The Validity of PjBL Tools with a Biodiversity Conservation Context to Improve Students' Numeracy Skills

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Abstract. Numeracy skills have a fundamental role in mathematics learning to build and develop student competencies, especially in 21st century learning. Mathematics learning tools by integrating real-life contexts need to be improved in order to help students in deepening mathematical understanding and involving numeracy skills in problem solving. However, the provision of learning tools related to contextual problem solving to support students' numeracy skills is still limited. The context selection of realistic problems in mathematics learning can be applied, such as integrating mathematics learning with the context of biodiversity conservation. Learning that involves direct student contributions really helps them in solving contextual problems. One of the learning models that supports is Project Based Learning (PjBL).This study aims to develop PjBL learning tools with biodiversity conservation contexts, using the Plomp process and prototype research and assessment phases. The tools include a teaching module, student worksheet, and numeracy test. The PjBL tools were validated by three experts and tested on three students at a junior high school in Banda Aceh. The results indicate that the PjBL learning tools in this research have met the valid and very valid criteria, but further testing is needed to determine their practicality and effectiveness.

Keywords: PjBL tools, Numeracy skills, Learning context, Biodiversity conservation

1 Introduction

Education has always been a system of change. The best education in the previous year is not enough to be successful in career and social life in the 21st century, so in this case the higher level of education and mental preparation is a challenge for the world of work in the 21st century. One of the fields that plays a very important role in improving and developing the quality of human resources in the world of education is mathematics. Learning mathematics has always been an essential tool for future education as well as improving someone's 4C skills which consist of collaboration, communication, creativity and critical thinking. These 4C skills can help human resources in facing the challenges of the 21st century. With these abilities, especially

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in learning mathematics. a person will be able to solve contextual problems by involving mathematics. One of the mathematical skills and the basic literacy that needs to be considered is numeracy skill [1]. Numeracy is one of the fundamental literacy abilities. The term "numeracy skill" is used for knowledge, attitudes, skills, and behaviors that call for the use of statistics and mathematics to manage and resolve issues in a range of real-world contexts [2]. Numeracy is associated with both statistical and mathematical abilities [3]. Given the need for numerical abilities in the twenty-first century, children must be prepared for them from an early age [4]. According to this study, numeracy is the ability to analyze, use, and interpret quantitative data to solve challenges in daily life that call for a foundational understanding of mathematics.

However, it was found that the numeracy achievements of Indonesian students are still low [5]. One of the problems leading to poor performance of students' numeracy skills is that students have difficulty in understanding problems as they cannot imagine the context of the problems given as well as at the same time the teaching applied is still guided by the teaching system [6][7]. Therefore, by connecting mathematics learning based on real scenarios, teachers need to implement innovative teaching and learning involving 4C skills to improve students' numeracy skill. One way that can be attempted is by implementing a Project Based Learning (PjBL) model.

PjBL is a student-centered teaching model that is oriented towards organized problems, in which it is believed that students can develop a deeper knowledge and skills through the content obtained previously when solving the problem by realizing it in a project [8][9]. One context or condition that can be used in PjBL is the biodiversity conservation context.

Issues in the context of conservation need to be raised considering that Indonesia is a country with high biodiversity. Indonesia is currently experiencing biodiversity degradation caused by a high level of environmental threat [10]. This occurs due to a lack of supervision and awareness of local communities in protecting a natural ecosystem [11]. One solution to prevent species extinction in an ecosystem is through conservation actions.

There are many types of species that have been assessed to be under threat of extinction without any conservation efforts being made. All parties should pay attention to this issue, one of which is the existence of bees as a population that is often found in Indonesia. The Directorate General of Higher Education and Technology have reported a drastic decline in the diversity of the bee population [12]. Bee cultivation needs to be carried out as a form of preservation and protection so that bees can continue to reproduce and produce honey with many benefits for humans both in terms of health, food and finances [13]. Through education, attitudes and behavior to protect the environment need to be instilled in students so that good habituation patterns towards the environment are formed [14]. By applying the context of biodiversity conservation in project-based mathematics learning (PjBL), it is expected that students will be more trained and accustomed to solve problems in their daily life.

The use of the context of biodiversity conservation through beekeeping efforts as a context in project design has a relationship to students' numeracy skills when solving problems presented in minimum competency assessment several to AKM type

problems. The project that students will work on is in the form of designing a sketch of a beehive image by utilizing pieces of paper as an auxiliary medium for students in understanding the mathematical concepts of counting operations of numbers and fractions taught. The basic questions presented in the project will train students to find solutions by involving mathematical skills. Students will also be trained in their numeracy skills when solving minimum competency assessment type problems that involve the context of biodiversity conservation through beekeeping efforts as a problem stimulus.

