ISSN 2502-5872 (Print)
ISSN 2622-3627 (Elektronik)

Volume 8 Number 2, May 2023, 329-344

APPLICATION OF CONTEXTUAL PROBLEMS TO HELP STUDENTS MATHEMATIC UNDERSTANDING ABILITY IN SCIENCE AND SOCIAL CLASS GRADES XI

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ABSTRACT

Learning mathematics aims to instill the ability to understand mathematics. This ability is important because it trains students to think deductively and realize the relationship between mathematical concepts in real life. Field facts prove that XI IPA IPS students from a private high school in the Lampung area have difficulty working on contextual questions as a result of their low ability to understand mathematics. The purpose of this research is to analyze the implementation of contextual questions in helping students' mathematical understanding abilities. The subjects in this study were 21 students of class XI IPA IPS at a private school in Lampung. The research method used is descriptive qualitative and data collection through written tests and interviews. The results of the study show that contextual questions can help students' mathematical understanding abilities. Through the results of this study, it is suggested that schools provide training in making contextual questions, teachers need to use contextual questions in learning, and further researchers expand the variables reviewed.
Keywords: Mathematical Understanding Ability, Contextual Problems, HOTS, Learning Assessment System

How to Cite: Anin, F. R & Dirgantoro, K. P. S. (2023). Application of Contextual Problems to Help Students Mathematic Understanding Ability in Science and Social Class Grades XI. *Mathline: Jurnal Matematika dan Pendidikan Matematika, 8*(2), 329-344. http://doi.org/10.31943/mathline.v8i2.376

PRELIMINARY

The world of education is inseparable from the practice of learning assessment systems. Indonesian educational assessment practices are regulated in government regulation number 13 of 2015 Article 1. In the school context, assessment aims to determine abilities, help improve student learning outcomes, and help educators evaluate learning (Kemendikbud, 2017). Particularly for students, assessment helps reveal their ability to discipline. Mathematics is no exception, ideally, the student's ability that is important to achieve is mathematical understanding (Nuraeni et al., 2018). The ability to understand mathematics is interpreted by Sari et al (2016) as an individual's ability to master mathematical concepts, not just in memorization.

Indonesian student's globally are considered to have low mathematical understanding abilities. The 2018 PISA results issued by the U.S Department of Education (2018) placing the ability of Indonesian student's mathematical understanding to rank 73 out of 79 countries. The PISA mathematics test emphasizes mastery of processes, understanding concepts, and skills in different contexts (Oktaviyanthi et al., 2017). The low PISA ranking emphasizes the weakness of Indonesian student's mathematical understanding abilities which leads to difficulties in solving math problems. This condition is proven by the existence of research by Pancarita & Zainah (2019) who concluded that the low ability to understand mathematics was seen when student's had difficulty solving middle-high type math problems such as contextual questions. PISA results and Pancarita & Zainah's research show that there is an influence of mathematical understanding ability on the successful completion of contextual math problems.

The low ability of student's mathematical understanding could be seen from the test instruments used by the teacher as part of the learning assessment system. This could be done because the test instrument is part of the learning assessment system which is directly correlated with student abilities (Angriani et al., 2018). The use of appropriate test instruments could reveal student mathematical understandings abilities. In particular, the test instrument that is Low Order Thinking Skills (LOTS) with the C1-C3 Bloom taxonomy domain is considered ineffective for developing student's mathematical understanding abilities (Khan & Inamullah, 2011). Reflecting on the results of the 2018 PISA, Indonesian student's could only solve problems below level 2 which contain LOTS questions. These results generalize that Indonesian student's have difficulty solving questions above the LOTS which require in-depth analysis. Furthermore, these results also had an impact on Indonesian teachers who were considered to often train their student's using the LOTS test instrument (Wantoro et al., 2016).

The low ability of student's mathematical understanding was found by researchers in one of the private high schools in the Lampung area, science and social class grade XI. The observation results show the fact that the practice questions that teachers often use are LOTS questions. Furthermore, the results of the initial test given by the researcher to students of science and social class grade XI regarding the linear programming material showed that no students passed. The implementation of the initial tests on several student subjects which were examined from indicators of mathematical understanding indicated failure of translation or modeling indicators. Furthermore, interviews conducted with 3

students also revealed the fact that students had difficulty completing existing initial questions because they did not understand the material well.

