve problems in complex educational practices also aims to advance knowledge. This research uses a cyclical process in the design, implementation and reflection processes. This research aims to design a Project learning design with a Project Based Learning model that develops students' mathematical reasoning abilities in the context of Globalization and Global Sustainability, especially on volume, surface area, comparison, social arithmetic and optimization. There are three steps in design research, namely preparation and design phase, design experiment, retrospective analysis. In the beginning researcher designed a lesson and created HLT (Hypothetical Learning Trajectory), the questions, problems and instruments. After that, executed the plan, observed the learning based on the PjBL steps, and analyzed the learning process based on the mathematical reasoning indicator. The research was conducted on March 2023. It took about 3 weeks to finish the research.

Research Instruments

Research instruments refer to the tools or methods used to collect data in a study. This instrument is designed to help researchers obtain the information needed to answer research questions or test hypotheses. The research instruments that will be used in this research are: Field Note Sheet containing PjBL steps that will be carried out by the teacher, activities carried out in each phase, and activities carried out by the teacher in each phase; The written test sheet is in the form of a student project sheet which is displayed in the form of a final house construction report, which contains the student's house design, calculation of foundation volume, construction columns, wall area, number of bricks, volume of cement and sand, finding the price of construction materials. Necessary, in this research written test will be classified based on the ten mathematical reasoning indicators. There are 24 questions related to the project building a house; A structured interview sheet which is a series of questions containing about the process from start to finish of building their house. Researcher decided to use the instruments based on the previous research and from the reference of Rahi (2017). The interview consists of 24 questions, related to the project of building house that students did.

The qualitative data analysis is done by reducing the data, presenting the data, and drawing conclusions from data that has been collected and verify the conclusion (Paruntu, et al., 2018). The way to reduce data for field note data is classifying field note data based on learning steps using Based Learning Projects. For tests and interviews is by classifying test and interview data based on reasoning indicators mathematics. Validity data is done

by the expert in education (lecturers). The researcher asked for consideration of three learning experts.

The data collection method used by the researcher is as follows: Field Notes, which are notes that contain everything the researcher obtained during observations and interviews. Field notes were made to record important things that occurred in the process of hypothesizing learning trajectories, the learning process, and to record how students' knowledge construction processes progressed in learning. This will be used by researchers in making reflective notes at the end of each lesson which are used to refine hypotheses throughout the next learning meeting; Written test, in order to determine a person's level of knowledge, skills, talents and abilities, a test can be carried out by presenting several questions that can be used when assess and evaluate the extent to which the learning process achieves the target objectives (Saâ, et al., 2021). Tests are used as a tool that provides information to read various important decisions in learning. Tests are also used to monitor student performance in learning so that teachers can reflect on teaching and determine student learning progress. The written test in this research was taken from students' answers to each problem that had to be solved in a house construction project; In this research, written test; Interviews can generally be interpreted as a method of collecting data or information material carried out through one-sided verbal questions and answers, based on predetermined objectives (Mania, 2017). In this study, the interview used by the researcher was a structured interview which contained questions regarding students' mathematical reasoning abilities in the project completion process. Interviews are conducted after students complete the project. All 6 students will be interviewed; Documentation, carried out by researchers to obtain data in the form of documents, photos, images, audio, from the implementation of learning using the Project Based Learning model, implementation of written tests, and interviews.

Data Analysis

The data analysis technique was carried out using descriptive qualitative data analysis techniques. There are three stages of analysis in qualitative, namely data reduction, data presentation, and drawing conclusions. Data reduction is a selection process, focusing on simplifying, abstracting and transforming rough data that emerges from written notes in the field (Rijali, 2019). Qualitative method is used to collect the in-depth details on a particular topic (Rahi, 2017). The qualitative researcher exchanges views with people about their incidents and insight. The most proper and systematic interviews whether individual or in group may be conducted (Buriro, et al., 2017).