According to the context selection in project-based learning, learning tools that support the implementation of PjBL by integrating the context of biodiversity conservation as the context of problems involving mathematical concepts are needed to improve students' numeracy skills. Previous studies regarding the validity of learning tools in the form of teaching modules with a biodiversity conservation context to improve learning outcomes reported that the PjBL module with a biodiversity conservation context was considered as very valid and practical with an average validation score of 89.25%, indicating that students had a higher difference in learning outcomes using the module compared to the learning outcomes not using the PjBL module in the context of biodiversity conservation [15]. However, there are no PjBL tools available in the context of biodiversity conservation that can improve students' numeracy skills. It is necessary to develop these specific PjBL tools. With this aim in mind, the research question in this study is, "How is the validity of PjBL tools with the context of biodiversity conservation to improve students' numeracy skill?"

2 Method

Developmental research with the Plomp model which consists of three stages, namely: (1) preliminary research or investigation; (2) prototyping design stage; and (3) assessment was performed [16]. However, in this study the researchers only studied the prototyping design and assessment stages. In the development or prototyping phase, the development and prototype of PjBL learning tools with the context of biodiversity conservation is carried out, namely teaching modules, student worksheet, numeracy test, and validation by experts to determine the validity of the products in the form of teaching modules, student worksheet, and numeracy test developed. In the assessment phase, a final assessment or evaluation is carried out on the PjBL tools that have been developed by conducting trials. This paper only discusses the results of validation and readability trials on a limited sample. The PjBL tools with the context of biodiversity conservation developed would first be validated by three competent validators. Validator 1 and 2 (V1 and V2) are mathematics education lecturers, Validator 3 (V3) was a junior high school mathematics teacher by using the validate form for several assessments such as content, language and construct of the tools.

Comments and suggestions provided by validators regarding the PjBL tools developed in biodiversity conservation context were considered as the data in this study. The data was analyzed by calculating the average value of the validity scores of the three validators for the PjBL tools in biodiversity conservation context that have

been developed. The validity criteria for the learning tools developed are as follows in Table 1 [17].

Table 1. Validation criteria for learning tools

Criteria	Average
Very valid	$4 \leq$ Validity Criteria < 5
Valid	$3 \leq$ Validity Criteria < 4
Less valid	$2 \leq$ Validity Criteria < 3
Not valid	$1 \leq$ Validity Criteria < 2

As shown in Table I, if the validation data obtain valid or very valid results, then the PjBL tools with a biodiversity conservation context that have been developed are suitable for use and testing in the field. However, if the validation results show that it is less valid or invalid, then the learning tool must be revised again.

3 Results and Discussion

The research results obtained include the validity of the PjBL tools in the context of biodiversity conservation to improve students' numeracy skills according to experts. As such, the learning tools developed in this study are teaching modules, Student Worksheet, and numeracy tests. The validation results of learning tools by experts are presented in Table II.

Table 2. PJBL Tools validation results

No	*PjBL Tools*	*Aspects being assessed*	*V1*	*V2*	*V3*	*Average*	*Validation Average*	*Validation Average of PjBL Tools*
1.	Teaching Module	Content	4.2	4.6	5	4.6	3.8 Valid	4.0 Very valid
		Language	3.8	3.3	4.6	3.8		
		Construct	3	3	3	3		
2.	Student Worksheet	Content	4	4.5	5	4.5	3.8	
		Language	3.6	3.6	5	4		
		Construct	3	3	3	3		
3.	Numeracy Test	Language	4.7	4	4.7	4.4	4.5	
		Construct	4	4.5	5	4.5		
		Content	4	4.5	5	4.6		

Based on Table II, the average value of the validation results obtained from V1, V2 and V3 for the teaching module learning tools on the content validation aspect was 4.6, the language aspect was 3.8 and the construct aspect was 3, so the overall average score for the teaching module was 3.8. As such, it was identified as a valid category. In this way, the designed teaching module can be used with minor revisions.

Meanwhile, the validation results obtained for student worksheet from validators 1, 2 and 3 revealed that the average validation value for the content aspect was 4.5, the language aspect was 4, and the construct aspect was 5 respectively, so that the overall average value of the validation results for Student Worksheet was 3.8 and was classified as valid. Thus the Student Worksheet draft can be used with slight revisions.

If we look at the validation results obtained for the numeracy test, it showed that the average validation value for the content aspect was 4.4, the language aspect was 4.5, and for the construct aspect was 4.6, so the overall validation result average for numeracy test was 4.5. It can be concluded that the numeracy test that has been designed can be used with slight revisions. Based on the results of expert validation for PjBL tools, it is found that PjBL learning tools with the context of biodiversity conservation consisting of teaching modules, student worksheets, and numeracy tests have met the very valid criteria with an average score is 4.0.