The low ability of student's mathematical understanding could be overcome by repetition of the test instrument above the LOTS, namely contextual questions that are applied in science and social class grade XI. Pancarita & Zainah (2019) states that contextual questions could be used to assess a student's mathematical understanding ability. Furthermore, Anggraeni & Herdiman (2015) also stated that contextual questions included variations of HOTS questions in real situations which had the potential to encourage students to demonstrate mathematical understanding skills through reasoning, creative, and critical skills in solving problems. The ability of student's mathematical understanding in solving contextual problems could be measured by translation, interpretation, and extrapolation indicators. Therefore, the formulation of the problem in this study is how to implement contextual questions in helping student's mathematical understanding of science and social class grade XI. Using a descriptive qualitative method, this study aims to describe the implementation of contextual questions in assisting the mathematical understanding abilities of students in science and social class grade XI. With this formulation of the problem and objectives, the uniqueness of this research is the research conditions or environment, namely the combined science and social studies class, different from general research which only focuses on one major.

METHODS

This research was conducted using a qualitative descriptive method. Qualitative descriptive was chosen in the hope of being able to describe the mathematical understanding abilities of students which could be seen from the actions of each subject in solving contextual problems. The subjects of this study were 21 students of science and social class grade XI, 9 science and 12 social studies students. The school studied was a private high school in Gunung Agung District, West Tulang Bawang Regency, Lampung Province. Research data were collected through written tests and interviews. The written test was carried out 2 times, with the initial test being attended by 19 students and the retest being attended by 14 students. Inequality in the number of students on the initial test and retest is caused by the phenomenon of students who are not present when the initial test and retest are carried out. While interviews were conducted with 3 students after the test was carried out. To represent the class, 3 students were randomly selected for research. Each subject is denoted by the letters A, B, and C.

All of the test items used to test student's mathematical understanding abilities were prepared under the guidelines for preparing HOTS questions and established assessment principles. Guidelines for making HOTS questions include basic competency analysis, compiling grids, selecting problem backgrounds, creating questions, and making scoring guidelines (Widana, 2017). While the principle of assessment according to the Indonesian Ministry of Education and Culture (2017) is valid, objective, fair, integrated, open, comprehensive and sustainable, systematic, based on criteria, and accountable. This whole process is used by researchers to develop initial test instruments and retest.

The results of student test work were examined according to Anggoro's qualitative analysis procedure in Febrianti & Nurjanah (2022) which are as follows:

1. Compile data obtained from the results of tests and interviews
2. Provide sign data based on indicators (Table 1)
3. Studying and analyzing student's difficulties in taking tests based on test results and interview data
4. Determine student difficulties
5. Presenting data in a narrative manner

Susanti & Widadah (2018) said that three indicators of mathematical understanding ability are not mutually exclusive, namely translation, interpretation, and extrapolation. The translation is the skill of students in giving symbols, names, pictures, or models as a description of the problem; interpretation refers to the ability of students to interpret what is already known; extrapolation is the ability of students to conclude answers to problems (Wuryanti et al., 2020).

The understanding of Susanti and Widadah (2018) and Wuryanti et al (2020) could be summarized in the form of the following table.

Table 1. Indicator of Mathematical Understanding Ability

Indicator	Explanation
Translation	Students are able to translate real mathematical problems into mathematical language through modeling using symbols, names, or pictures
Interpretation	Students are able to determine and use mathematical concepts as a solution to problems
Extrapolation	Students are able to convey conclusions from a mathematical problem

RESULT AND DISCUSSION

In the written test, students as research subjects were checked for their initial mathematical understanding abilities by carrying out an initial test that contained 3 linear programming contextual math questions. The retest was given after the repetition of contextual questions in learning.

Analysis of making initial test questions and retesting

In this initial test, question number 1 is prepared with domain C3, while questions 2 and 3 are contextual questions with domain C4. While the retest was designed with numbers 1 and 2 with Bloom's taxonomy C3, while question 3 was a contextual question with C4. In particular, in this study, the focus of student work analysis was carried out on numbers 2 and 3 on the initial test and number 3 on the retest. This is because these questions are contextual mathematical problems. Jayanti et al (2018) argues that contextual questions are included in the problem-solving test which could train an individual's mathematical understanding abilities. With these characteristics, contextual questions need to be prepared with basic competency analysis, making grids, selecting backgrounds, creating questions, and scoring guidelines. The following is table 2 of making contextual questions for the initial test and retest.

Table 2. Making Contextual Questions for Initial Test and Retest

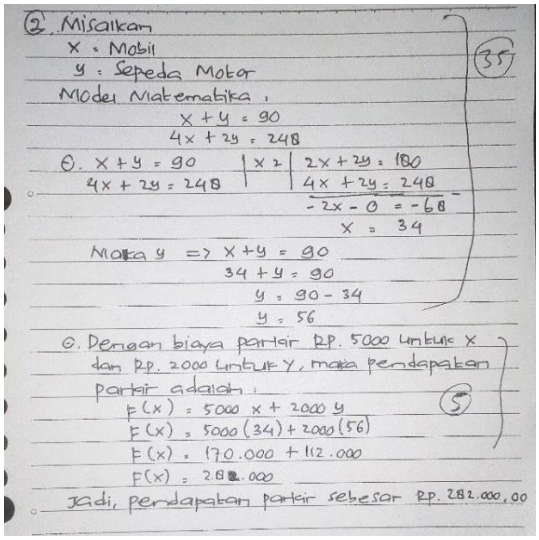
Basic Competency	Type	Grids	Backgrounds	Questions making	Scoring Guidelines
3.1 Explain linear programming two variables and methods the solution by using contextual problem	Initial test number 2 and 3	The contextual problem with domain C4. Completed with modeling, interpretation of elimination and substitution, and inference answer	Public and Family	*Figure 1*	*Figure 2*
3.1 Explain linear programming two variables and methods the solution by using contextual problem	Initial test number 3	The contextual problem with domain C4. Finished with modeling, interpretation of elimination and substitution, and inference answer	Public	*Figure 1*	*Figure 2*

