AlphaMath
Journal of Mathematics Education, 7(2) November 2021

Mathematical Reasoning of Vocational High School Students on Mathematical Tasks in the Law of Demand Context

Ai Tusi Fatimah*
Program Studi Pendidikan Matematika, Universitas Galuh Ciamis, Indonesia
*aitusifatimah@unigal.ac.id

ABSTRAK

Penelitian ini bertujuan untuk menggambarkan kemampuan penalaran matematis siswa Sekolah Menengah Kejuruan (SMK) Bidang Keahlian Bisnis dan Manajemen dalam menyelesaikan tugas matematis dengan konteks masalah hukum permintaan. Penelitian ini menggunakan metode kualitatif deskriptif. Partisipan terdiri dari enam siswa dari salah satu SMK di Kabupaten Ciamis, Indonesia. Tugas matematis dirancang untuk menggali kemampuan penalaran matematis siswa dalam situasi hukum permintaan. Hukum permintaan adalah konsep yang telah dipelajari pada Mata Pelajaran Ekonomi Bisnis. Situasi tugas kemudian diperluas sebagai alternatif penyelesaian tugas yang lebih bersifat prosedural matematis. Data diperoleh dari hasil jawaban siswa, hasil wawancara, dan rekaman video. Analisis data mengacu pada karakteristik penalaran matematis yang terdiri dari penalaran imitatif (mengingat, algoritmik) dan kreatif. Hasil analisis data menunjukkan bahwa siswa cenderung melakukan penalaran imitatif. Siswa cenderung mengingat formula hukum permintaan dan melakukan prosedur matematis yang diingatnya. Siswa juga seringkali melakukan prosedur matematis yang kurang sesuai dengan sifat matematika.

Kata kunci: hukum permintaan, penalaran imitatif, penalaran kreatif

ABSTRACT

This study aims to describe the mathematical reasoning abilities of vocational high school students in the business and management expertise in solving mathematical tasks in the law of demand context. This research uses the descriptive qualitative method. The participants consisted of six students categorized into three groups: high, medium, and low mathematical abilities. Participants from one of the vocational schools in Ciamis, Indonesia. Mathematical tasks to explore students' mathematical reasoning abilities in the law of demand context. The law of demand is a concept in business economics subjects. The task situation expanded as an alternative to solving more mathematical tasks—data from the results of student answers and interviews. Data analysis refers to the characteristics of mathematical reasoning, which consists of imitative and creative reasoning. The stages of data analysis are reduction, presentation, interpretation, inference, and verification. The results of data analysis show that all students tend to do imitative reasoning on each given task. Students tend to remember the law of demand formulas and perform mathematical procedures that they remember. Students often perform mathematical procedures that are not by the nature of mathematics so that the resulting solution is wrong. The law of demand questions designed to explore creative reasoning abilities has not been able to bring students to the flow of creative mathematical reasoning.

Keywords: creative reasoning, imitative reasoning, the law of demand

Received: 2021-05-30 / Accepted: 2021-11-06 / Published: 2021-11-15

Introduction

Lithner (2008) researched reasoning on mathematical tasks. Analysis of mathematical reasoning on the tasks given to students shows that students tend to do reasoning that is limited to mathematical concepts that are remembered and encountered (Lithner, 2000a). In general, the task completion strategies carried out by students tend to be dominated by reasoning based on experience while specifically influenced by sound reasoning. (Lithner, 2000b). Reasoning by identifying commonalities is found in many tasks that are training (Lithner, 2003). Reasoning that makes global sense is more likely to be difficult for students compared to reasoning that makes local sense or reasoning by identifying similarities (Lithner, 2004). Based on the results of these studies, finally, Lithner (2008) put forward the characteristics of mathematical reasoning in solving mathematical tasks into two major parts, namely creative and imitative reasoning.

Lithner's studies also show that the type of mathematical task influences students' reasoning. It is supported by Boesen et al. (2010). His research shows that when students are faced with tasks such as in a textbook, students solve them by trying to remember facts or algorithms. On the other hand, task tests outside of textbooks mostly elicit creative mathematical reasoning. Therefore, it is clear that the nature of the task affects the characteristics of the mathematical reasoning that students perform when solving the tasks.

Lithner (2017) provides a way of designing tasks based on reasoning, namely memory, algorithmic, and creative reasoning. In this study, mathematical tasks are designed to facilitate all types of reasoning classified by Lithner. A task in an unusual situation in learning mathematics but familiar in learning students' vocational competencies. The task is designed in the context of the law of demand. This task is used to see how environmental experiences influence the completion of mathematical tasks. Lithner (2008) revealed that reasoning results from a thinking process influenced by student competence and the environment.

Understanding the law of demand is a competency that must be possessed by vocational high school students in business and management Skills class X. In the Business Economics subject, there are basic competencies that students must possess from knowledge and skills. The basic competence is to understand the law of demand, supply, the concept of elasticity, and market equilibrium prices.

In Indonesia, vocational high school is a formal education pathway that prepares students, especially to work in certain fields. As a consequence of this goal, the integration of theory and practice becomes very important (Inglar, 2014) in every subject matter in vocational high schools. Mathematics is one of the national content subjects studied in SMK. In particular, vocational mathematics has a great contribution to the world of work. Vocational mathematics aims to prepare students for certain careers or develop existing jobs (Bakker, 2014). The scope of vocational mathematics education is to prepare students to continue their education or work skills, ranging from simple jobs to professions (FitzSimons, 2014).