3.1 **Teaching Module**

First, validators provided many comments to researchers regarding the teaching module being developed. All validators stated that the use of sentence editing needs to be improved so that it did not have double meaning. Apart from that, the teaching module only presented general activities, so researchers need to make more detailed and restructured learning activities. The following Table III are all validator comments and suggestions for the teaching module and the results of the revisions.

Table 3. Results of Validators Comments and Suggestions on the Teaching Module

Validator	Comments and Suggestions	Results of the Revisions
V1	On the content aspect, only positive numbers are used.	Negative integer operations have been shown in the teaching material.
	Meeting 1 is in accordance with the PjBL model, but meetings 2 and 3 are not in accordance with the PjBL model syntax.	Meetings 2 and 3 are in accordance with PjBL syntax.
	The editorial sentence needs to be changed so that it shows the extent to which students are active.	The editorial sentences have been changed to show the extent to which students are active during learning.
	For time allocation, 2 meetings are enough for the project, the rest can be alloted for presentations.	Phases 1 and 2 were used as project work phases at meeting 1, phases 3 and 4 were used as project evaluation and presentation at meetings 2 and 3.

Validator	Comments and Suggestions	Results of the Revisions
V2	There are contextual issues that are less related to the context of bee conservation.	Contextual issues related to the biodiversity conservation context in bee conservation efforts have been added and clarified.
	There are still writing errors, spacing discrepancies, discrepancies in the words/terms used, incomplete sentences, and so on.	The writing format, use of words or terms in sentences have been revised.
V3	There are some sentences that need to be revised to be simpler and do not have double meaning.	Sentences with double meanings have been corrected and simplified.
	Correct the sentences such as "40 is divided by 5 people, or each person gets 40 sachets?" to make them easier to understand	The sentence has been corrected, that is "each patient gets 40 sachets of honey."
	It is better to specify more detail on the size of the wood in terms of length and width, such as 6 cm x 6 cm.	The size of the 6 cm piece of wood has been corrected to 6 cm x 6 cm.

3.2 **Student Worksheet**

The comments given by V1, V2, and V3 were that the content suitability for learning objectives with learning outcomes need to be reconsidered. Besides, all validators suggested to researchers to add activities that practice students' numeracy skills in the Student Worksheet. The learning tools developed were expected to improve students' numeracy skills. Apart from these comments and suggestions, there are other several comments and suggestions as shown in Table IV.

Table 4. Results of Validators Comments and Suggestions on the Teaching Module

Validator	Comments and Suggestions	Results of the Revisions
V1	The image layout placed on each sheet is less efficient as there is still a lot of empty space.	The images on each sheet are placed efficiently and the space is used efficiently and compactly.
	The use of language on the last page is less communicative.	The use of language on the last page is communicative.
	Instructions and directions still need to be checked so that they are more appropriate and easier for readers to understand.	The use of instructions and directions is appropriate and structured.
V2	Are the intended dimensions in question really L x W x H? Or will it be determined by the teacher later?	The dimensions referred to are in the form of L x W x H and the size of the honeycomb drawing that the students will create is determined by the teacher.
	Pay attention and match the correct scientific name, such as *Trigona* or *Trigona sp*.	*Trigona sp* is the correct use of Latin
	There is no place for students to draw the design of each bee box on the Student Worksheet (there are only entries in the	Students are asked to draw beehive drawing designs on cardboard.

Validator	Comments and Suggestions	Results of the Revisions
	table). Are students asked to draw it on cardboard too)?	
V3	The practice questions related to biodiversity conservation context issues have been added to 4 questions.	The practice questions related to biodiversity conservation context issues and related to the project have been added to 4 questions.

3.3 **Numeracy test**

According to the validators, the numeracy skill test needs to be readjusted to the numeracy skill indicator. All validators also suggested giving a numeracy skill test at the end of every meeting, not just at the last meeting. This should be carried out to determine the achievement of learning objectives at each meeting and to determine students' abilities after participating in learning activities. The following are all validators' comments and suggestions for the teaching module and the results of the revisions can be seen in Table 5.

Table 5. Results of Validators Comments and Suggestions on Numeracy test

Validator	Comments and Suggestions	Results of the Revisions
V1	Students take a long time to answer the stimulus travel route of 1 dotted line and if the route is in the shape of a triangle with the dimensions in the question, it will form a Pythagorean triple.	Delete the dotted line on stimulus route 1, then replace the lines and numbers on each travel route. So there are changes to the questions related to stimulus 1.
	Question number (3) contains two statements about the longest route, it is better to have only one statement for the longest route.	Replace one of the statements that uses the longest route, into how many routes can be taken.
	The image in stimulus 2 regarding the design of the honeycomb media is not clear, it does not show the shape of the nest.	Change the media image of a beehive, becoming a clearer image which shows the shape of the beehive.
V2	Correct the words in stimulus 2, namely "A group of students will design Trigona beehive media using recycled wood obtained from the surrounding environment.	Correct the words in stimulus 2 to be "A group of students will design Trigona beehive media by using recycled wood with the same shape and size obtained from the surrounding environment."
V3	Correct the words in question number (5) "The pieces of wood that have been produced in question number 43)"	Correct the word in question number (5) to be "The number of pieces of wood produced in question number (4)"