The following presents questions on the initial test and retest:

2 Sebuah tempat parkir memiliki kapasitas 90 kendaraan baik untuk mobil maupun motor. Jika dihitung roda keseluruhan ada 248 kendaraan. Tentukanlah pendapatan uang parkir jika biaya parkir sebuah mobil adalah Rp. 5000,00 dan sebuah motor adalah Rp. 2000,00! 3 Selisih uang Adik dan kakak Rp10.000,00. Dua kali uang kakak ditambah uang adik berjumlah Rp40.000,00. Tentukanlah jumlah uang mereka !	**English Version:** **2.** A parking lot has a capacity of 90 vehicles (cars or motorbikes). If there are 248 vehicle wheels, determine parking fee income if the cost of parking a car is IDR 5000 and a motorbike is IDR 2000 **3.** The difference between a brother's and a sister's money is IDR 10,0000. Twice the brother's money plus the sister's money is IDR 40,000. Determine the amount of their money.
3. Perhatikan masalah berikut: Pedagang buah memiliki modal Rp 2.000.000,00 untuk membeli apel dan pisang untuk dijual kembali. Harga beli tiap kg apel Rp 4000,00 dan pisang Rp 3000,00. Tempatnya hanya bisa menampung 600 kg buah. A. Buatlah model matematika jika X adalah apel dan Y adalah pisang B. Tentukan nilai X dan Y (Note: Gunakan Eliminasi dan Substitusi)	**English Version:** **3.** Pay attention to the following problem: A fruit trader has IDR 2,000,000 to buy apples and bananas for resale. The purchase price for a kg of apple is IDR 4000 and for banana is IDR 3000. The place (basket) can only hold 600 kg of fruit. Determine: **A.** Make a mathematical model if x is an apple and y is a banana **B.** Determine the value of X and Y (use elimination and substitution)

Figure 1. Initial Test (above) and Retest (bellow)

While Figure 2 shows the scoring guidelines used in the initial test and retest:



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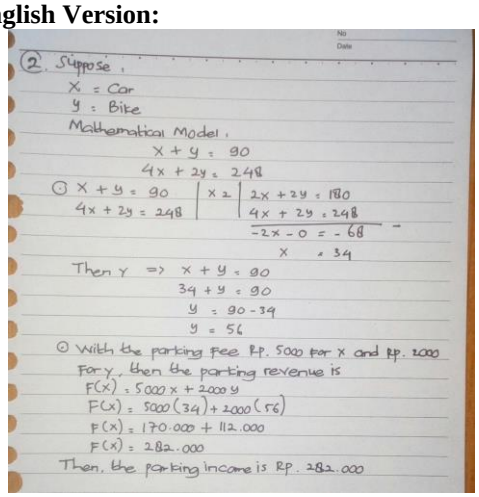