The data that will be obtained from this research is field notes, tests and interviews. Because field note data is obtained based on Project Based Learning steps, to reduce field notes is to classify field note data based on learning steps by using Project Based Learning. The way to reduce data for tests and interviews is because test and interview data are obtained based on indicators of mathematical reasoning ability, then to reduce test and interview data is to classify test and interview data based on indicators of mathematical reasoning, namely using reasoning on patterns and properties (analyzing problems), carrying out mathematical manipulations in making generalizations (starting a strategy), compiling evidence or explaining mathematical ideas and statements (searching for and using relationships), and making generalizations (reflecting on the solution to a problem).

Data presentation is carried out by presenting data based on classifications made

for each data such as data on the results of completing projects carried out by students, data on hand notes and data from interviews. To make conclusions, researchers will conclude the data based on the classification made for each data.

▪ RESULT AND DISSCUSSION

Implementation of Project-Based Learning

This research was carried out by giving assignments to students based on projects, carried out in eight meetings. The time allocation for each meeting is 60 minutes. In meeting 1, students were introduced about the house project and how to draw the house plans. In meeting 2, students researched on foundations and calculated 3D building volumes. In meeting 3, students researched and calculated on house foundations. In meeting 4, students researched and calculated the volume of house construction columns. In meeting 5, students calculated the area of the walls of the house. In meeting 6, students calculated the number of bricks, volume of cement and sand for the walls of the house. In meeting 7, students made a cost budget. In meeting 8, students presented their project in front of the class. Analysis of Students' Mathematical Reasoning

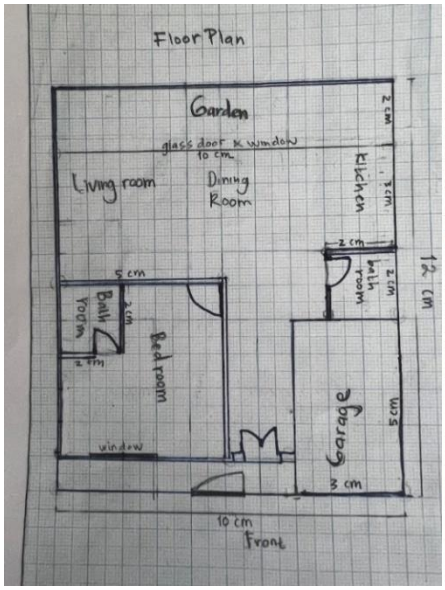

Figure 1. House Plan Group 1

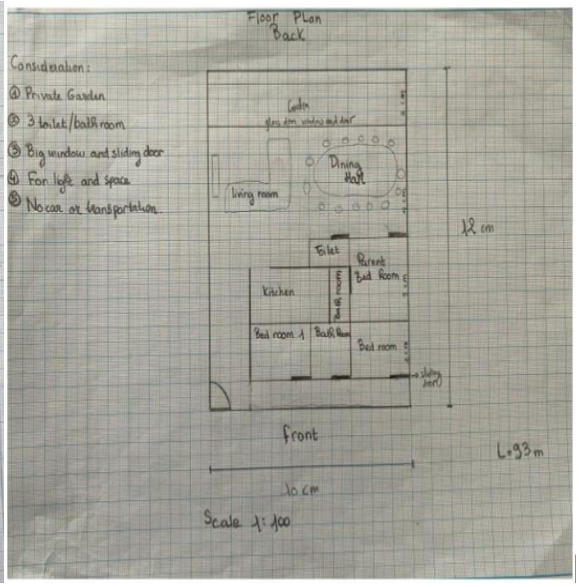

Figure 2. House Plan Group 2

Figure 1 shows that group 1 considers things such as large glass doors and windows for air circulation and sunlight. There are two bathrooms in it and a garage, a large room without partitions so the room looks big. Based on these answers, students are able to gather relevant information and use relevant mathematical concepts such as scale and comparison to create a house plan. Figure 2 shows that group 2 considers things such as a fairly large private garden at the back of the house, 3 toilets, large glass doors and windows for air circulation and sunlight that connect the house to the back garden. This house design does not have a garage because the assumption is that it does not have a vehicle. This group drew a plan of their house using a scale of 1:100. Students worked in group when doing this project and they could solve a problem through collaboration. This is in line with the statement of Lazic, et al. (2021) that mathematical projects also give

students the opportunity to collaborate, where one person is in charge. Teacher divided the students into groups with different ability and chose one person as a person in charge to organize the group work. Both groups could create their own house plan by their own idea. Students construct their knowledge through their own thought with their own reason. This is in line with the statement of Glaserfeld and Matthews in (Abidin, et al., 2020) that constructivism has a big role in meaningful learning can make students find their own concepts.

