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DEVELOPING MATHEMATICS QUESTIONS OF PISA TYPE USING BANGKA CONTEXT

M. Noviarsyh Dasaprawira[1], Zulkardi[2], Eli Susanti[2]

[1]Universitas Nahdlatul Ulama Al Ghazali, Jl. Kemerdekaan Barat No 12 Kesugihan Kidul, Cilacap, Indonesia
[2]Universitas Sriwijaya, Jalan Srijaya Negara, Bukit Besar, Palembang, 30139. Indonesia
Email: zulkardi@unsri.ac.id

Abstract

This study aims to develop a math problem type PISA to familiarize students using problems with PISA standard and produces a valid, practical, PISA context of Bangka (Tanjung Kalian Lighthouse) type and see the Basic Math Skills (BMS) seen from the context of Tanjung Kalian lighthouse. The research method used is design research with the type of research development or development studies. The result of the research is a valid PISA math problem at the expert review stage and one to one, while small group stages do the practicality. The ability that is found in the form of communication, representation, mathematical, reasoning, and argument, and formulates a strategy to solve the problem.

Keywords: PISA, Mathematical Literacy, Bangka Context, BMS

Abstrak

Penelitian ini bertujuan untuk mengembangkan soal matematika tipe PISA untuk membiasakan siswa menggunakan soal-soal berstandar PISA dan menghasilkan soal tipe PISA konteks Bangka (Mercusuar Tanjung Kalian) yang valid, praktis dan melihat kemampuan dasar matematika (KDM) yang terlihat dari konteks mercusuar tanjung kalian. Metode penelitian yang digunakan adalah *design research* dengan jenis penelitian pengembangan atau development studies. Hasil penelitian berupa soal matematika tipe PISA yang valid pada tahapan *expert review* dan *one to one*, sedangkan kepraktisan dilakakukan tahapan small group. Kemampuan yang ditemukan berupa komunikasi, representasi, matematisasi, penalaran dan argument, serta merumuskan strategi untuk memecahkan masalah.

Kata kunci: PISA,Literasi Matematika, Konteks Bangka, KDM

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Based on the results of PISA in 2012 and 2015, Indonesia is still in a position under dependent neighboring countries; this result is still not good in the eyes of the world. The ability of Indonesian students in solving problems that require the ability to review, giving reasons and communicating effectively, and solve and interpret problems in various situations is still lacking (Kamaliyah, *et al*. 2013). It is based on students 'weak mathematical literacy about Indonesian students' mathematical literacy skills. Mathematical literacy emphasizes the ability of students to analyze, reason, and communicate ideas effectively in fractions of mathematical problems they encounter (OECD, 2009).

Mathematical abilities require disposition knowledge to think and act systematically in applying certain mathematical principles to everyday problems and involve critical aspects and related to life (Wijaya, 2016; Permatasari, *et al*. 2018). Mathematical Literacy is a person's ability to formulate, implement, and interpret mathematics in various contexts of everyday life problems efficiently (Sari, 2015). So that learning in the classroom must be with a variety of situations related to everyday life.

Also, students are accustomed to obtaining formal mathematical knowledge in the classroom so that it causes students' weak ability to work on problem-based questions such as PISA questions (Novita, *et al*. 2012). Similar to what was said by Novita and Putra (2016) that students always get non-routine problems and formal knowledge in their classrooms, so that students lack mathematical literacy skills.

In connection with the OECD results and previous researchers, Indonesian students are relatively low in answering high-level questions, and the teaching process in schools only learn mathematics conventionally without using the context of daily life or cultural context. This result has become the foundation of researchers to improve the quality of education in Indonesia by creating and developing mathematical questions in the context of daily life or cultural contexts. By previous researchers, Indonesian students should change their habits and try learning-based PISA questions that include basic math skills. One way to help teachers implement PISA-based learning to familiarize students is to provide banks with the model PISA (Zulkardi & Kohar, 2018). It is by what is obtained from the score of PISA in 2012, Indonesia was scoring 371, while in 2015 Indonesia obtained a score of 375.

Indonesian students should be familiarized in the learning process using the problem of PISA to be able to improve students' literacy skills, so that will impact on the results of PISA in the next year. Learning uses the context of making students find meaningful relationships between abstract ideas and practical applications in real contexts (The Cornerstone of Tech Prep, 1999). Whereas, the use of local contexts can help students understand the phenomenon of mathematics from the perspective of their own life experiences (Charmila, *et al*. 2016). Furthermore, OECD (2013) stated that mathematical literacy is the ability of individuals to formulate, apply, and interpret mathematics in various contexts, not only about the context in everyday life. Making a question is not only reasonable that can be solved, but also the problem must be authentic that relates to the real world and is modeled mathematically (Zulkardi & Kohar, 2018). On the other hands, the use of context in learning is very important because context can present mathematical problems in abstract form to representations that are easily understood by students (Fajriyah, *et al*. 2017).