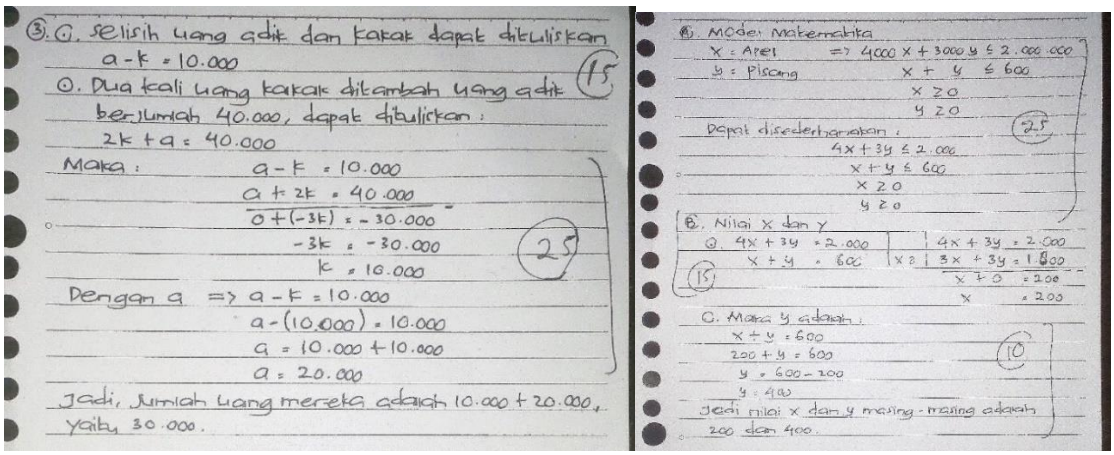

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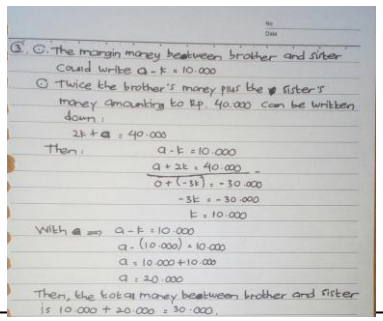


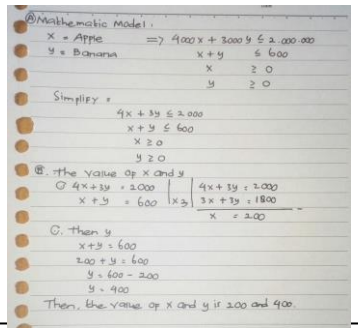
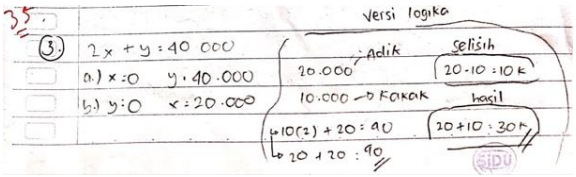


Figure 2. Scoring Guidelines for Initial Test and Retest

Analysis of student's difficulties in solving initial test questions number 2 and 3

The results of the work show that students have difficulty solving problems. Following are some of the results of working on questions 2 and 3 from subject A and subject B.



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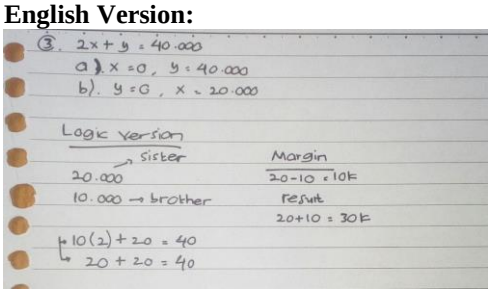
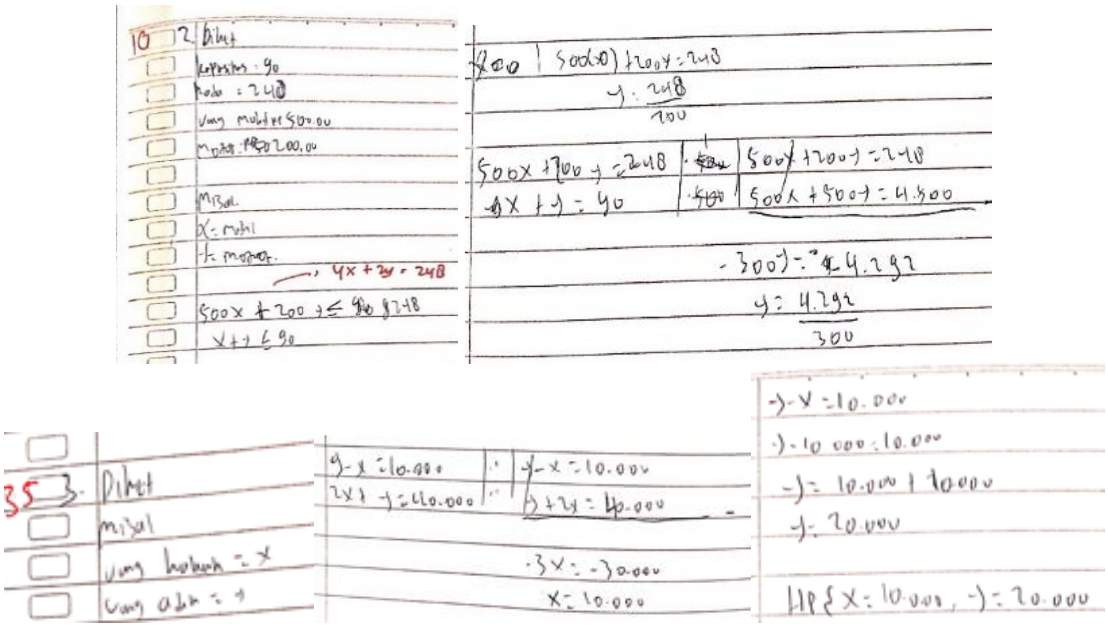


Figure 3. Answers Number 2 and 3 Subject A (left to right)