Comments and suggestions given by validators on teaching modules, student worksheet and numeracy test have been followed up and revised so that the resulting PjBL tools using the biodiversity conservation context have met the valid and very

valid criteria. The teaching module developed meets the valid criteria with a score of 3.8. In general, the success of a person's learning implementation is largely determined by the quality of the planning made in the teaching module [18]. This teaching module is in accordance with the learning stages with PjBL, so that it can practice students' 4C skills. The application of project-based learning (PjBL) encourages students to think critically, have the ability to solve problems, improve student achievement so as a result, it will have an impact on improving students' numeracy skill [19].

Meanwhile, the developed Student Worksheet received a score of 3.8 with valid criteria. The assessed aspects in the Student Worksheet such as the presentation of material or content, language aspects, and constructs related to Student Worksheet activities with PjBL characteristics are very suitable so that they can practice students' thinking skills. Activities in project-based Student Worksheet using the biodiversity conservation context can help students solve problems and make scientific conclusions, and can support improving students' critical thinking skills and creative thinking skills [20]. Thus, during the project completion process, students' numeracy skills will also be practiced simultaneously when they solve contextual problems related to biodiversity conservation in bee cultivation efforts.

The numeracy test received a very valid category as the validator's assessment of the content, language and construct aspects obtained an average score of 4.5. However, there are still several suggestions from the validators for numeracy tests, such as the researchers can add numeracy tests to each meeting. Furthermore, researchers also made improvements according to suggestions and comments provided by validators.

The student worksheet and numeracy test that have been validated will then be tested for readability on three students at one of the junior high schools in Banda Aceh. After analyzing students' responses when reading the student worksheet, students provided suggestions for improving the student worksheet, namely that there are several uses of words and sentences that are difficult to understand, details of project work still need to be clarified and numbering is inconsistent. Based on the suggestions given by the three students, the researchers draw the conclusion that the student worksheet that has been developed can be understood well and then the researchers will revise the student worksheet according to the suggestions and comments given.

Likewise, when testing the readability of students' answers after doing a numeracy test, the researchers then observe the students' comments and suggestions in writing, including the following: "Do you understand the meaning of the questions given?". They could understand some of the questions, but the questions were too complicated and long, the pictures presented were too small, and there were editorial sentences that were not well understood. Based on comments and suggestions from students, the researchers drew the conclusion that the questions that were developed could be understood well. The only drawback lies in some questions that are considered complicated and long, so students answered incorrectly and did not answer the questions. In this way the researchers will revise the intended questions.

Student achievement is also improved when learning tools provide a model from PjBL by local context is used [21]. Learning that incorporates local contexts of biodiversity conservations is helpful and can be used to improve students' reading

skills [22]. Numeracy is one of the basic literacy abilities that must be acquired. Numeracy is related to the ability to apply numbers, facts, and mathematical symbols [2]. The ability can be used to assist in the resolution of human problems [4]. Numeracy skill plays an essential role in the students' cognitive [2]. Previous study stated that there are three critical aspects of creating a supportive environment for numeracy skills. They are 1) the demands for numeracy skill, 2) opportunities to apply numeracy skill, and 3) the support and resources offered as well as solutions to the barriers that hinder numeracy skill [29].

The issue is that teachers lack the knowledge and expertise necessary to create instructional resources for reading and numeracy that are based on challenges and projects. According to an examination of the learning plans and designs, the majority of them continue to provide learning results at a low level, and the improvement of reading and numeracy in the classroom is still restricted to basic literacy abilities and language that is only partially expressive. As a result, steps must be taken to enable educators to create project and problem-based reading and numeracy teaching tools [20]. Based on the results of expert validation for PjBL tools, it is found that PjBL learning tools with the context of biodiversity conservation consisting of teaching modules, student worksheets, and numeracy tests have met the very valid criteria with an average score is 4.0. Therefore, all learning tools that have been developed can be used.

4 Conclusion

Based on the research and discussion results that have been explained, it can be concluded that the validation result of the PjBL tools in the context of biodiversity conservation consisting of teaching module with score 3.8, student worksheet with score 3.8 and student numeracy test with score 4.5 have met the validity criteria that very valid with an average score is 4.0 and are suitable for use with slight revisions. However, the PjBL tool in the context of biodiversity conservation still needs to be tested further to determine its practicality and effectiveness.

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