Researchers use the context in Indonesia to get students to familiarize themselves with the standard PISA problems and improve math scores at the OECD level. Several researchers already develop the PISA-like problems by using the context in Indonesia, such as Indonesia natural and cultural heritage (Oktiningrum, *et al*. 2016), rice fields context in Karawang (Aini, *et al*. 2019), and some games in the Asian Games in Indonesia (Nizar, *et al*. 2018; Permatasari, *et al*. 2018; Jannah, *et al*. 2019; Yansen, *et al*. 2019). Therefore, the researcher developed a PISA type math problem using a valid and practical Bangka context.

METHODS

This research method is design research with the type of research development or development studies. This development research aims to generate a PISA mathematical problem using a valid and practical Bangka context as well as to see how the potential effects of the problems developed on the

mathematics ability of junior high school students. This math research development study consists of two stages of preliminary or formative evaluation. (Zulkardi, 2002). Stages of formative evaluation consist of self-evaluation, expert reviews, and one-to-one, and small group and field test (Tessmer, 1993).

At the preliminary stage, the researcher performs student analysis, curriculum analysis, context analysis of Bangka, and PISA analysis. Furthermore, the researcher designed the problem of lattice problem, problem rubric, and question card. The process of this stage is called an early prototype, then performed at the formative evaluation stage. The first stage of the formative evaluation is self-evaluation.

This stage is in the self-evaluation by the researchers, after the researchers asked colleagues to see the problem developed whether there is a mistake on reading, and then evaluated by the supervisor and testers at the first defense of this process is called prototype 1. The next step the researchers validate to experts about PISA is called the stage expert review; simultaneously, the researchers perform one to one stages to the students. After doing the process, the researchers revised the pass by the validator. The results of the expert review stage and one to one is to look into the validity of a prototype. This prototype is called prototype 2. The next stage, the researchers tested into small groups or small groups while viewed in this process to see the practicality of prototype 2. Results revision at this stage, then researchers get prototype 3. The last step is the field test using prototype three, where the field test stage, the researcher sees a potential effect on basic mathematical skills that arise.

The data collection techniques used in the form of documentation in the form of PISA design, walkthrough, test in the form of a third prototype tested to students who have been determined. The results of this field test are used to obtain data about the potential effects of PISA-type mathematics that are developed to the mathematical communication ability of junior high school students of class IX, interviews, and Questionnaire.

RESULTS AND DISCUSSION

This development uses design research with the type of development studies. The development of a PISA mathematical problem using the Bangka context, namely *Tanjung Kalian Mercusuar,* produces valid and practical questions and has a potential effect on students' basic math skills.

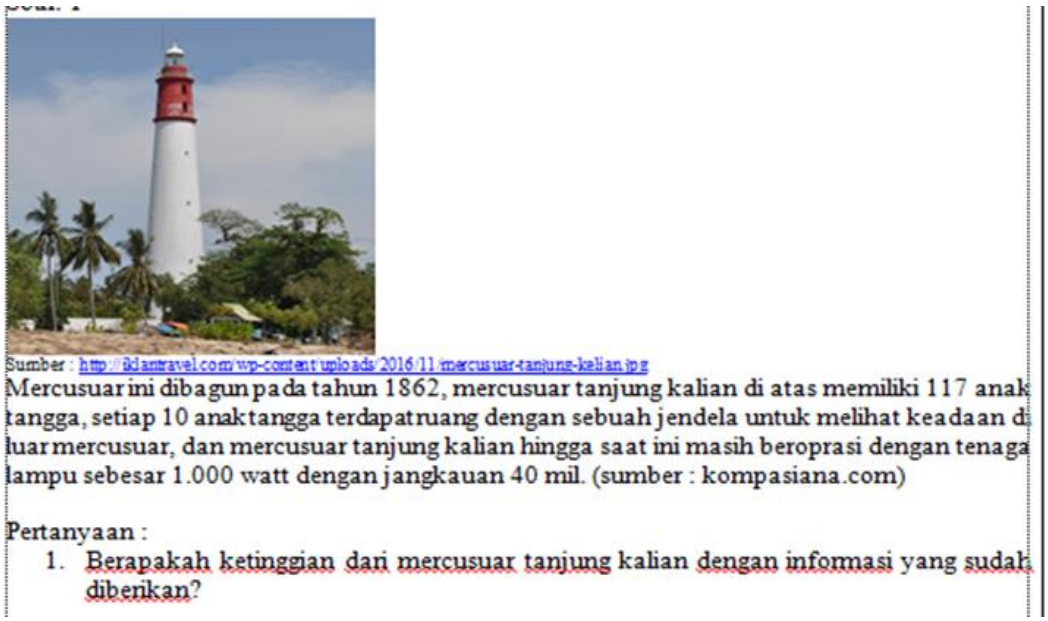
The test subjects include students of class IX SMP Srijaya State Palembang city. In the preliminary stage the researchers conducted an analysis of students, curriculum, and PISA problems that will be developed this is called the initial prototype, subsequently carried out formative evaluation in the form of self-evaluation, this stage uses the initial prototype for the re-check by colleagues, supervisors, and lecturers testers who did when the proposal seminar.