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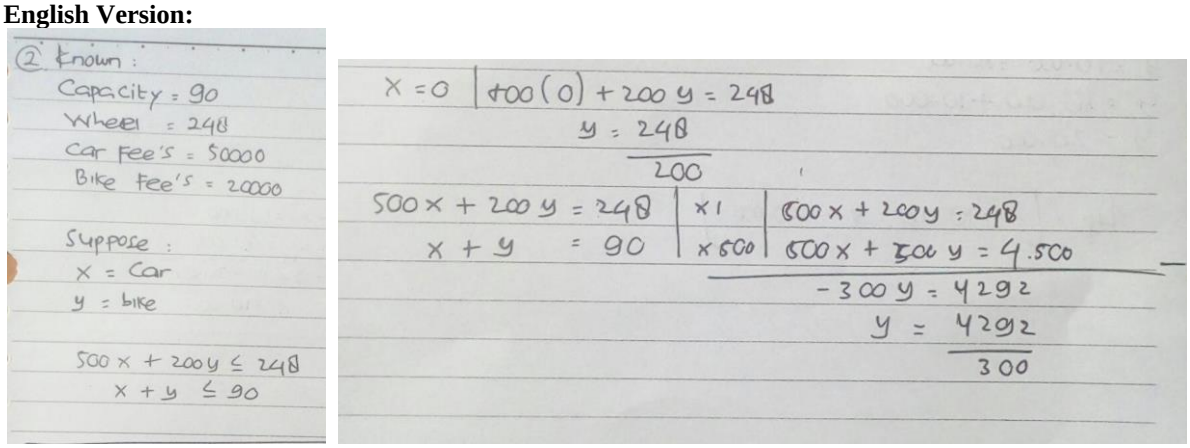


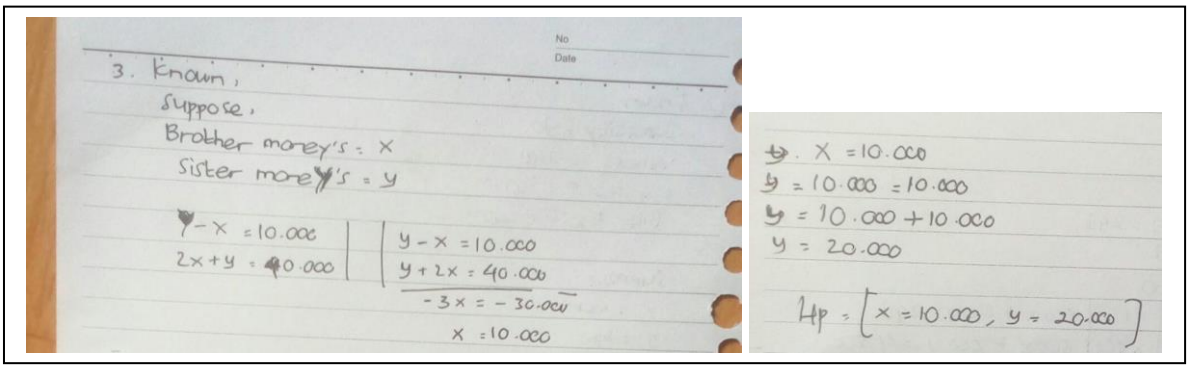


Figure 4. Answer Number 2 and 3 Subject B (above to bellow)

In Figure 3 it could be seen that subject A was not able to understand the context of questions number 2 and 3 properly so that the mathematical model made was not quite right. Another difficulty that could be seen from working on subject A number 2 is not being able to choose the right mathematical concept to solve the problem. Whereas in number 3, subject A experiences similar difficulties to number 2, but tries to find a solution with logic. These difficulties are further emphasized by interviews with subject A as follows:

Researcher : Out of all the initial test, which questions were the most difficult?

Subject A : Question number 2, sir, I don't understand the problem very well, sir. Especially the wheels of the vehicle, sir. I'm just thinking about X and Y, sir

Researcher : Did you succeed in making the mathematical model for numbers 2 and 3?

Subject A : No sir, I was wrong

Researcher : Especially number 3, I see you are using logic. Why?

Subject A : Because I'm sure that there are many solutions from mathematics, sir

From the written results and interviews, it was stated that subject A still failed in the indicators of ability to understand translation, interpretation, and extrapolation.

Whereas Figure 4 shows the ability of subject B who could already understand the context of the problem and could make an appropriate mathematical model from numbers 2 and 3. However, subject B is indicated to have difficulty interpreting the elimination and substitution of problem number 2 properly. Especially number 3, subject B seems to have been able to carry out the interpretation of elimination and substitution well, but was unable to conclude the answer as requested by the question. The difficulty of subject B is emphasized by interviews as follows.

Researcher : Out of all the initial test, which questions were the most difficult?