At the first meeting regarding making house plans, indicators of mathematical reasoning ability used were indicator 1, using reasoning on patterns and properties in looking for hidden structures about making house plans and indicator 2 carried out mathematical manipulation in making generalizations by presenting mathematical statements in writing. A total of 4 students met both indicators, but 2 students only met indicator 2 because these students were not fully able to look for hidden structures in making a house plan, for example determining the proportions of each room or its size but understood how to draw a house plan and the symbols in it.

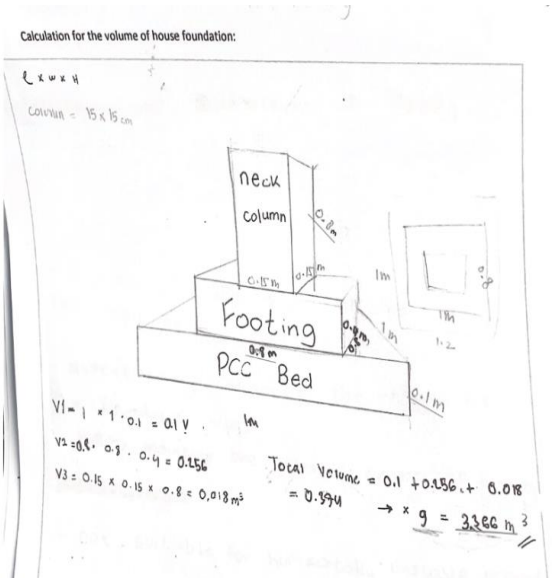

Figure 3. Footing foundation group 1

In Figure 3, the students in group 3 decided that footing foundation consists of 3 parts, namely PCC bed, footing and neck column. In the first stage, students determine the size of the parts based on the results of their research. Students draw a sketch of the shape of their foundation and write down the size of the foundation in meters. Students first calculate the first volume of PCC bed by multiplying 1 m x 1 m x 0.1 m. After that, students calculate the second volume of footing by multiplying 0.8 m x 0.8 m x 0.4 m. Then students calculate the third volume which is neck columns by multiplying 0.15 m x 0.15 m x 0.8 m. The next step, students add up the three volumes and multiply them by the total number of site foundations used totaling 9 site foundations and get a total foundation volume of 3.366 m3.

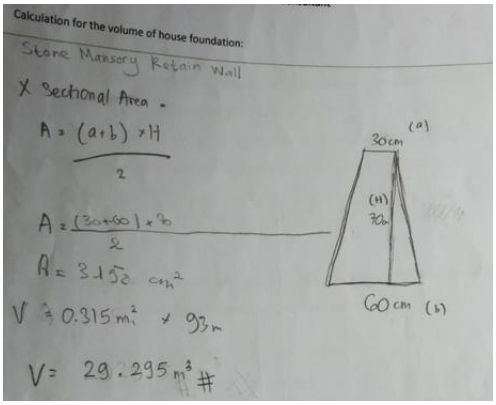

Figure 4. Stone masonry foundation group 2

In Figure 4, group 2 calculated the volume of the stone masonry foundation in the shape of a trapezoidal prism by multiplying the cross-sectional area of the trapezium by the total length of the river stone foundation which is 93 m.