This research produces prototype three consists of 11 Mathematical Problem Type PISA using Bangka context. As a detail that of the 11 questions, there are 3 questions with the context of *Tanjung Kalian Mercusuar* (the lighthouse of Tanjung Kalian), such as 1 question with the context of the lake of kaolin, 1 question with the context of the three pyramid, 2 questions with the context of the population in Bangka, 2 questions with the context of the Bangka Gold bridge, and 2 problem with the

context of Bangka Botanical Garden. This study produced 11 PISA type Mathematics questions from various contexts, and various levels used. Mathematical problems in context Bangka has valid and practical criteria and has a potential effect seen in students' mathematical literacy abilities.

Product validation was developed based on the comments of the validators. The validation process in terms of content by PISA, the construct adapts to student characteristics and the level of PISA questions, and the language used does not interpret clear and understandable double spelling and language spelling. The potential effects are generated in the analysis of student answers carried out in the stages of the field test, analysis of student answers aims to see seven basic mathematical abilities.

At the next stage, the product developed was evaluated so that it became prototype 1, then one-to-one and expert stages were carried out. One of the problems in the context by using the context of Tanjung Kalian Lighthouse can be seen in Figure 1.


Sumber : http://ildantravel.com/wp-content/uploads/2016/11/mercusuar-tanjung-kelian.jpg

Mercusuar ini dibagun pada tahun 1862, mercusuar tanjung kalian di atas memiliki 117 anak tangga, setiap 10 anak tangga terdapat ruang dengan sebuah jendela untuk melihat keadaan di luar mercusuar, dan mercusuar tanjung kalian hingga saat ini masih beroprasi dengan tenaga lampu sebesar 1.000 watt dengan jangkauan 40 mil. (sumber : kompasiana.com)

Pertanyaan :

1. Berapakah ketinggian dari mercusuar tanjung kalian dengan informasi yang sudah diberikan?

Figure 1. The problem of Tanjung Kalian Lighthouse

Along with the stage of the expert review conducted one-to-one stage with students of class IX SMP Srijaya Negara, used as many as three students who have high ability, medium, and low and aged 15 years. Prototype 1 is given to the validator at the expert review stage. As for the validator at this stage is Prof. Ahmad Fauzan, and Prof. Hasratuddin. The validation process is done via email delivery. The results of the good validator from Prof. Ahmad Fauzan and Prof Hasratuddin that the questions in the context are good, but improve the level of question number 3.

The validators validate the problem, the rubric of the problem, the question card, the lattice grid about views of content, constructs, and language. As stated by Zulkardi (2006), the validity of the problems in terms of content was by the domain of mathematics literacy in PISA, such as content, context, and mathematical process. The construct was by the characteristics of PISA problems level and capabilities of the tenth-grade students; language was the problem of the use of enhancing

spelling, could be understood, and did not have a variety of meanings. And Then, the challenges include the difficulties experienced by the designers when developing PISA like tasks, namely creating more authentic, more accessible regarding the use of language structure, and more cognitively-demanding tasks (Zulkardi & Kohar, 2018).

Furthermore, small group stages are done using students from the same school of SMP Srijaya Negara. Students are in use as many as six students or 2 groups that each group has high-ability students, moderate, and low. In the small group process to see the practicality of a problem that has been developed. According to Zulkardi (2006), the practicality of the problem was illustrated from the result of the small group where the problems could be understood, easy to use, could be administrated, and interpreted well by the students. After this process, the researcher revises to be continued in the field test in grade IX students of SMP Srijaya Negara.