Subject B : Number 2 sir

Researcher : Why?

Subject B : I confused about how to understand the problem sir

Researcher : Are you having trouble making a mathematical model for question number 2?

Subject B : It's difficult, sir, especially in understanding the wheel for question number 2, sir

Researcher : How about number 3?

Subject B : I could do well, sir. I was wrong yesterday because I mistakenly drew conclusions

The results of the initial tests and interviews also showed that subject B failed in the indicators of ability to understand mathematical interpretation and extrapolation.

The following is a table of student difficulties based on the results of the analysis of initial test and interviews with subjects A and B as measured by indicators of mathematical understanding ability.

Table 3. Difficulties Experienced by Subjects A and B In the Initial Test

Research subject	Written test and interviews	
	Question number 2	**Question number 3**
A	1, 2, 3	1, 2, 3
B	2, 3	3

Information:

1 : Translation difficulties

2 : Interpretation difficulties

3 : Extrapolation difficulties

From Table 3 it is clear that the results of the analysis with indicators of mathematical understanding ability for 2 subjects in science and social class grade XI show a tendency for students to fail in the indicators of translation, interpretation and extrapolation. This result is supported by the subject having difficulty solving contextual questions in the tests conducted. The research data is in line with the opinion of Rahmawati & Roesdiana (2022) in his research which found the inability of Indonesian high school students to solve contextual problems as evidence of low ability to understand mathematics.

The difficulties experienced by subject A and subject B are sufficient to represent the low ability of mathematical understanding of science and social class grade XI. This is known from the existence of data supporting the initial test results of 19 students who noted the inability of all students to achieve a cut score, that is 70.

Repetition of contextual questions as a solution helps the mathematical understanding abilities of science and social class grade XI

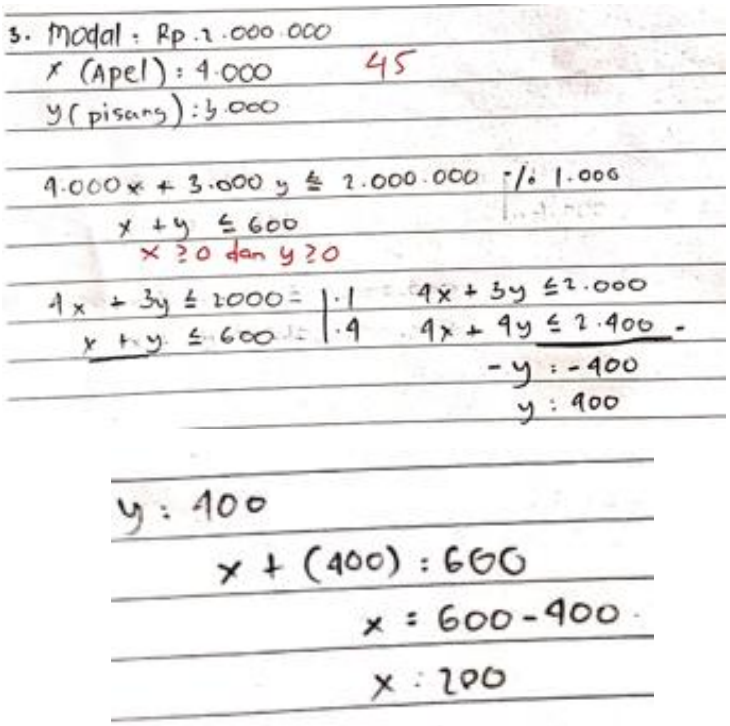
The efforts that researchers make to help student's mathematical understanding skills are by familiarizing students with solving contextual math problems. Habituation through repetition is an important factor because it could increase individual experience in dealing with mathematical concepts (Khotimah, 2019). In this study, repetition was carried out in two meetings with the hope that students would get used to understanding the flow of modeling, selecting concepts and calculations, and drawing conclusions as part of the indicators for solving contextual problems. Repetition of contextual questions is provided through examples, exercises, and homework. Here are examples, exercises, and homework given to students.