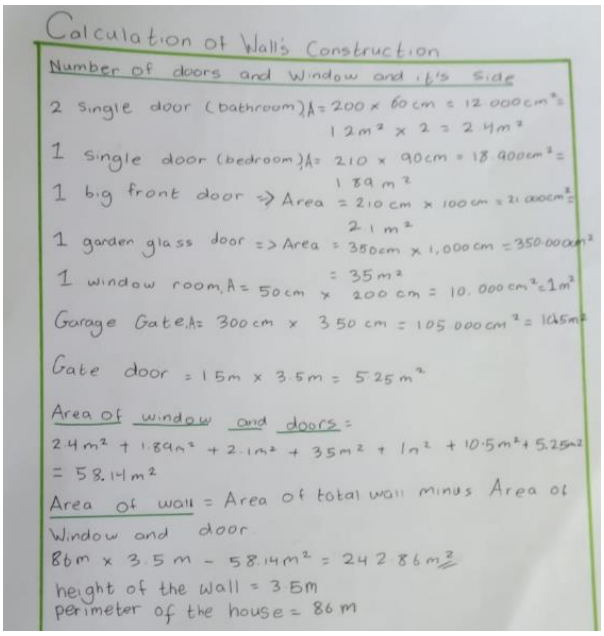

Figure 5. Calculation of group 1 wall area

Figure 5 shows that group 1 calculated the area of the walls of the house by calculating the perimeter of the house from the design that was made, which is 86 m and multiplying it by the height of the house, 3.5 m. After that, subtract the total area of windows and doors to get a house area of 242.86 m2. Group 2 did the same thing with the same method in calculating the wall surface area. Students were able to find an idea to investigate and find the surface area of the house by finding perimeter of the house multiplied by the height of the house. This is the proof that the connected mathematics project is designed to investigate important mathematical ideas in developing students' understanding and reasoning (Wafirah and Asih, 2019).

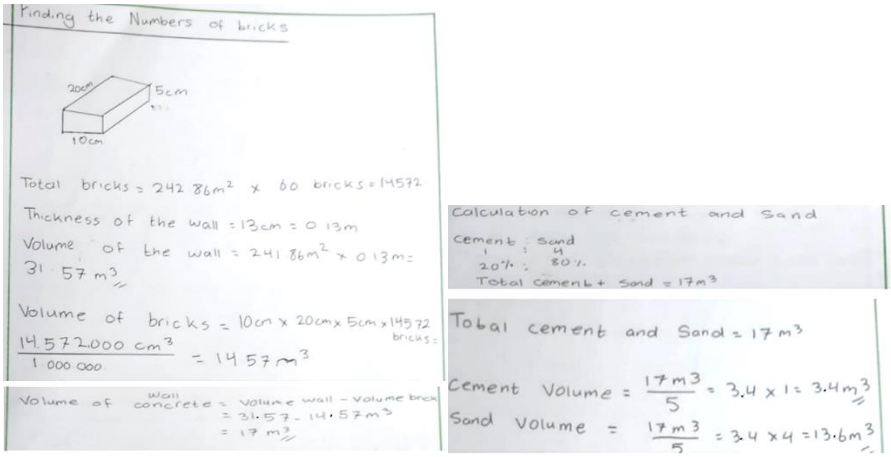

Figure 6. Calculation of the number of bricks, cement, and sand for Group 1

In Figure 6, students calculate the number of bricks by multiplying the surface area of the wall by 60 bricks because they get the information that in 1 m2 of wall there are 60 bricks. Students calculate the volume of the house walls by multiplying the wall surface area of 242.86 m2 by the thickness of the house walls, which is 13 cm. Then find the volume of cement mixture by subtracting the volume of the wall by the total volume of bricks. The volume of cement mixture for the wall is obtained as 17 m3. After that, students use the ratio 1:4 to find the volume of cement and sand and then get the results. Volume of cement is 3.4 m3 and volume of sand is 13.6 m3. The answers are correct. Students show and improve their mathematical reasoning ability through this house project with the proof that students can find the correct solution. This is in line with the statement of Zilda and Padang (2022) that reasoning ability in mathematics is an ability to use rules, properties or mathematical logic to get a correct conclusion.

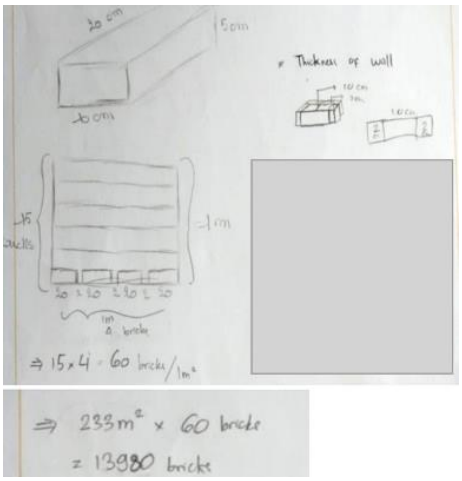

Figure 7. Number of bricks' calculation group 2

In figure 7, group 2 calculations in terms of calculating the surface area of the wall, number of bricks, volume of cement, sand and price have the same concept as group 1, the difference is only in showing the calculation of finding the number of bricks in 1 m2 of wall using the position of the bricks based on the size. This group use the arrangement

and size of the brick to determine the number of bricks is one 1 m2 of the wall. This fact is in line with the statement of Yunita, et al. (2021) that the PjBL learning provides various options in the problem-solving process and can drive students' challenge. We can see that students used different method to find the total number of bricks for the house wall.