In the last stage or field test, the problems used in the form of prototype 3. Prototype 3 is tested to students of class IX D SMP Srijaya Negara with a total of 29 students. The problem is given as many as 11 problems done for 80 minutes. Students are asked to do all the problems and solve the PISA problem with the students' creativity strategy to answer the question. This activity is to see what basic mathematical skills emerge from student answers.

The question shown is in the form of a matter of context of Tanjung Kalian Tower with three questions. On the question, it looks easy, but the results of the answers of students working on various kinds of perceptions so that it is quite interesting to the question. When interviewing students about the question, they were happy because they got some answers to the various processes carried out, this was very good in terms of student development when finding similar questions.

On the matter of number 1, it discusses the height of the lighthouse. In completing the PISA problem creativity, broad intelligence is needed in interpreting a given problem. Hoerr (2000) stated that comprehensive intelligence consists of linguistic intelligence, logical-mathematical, musical, spatial, kinesthetic, interpersonal, intrapersonal, naturalist, and existential intelligence. In this problem, students can be creative in answering and using logical reasoning to what has been provided in the picture and information on the matter In this case, students can be creative in answering and using logical reasoning for what has been provided in the image and information about the issue that can be seen in Figure 2.

This context is chosen because of the lighthouse function. The content contained in this context is a comparable comparison that is learned in junior high school, so it is by the object of junior high school students. On this issue raises some basic mathematical skills other than students using reasoning and argument, the basic mathematical ability that arises is the mathematics in which it performs. As described by Anisah, *et al*. (2011), mathematical reasoning is a thought process that is carried out by drawing conclusions and reasoning abilities that can make students solve problems in life, inside and outside of school.

Sumber : http://diantravel.com/wp-content/uploads/2016/11/mercusuar-tanjung-kalian.jpg

Mercusuar ini dibagun pada tahun 1862, mercusuar tanjung kalian di atas memiliki 117 anak tangga, setiap 10 anak tangga terdapat ruang dengan sebuah jendela untuk melihat keadaan di luar mercusuar, dan mercusuar tanjung kalian hingga saat ini masih beroprasi dengan tenaga lampu sebesar 1.000 watt dengan jangkauan 40 mil. (sumber : kompasiana.com)

Pertanyaan :

1. Berapakah ketinggian dari mercusuar tanjung kalian dengan informasi yang sudah diberikan?

Figure 2. Problem number 1 context of Tanjung Kalian Lighthouse

OECD (2003) stated that mathematical PISA content is related to students' ability to analyze, reason, and communicate effective ideas because they describe, formulate, solve, and interpret mathematical questions in various situations problem. Here, there are two answers from different students that can be seen in Figure 3 and Figure 4.

In Figure 3, the researcher assumes that the student solves the problem with mathematical ability and the representation of what has been informed on the question. Besides this student uses his strategy in solving the problem with information on the problem or known in the matter (Prahmana & Suwasti, 2014). This student's answer has been predicted by the researchers the possibility of students using the strategy, only that there is a difference in determining the height of each ladder. This answer is not a problem because a ladder across different places has a difference. And the student understands that the height of each ladder is the same as that which the researcher justifies what the student is answering. Therefore the matter of the lighthouse of your cape can make students out the ability mathematization, communication, representation, reasoning and arguments and the ability of students in using strategies to solve the problem. The students with reasoning abilities can understand, formulate, and solve problems properly and correctly (Ahyan, *et al*. 2014; Saleh, *et al*. 2018).

The second answer sheet for this student is correct (Figure 4). On the results of this student answer using his strategy is different from other friends. The student solves the height of the lighthouse by comparing something in the picture. These students use coconut trunks to compare with the height of the lighthouse. This context is justified according to the researchers.

As Stacey (2014) pointed out that in PISA, all logical methods can be used in solving the given problem given full value. The result of this student's answer has a mathematical ability, a communication in which the student can explain again what he has answered, the reasons and arguments are seen from the student's answer using the reason that the height of the lighthouse can be calculated by comparing with how many coconut trunks, the PISA problem.