SPtLDV Dalam Kehidupan Suatu jenis makanan ternak membutuhkan 5 kg daging dan 3 kg tepung. Makanan ternak jenis lain membutuhkan 6 kg daging dan 8 kg tepung. Telah diketahui tersedia daging 60 kg dan tepung 48 kg. Gambarlah daerah penyelesainnya !	**English Version:** A type of fodder requires 5 kg of meat and 3 kg of flour. Another type of fodder requires 6 kg of meat and 8 kg of flour. It is known that 60 kg of meat and 48 kg of flour are available. Draw the solution area!
Luas daerah parkir adalah 1760 m^2. Luas rata-rata mobil kecil adalah 4 m^2 mobil besar adalah 20 m^2. Daya tampung maksimun parkiran adalah 200 kendaraan dan daya tampung mobil kecil adalah Rp. 1.000,00/jam dan mobil besar 2.000,00/jam. Jika dalam satu jam terisi penuh dan tidak ada mobil keluar masuk, hitunglah pendapatan maksimunnya!	**English Version:** The area of the parking area is 1760 m^2. The average area of a small car is 4 m^2 and the large cars is 20 m^2. The maximum parking capacity is 200 vehicles and the price of parking for a small car is IDR 1000/hour and a large car is IDR 2000/hour. If in one hour it is fully charged and there are no cars in and out, calculate the maximum revenue.
1. Gambarlah daerah penyelesaian dari: $3x - 2y < 12$ 2. Gambarlah daerah penyelesaian dari masalah berikut: Pedagang ikan memiliki modal Rp. 10.000.000,00 untuk membeli jaring dan bambu. Harga beli tiap jaring Rp 3.000.000,00 dan bambu Rp 1.000.000,00. Tempatnya hanya bisa menampung 50 buah jaring maupun bambu.	**English Version:** **1.** Draw the solution area from: $3x - 2y < 12$ **2.** Draw a solution to the following problem: Fish traders have a capital of IDR 10,000,000 to buy nets and bamboo. The purchase price for each net is IDR 3,000,000 and for bamboo IDR 1,000,000. The place can only accommodate 50 nets or bamboo.

Figure 5. Examples, Exercises, and Homework

Analysis of student's difficulties in completing the retest on question number 3

The results of the retest showed that students experienced significant changes. The following are the results of work of subjects A and C on the retest conducted.



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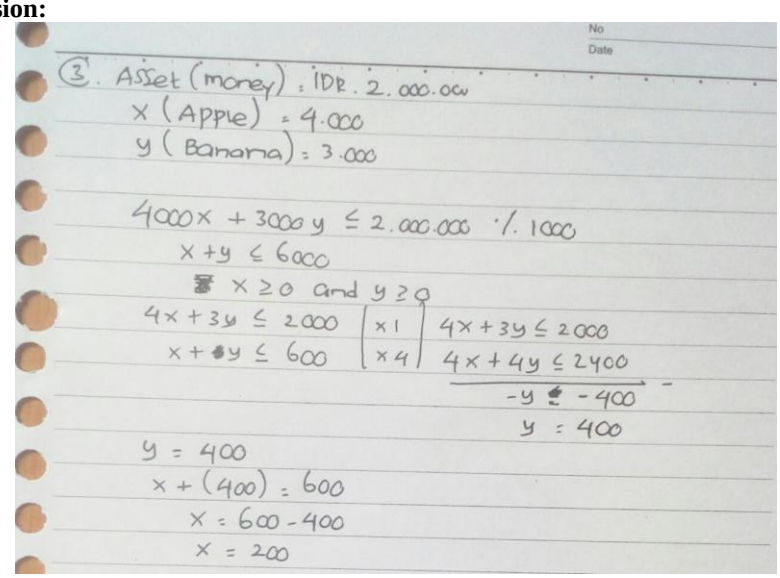