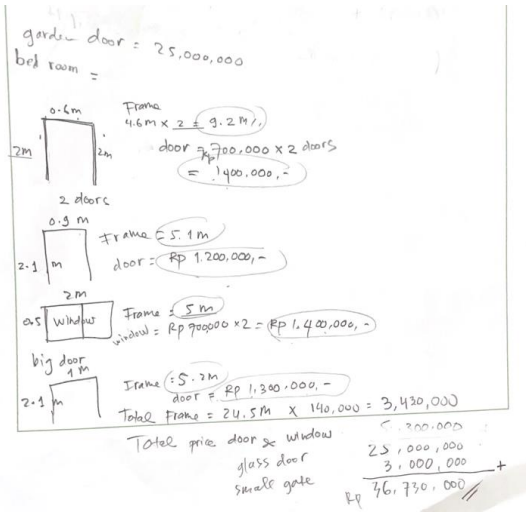

Figure 8. Window and door cost calculation

In figure 8, group 1 chose wooden doors and windows that had frames. Prices for frames and windows are calculated separately. Students first calculated the total length of the frame and multiply it by the price, then add it to the price of the door and window leaves. Whereas, group 2 chose sliding doors and to find the answer they just need to multiply the number of doors by the given price. Students chose different methods. Through this fact, we can see that project-based learning is an instructional strategy to strengthen the teaching and learning process of knowledge and demonstrate new understanding with various methods (Prabawa and Zaenuri, 2017).

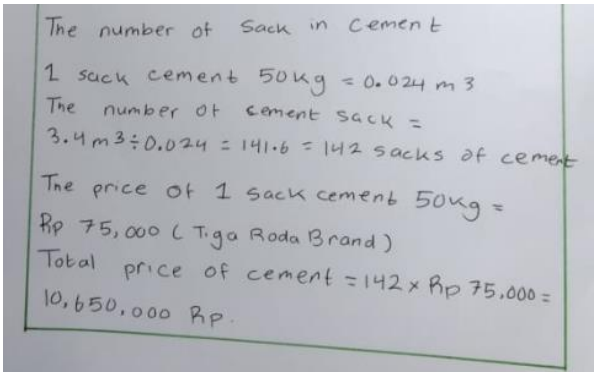

Figure 9. Cement sack' calculation

In figure 9, to calculate the cost of a sack of cement, students first calculate the number of sacks of cement needed by dividing the total volume of cement needed 3.4 m3 by the volume of 1 sack of cement 50 kg which is equivalent to 0.024 m3. After that, students round up and multiply the number of sacks of cement by the price of 1 sack of

cement and get a result of IDR 10,650,000.00. At the end, students created the report containing all the steps that they did to make a budget of building a house and make conclusion that the price to build a house depends on how big and how good is the material quality of the house. From the proof of students' work, it can be seen that students demonstrate mathematical reasoning in solving problems regarding a house construction planning project. This is in line with the statement of Sumartini (2015) that reasoning is a process or activity of thinking to draw a conclusion or make a new statement that is truly based on several statements whose truth has been previously proven or promised.

The achievement of mathematical reasoning abilities based on the mathematical reasoning indicators that Grade X students have been able to carry out in a house construction planning project are as follows: Five students have shown indicators of mathematical reasoning in terms of analyzing problems by looking for hidden structures, looking for patterns and relationships, making connections with previous work in completing a house construction planning project, especially in making a house plan and naming the rooms, counting the number of columns. and the volume of the construction column as well as finding the surface area of the house walls.