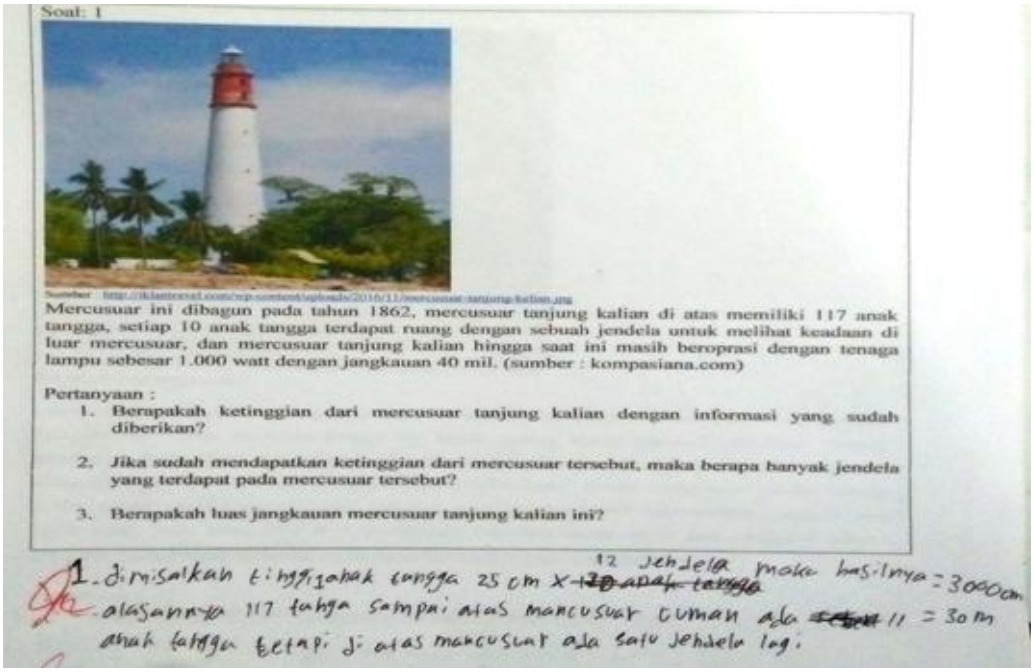


Figure 3. Student answer number 1.

The difference between these two answers the researcher does not blame for what has been said to be valid and practical. But this question is already well proved by different student answers and can lead to basic mathematical skills.

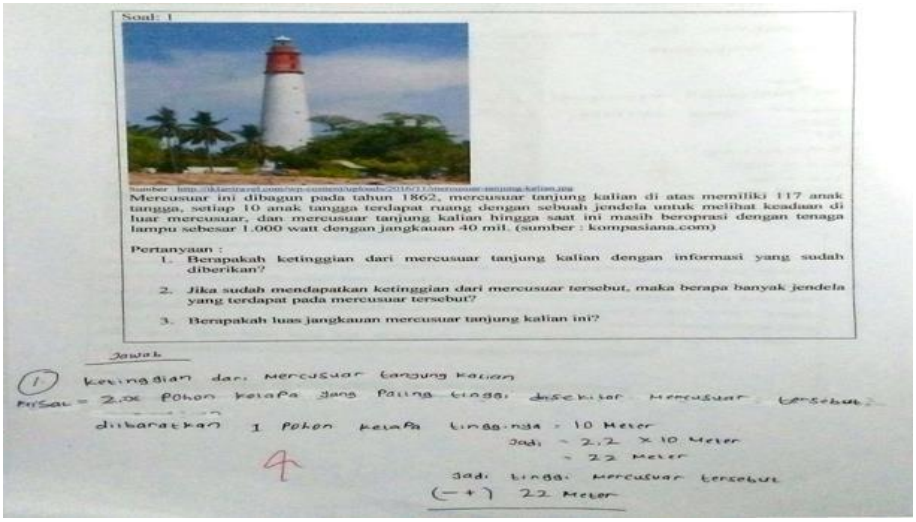


Figure 4. Answer sheet of a student to 2

In Figure 5, question number 3 students are required to imagine the function of the lighthouse. Students must always associate their mathematical knowledge with practical situations or problems encountered in everyday life (Hayat dan Yusuf, 2010; Hendroanto, et al. 2018; Risdiyanti & Prahmana, 2018). So students can see broadly about the context. When students can know the function of the lighthouse and what is formed if the lighthouse is operating.