Figure 6. Results of Work Number 3 Subject A

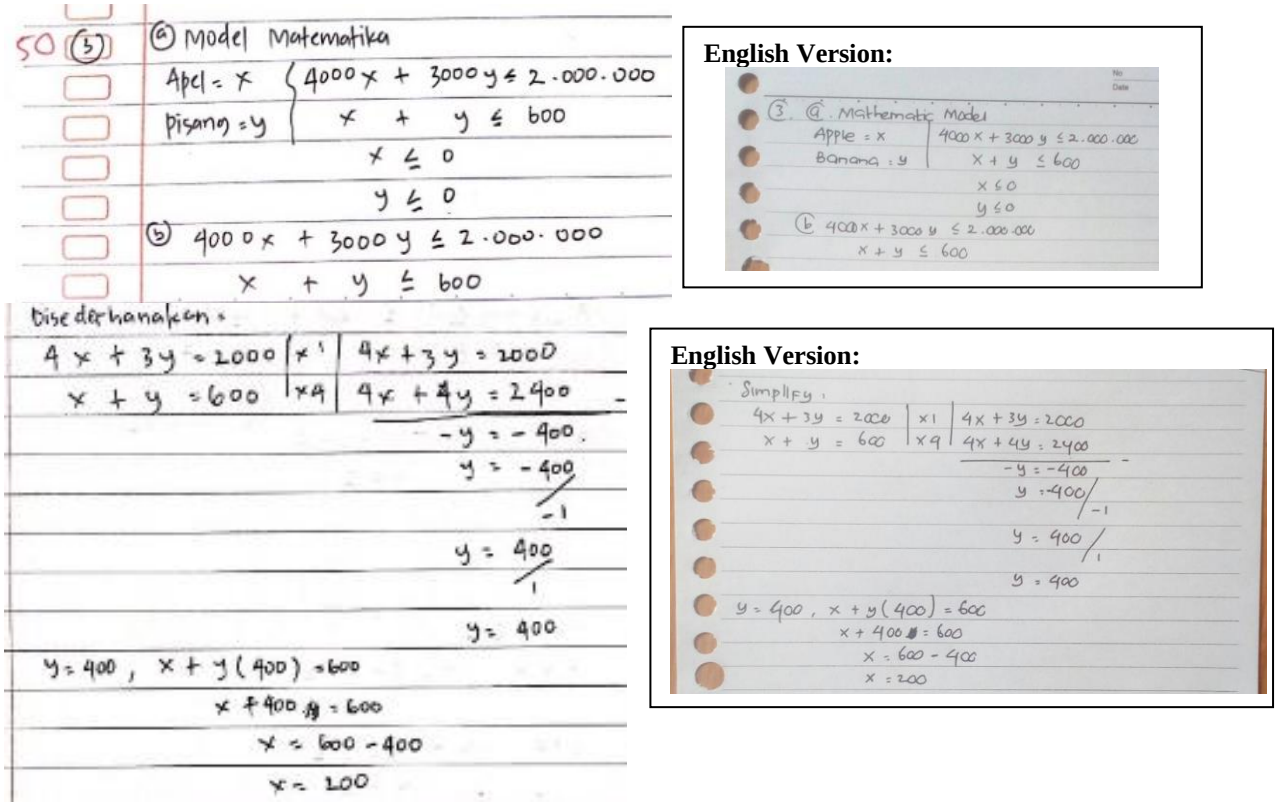

Figure 7. Results of Work Number 3 Subject C

In Figure 6 it could be seen that subject A has understood the context of question number 3 well. Subject A could make an example by assuming the variables x as apples and y as bananas. From the existing examples, subject A could already do mathematical modeling. Furthermore, subject A also seems to have used mathematical concepts and operated them correctly. In this context, the mathematical concepts used are elimination and substitution to find the values of the x and y variables, respectively. Finally, subject A could also conclude answers according to the question's request, namely concluding x and y are worth 200 and 400 respectively.

Through interviews with subject A, it was also discovered that there were changes in subject A behavior and understanding when working on contextual questions:

Researcher : Through all the retest questions, which one is the most difficult?

Student : Number 3 is a bit tricky, sir

Researcher : Could you solve the mathematical question number 3?

Student : I could do it sir

Researcher : How about elimination and substitution in problem 3b?

Student : I could still do it, sir

Figure 7 shows the results of retesting number 3 from subject C. It could be seen that the subject was able to model mathematical problems correctly. Subject C is also seen to be able to perform elimination and substitution operations and calculations correctly, to find the answer key.

The following are the tabel of mathematical understanding abilities of subjects A and C which are reviewed using translation, interpretation, and extrapolation indicators

Table 4. Student Ability to Complete Retest

Research subject	Written test and interview
	Question number 3
A	1, 2, 3
C	1, 2, 3

Information:

1 : Could do the translation

2 : Could do the intrepetation

3 : Could do the extrapolation

The ability to solve contextual question number 3 from subjects A and C as a result of the ability to understand mathematics is also experienced by students in science and social class grade XI. This is shown by the results of the retest which was attended by 14 students of science and social class grade XI with the results is 12 students passing and only 2 students failing.

In general, the analysis carried out showed that there was a change in the ability of science and social class grade XI in solving contextual questions after the repetition of contextual questions in learning. This development was supported by an increase in the sample indicator level, from only being able to carry out translations to being able to carry out translation, interpretation, and extrapolation indicators. Therefore, the use of HOTS contextual questions compiled with educational assessment guidelines influences student's mathematical understanding abilities. In addition, the preparation of contextual questions could also help the teacher's understanding and skills in compiling HOTS-based questions (Riadi, 2021). Therefore, the actions taken by the teacher have a positive impact on both students and teachers.

CONCLUSION

Based on the research, it could be concluded that the low ability of student's mathematical understanding of science and social class grade XI is caused by student's

limitations in solving contextual problems in learning. The implementation of contextual questions with real backgrounds in learning is regularly proven to be able to help student's mathematical understanding abilities at the levels of translation, interpretation, to extrapolation. Concrete actions that need to be carried out by the teacher include repetition of giving contextual questions through examples, exercises, homework, to tests carried out. Based on the existing findings, educational institutions are advised to monitor the use of assessment instruments prepared by teachers. Teachers are also advised to increase the use of contextual questions in learning. Teachers could also independently learn to compose HOTS contextual questions and according to the Indonesian Ministry of Education and Culture's assessment guidelines.

ACKNOWLEDGMENTS

Big thank you to Pelita Harapan University and also the school which has allowed researchers to conduct research in a private school in the Lampung province.

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