Five students showed indicators of mathematical reasoning in terms of being able to start a strategy by choosing mathematical concepts, representations or procedures that might be used, utilizing procedures, especially in finding combined volumes and rules for laying construction columns, calculating the number of bricks in the walls of the house. Four students showed indicators of mathematical reasoning in terms of being able to find and use relationships by connecting seemingly different mathematical domains, contexts and representations in calculating the foundation of a house, finding the surface area of a house wall. Five students were able to make generalizations by interpreting the solution and how it answered the problem and 4 students were able to check the correctness of the solution and make conclusions in terms of determining the cost and purchase price of the items needed as well as finding solutions for planning the construction of a house.

Based on the results obtained from the research, it was found that students were able to show solutions in terms of solving problems related to building a house, calculating the volume of the house foundation, the surface area of the house walls, finding the number of bricks and the volume of cement, sand and calculating the costs required. This is in accordance with the opinion of Gardner (2015), stating that mathematical reasoning ability is the ability to analyze, generalize, integrate, provide appropriate reasons and solve non-routine problems. Students are able to explain their ideas in completing this project by explaining clear reasons, logistics and presenting systematic and clear calculations that can answer questions. Apart from that, the project-based learning activities carried out follow the project-based learning steps. The teacher starts with essential questions and students begin to develop resolution strategies, arrange schedules, solve problems, carry out evaluations and reflect.

To strengthen the results of the discussion of this research, the researcher compared it with relevant previous research, namely: (1) The result of Harahap and Manurung (2023) concluded that application of the project-based learning model which was better than those using conventional learning assisted by the Geogebra application can improve students' mathematical reasoning abilities at MTs Nurul Islam Indonesia Medan. This research is also in line with the previous research from Utami (2018), which examined improving the mathematical reasoning abilities and independence of junior high school

students through the project-based learning model. Through this research, we can also see that students are able to use their mathematical reasoning to solve a problem about making a house project because students can imagine the real context about house around them in every-day life. The research results show that there is an increase in the mathematical reasoning abilities of students who use the Project Based Learning model and the improvement is better than students who use conventional learning models. This research is also inline with others research. The difference is this research is for grade X in senior high school.

▪ CONCLUSION

Based on the discussion that the researcher explained previously, the researcher can draw several conclusions. Learning design using the Project Based Learning approach in the global context of Globalization and sustainability in the IB (International Baccalaureate) curriculum in designing the construction of a house is as follows:

Learning was carried out over 8 meetings, with details of 7 meetings used to complete the project and 1 meeting for presentation activities. The researcher conveys the learning objectives, plans for activities to be carried out, followed by coordinating the planning problem of building a house; The researcher divided 6 students into two groups so that each group consisted of 3 people; The researcher helps students solve the problem given by providing supports that have been provided in the HLT (hypothetical learning trajectory) that the researcher has designed. Apart from that, researcher provides direction based on the responses given by students in the learning process; Based on analysis of test and interview data, the results showed that five out of six students were able to use mathematical reasoning to make a house plan including the rooms, factors to consider in making a house plan, to calculate the number of columns and volume of construction columns, and to find the surface area of a house wall in general. Five students were able to choose a mathematical concept and utilize the procedures in it to find the combined volume and explain the rules for placing construction columns and calculate the number of bricks, the volume in the walls of the house. Four students were able to look for concepts and use them in the mathematical domain to calculate the volume of a house foundation and find the surface area of a house wall, the volume of cement and sand to make a house wall. A total of four students were able to check the correctness of the solution and make conclusions in terms of finding the costs and prices needed as well as finding solutions for planning the construction of a house.

Based on the conclusions obtained from the research results and experience during the research, the researcher provides the following suggestions: Suggestions for students, good time management is needed to be able to complete a house construction project using a project-based learning approach. Apart from that, involvement, cooperation within the group and attention to the process are required in order to complete this project; Suggestions for the future teachers or researchers, it is necessary to pay attention to the grouping of students, ensuring that within each group, student characteristics must be heterogeneous with different ability in terms of response in understanding instructions or activeness in class so that problems in the project can be resolved well. Apart from that, teachers need to pay attention to time management in designing project-based learning that is in accordance with the curriculum or material being taught, so that time can be utilized properly.

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