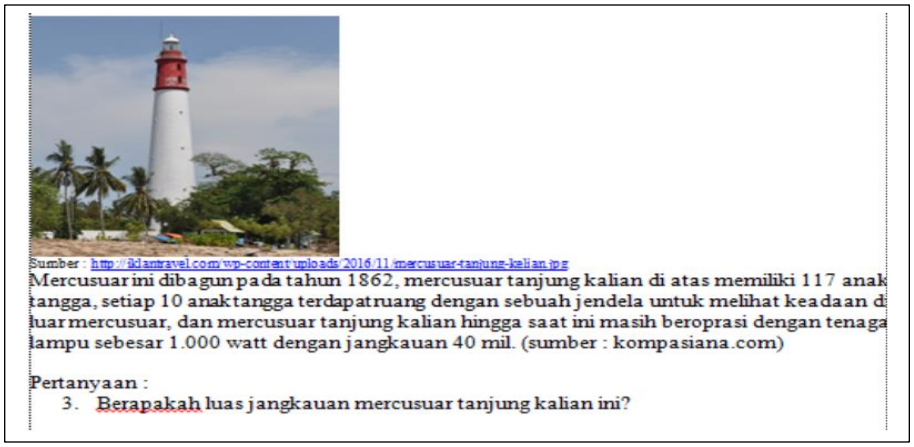


Figure 5. About PISA Lighthouse Tanjung Kalian Bangka

Students are required to use their strategy how to solve question number three, students are required to understand the function of the lighthouse, after which the students implement the function of the lighthouse into a question on the question, so students will be able to solve the problem. Here the researchers present one of the answers found when the field test stage (Figure 6).

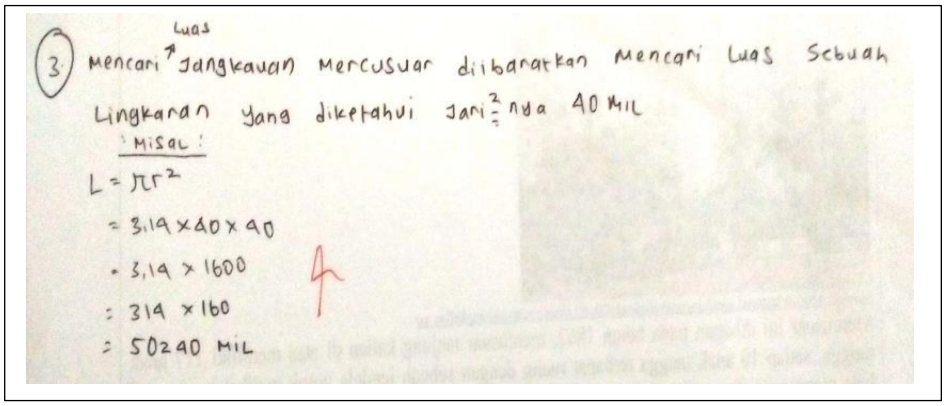


Figure 6. Answer the student

Figure 6 shows one of the students' answers found in the field test stage. In the above answers, the researcher assumes that the students do an understanding of the circle-shaped lighthouse function it resembles the reasoning capability and meaningful argument that students reason logically to connect problems so that students can find solutions to problems. Furthermore, students perform mathematical calculations obtained on the ability of reasoning and visible student representation of the images given in the above problems. The students 'mathematical ability is seen in the students' answers which assume the widest range of the lighthouse, as well as modeling the mathematics in the context of the context problem, and in the student's answer seen the communication where the students solve the problem and present the answers according to the justification that the students do. So, in this problem can bring up some basic math skills in the form of reasoning ability and argument, mathematization, representation, and communication.

In general, the results of the learning process show students can solve the context problem involving seven basic mathematical abilities or mathematical literacy abilities. However, there are still

students who have difficulty in answering these questions, because they are still not accustomed to students working on problems that are contextual and creative thinking in which if ordinary students are only given formal lessons such as those in textbooks. The results of this research process researchers find pleasure in students by conceptualizing students' answers to student creativity without any limitations, and students can think broadly when listening to answers that are different from other friends.

CONCLUSION

This study resulted in 11 mathematical questions of type PISA using a Bangka context that was valid and practical and had potential effects. Validity is carried out at the stage of expert review and one-to-one, in this case, in terms of content, constructs, and discussion. While in practicality carried out at the small group stage, the interpretation of practicality is administratively when used in learning and said by the students. The results of the analysis of the Tanjung Lighthouse Tower unit show that 15 of the 29 students were able to engage in communication skills, mathematical abilities, and reasoning abilities. While ten students were able to involve mathematical abilities, only four students had difficulty in answering the question. Based on interviews with 15 students regarding the context of your cape lighthouse tower that this context can improve students' abilities in reasoning, mathematical and communication. while for 4 students who had difficulty just saying they did not understand the questions and images given, this the researcher assessed that these students were not familiar with questions that needed creativity and reason.

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