Reasoning is an important aspect in dealing with the complexities of the world of work. FitzSimons & Björklund Boistrup (2017) state that problems in the workplace require mathematical calculations, reasoning, speed, and accuracy of problem-solving, as well as considering relevant contextual knowledge in making decisions. Mathematics often enters and blends in various vocational contexts in various forms. Bakker et al. (2014) refer to it as a black box. In the case of this study, the mathematical concept merges into the concept of the law of demand. The law of demand is the most basic economic theory in economic theory. Based on historical developments, economic theories show that the essential constituents of the economy are the law of demand, utility functions, production functions, and general equilibrium (Aruka, 2015).

In this mathematical task, mathematical concepts are integrated with the law of demand. It is done to train students' thinking processes in an integrated manner. In addition, the integration of academic and vocational materials was offered in response to efforts to make mathematics learning meaningful and interesting for all students and assist in preparing a mathematically literate workforce (Nicol, 2002).

p-ISSN 2477-409X, e-ISSN: 2549-9084 and website: http://jurnal nasional.ump.ac.id/index.php/alphamath/

Mathematical tasks with the context of the law of demand are aimed at exploring deeper into the mathematical reasoning performed by vocational students in business and management expertise in solving tasks in the context of the law of demand. Thus, this study aims to describe students' mathematical reasoning abilities in solving mathematical tasks in the context of the law of demand.

Methods

This research uses the descriptive qualitative method. The description of the ability to understand mathematical reasoning is carried out on the mathematical thinking process of students while completing the task of the law of demand context. Participants consisted of six students from Vocational Schools in Business and Management, three students in grade ten, and three students in grade eleven. Participants were selected from each group of students with high, medium, and low mathematical abilities. The grouping is based on the average results of mathematics tests that students have carried out. The selection of students based on class and mathematical ability is done not to see the effect of mathematical ability on mathematical reasoning but to see an overview of the reasoning of students from various classes and mathematical abilities who have studied the concept of the law of demand. Participants' names were coded ENF, LC, YL, RMR, TA, and NO. The tenth-grade students consist of ENF, LC, and YL. The eleventh-grade students consist of RMR, TA, and NO. YL and NO are students with high mathematical ability, ENF and RMR are students with moderate mathematical ability. LC and NO are students with low mathematical abilities.

Tasks are designed to define the demand function. This task situation does not exist in mathematics textbooks and has never been given by a mathematics teacher. This task situation is expected to bring up students' mathematical creative reasoning abilities. This mathematical task in the context of the law of demand is referred to as the initial task. The tasks are as follows:

The law of demand states: “if the price of good increases, the quantity demanded per unit of time will decrease. On the other hand, if the price of goods decreases, the quantity demanded per unit of time will increase. Table 1 below presents an example of the number of requests for goods and the price of an item that represents the law of demand.

Table 1. Demand for Goods at Various Price Levels

Number of Demand	Price
100	50000
200	40000
300	30000
400	20000
500	10000

Next, the researcher anticipates the task if the student cannot complete the initial task. Additional situations guide students in a mathematical method and procedure they have learned in mathematics class. The topic is a two-variable system of linear equations. The reason for choosing this topic is because the topics of the law of demand and systems of linear equations are both studied in the tenth grade of the first semester.

Through the expansion of this task, students are expected to know, connect, transition, and adapt mathematical concepts to the law of demand. Thus, the expansion of the task is intended to allow students to apply procedures in new situations (Johnson et al., 2017). The nature of this task is algorithmic, which allows students to perform imitative reasoning. The expansion of mathematical tasks in the context of the law of demand is as follows:

Table 1 can be represented in graphical form (with Cartesian coordinates). We can relate it to the knowledge of Cartesian coordinates that we have learned in junior high school. The Cartesian coordinate system consists of horizontal lines (X-axis) and vertical lines (Y-axis). The location of a point in Cartesian coordinates is represented by a pair of points (x,y) with x abscissa and y ordinate. In this case, we can make Cartesian coordinates with the horizontal axis (P-axis) and vertical axis (Q-axis). The pair of points (p, q) consists of five pairs of points, as shown in Figure 1 below.

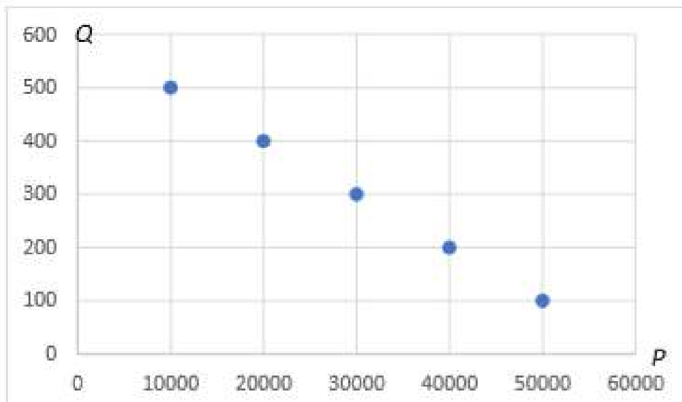

Figure 1. Cartesian Coordinates of Demand for Good X at Various Price Levels

Mathematically the concept of demand is often expressed as a demand function. Since each member of P has a pair in Q and each member of P is paired with exactly one member of Q, the pair of P and Q is called a function. In this case, it is called the demand function, which Qd denotes. Based on Figure 1, if a pair of Cartesian products are connected, a linear curve is formed to produce a linear function.

The demand function is usually written as:

$$Q_d = -bP + a\,,\ a,b \in \mathrm{R} \qquad (1)$$

b is the slope, and a is the intercept.

Next, we will define a demand function based on the data in Table 1 or Figure 1 by specifying the values of a and b. For example, we take any two points (p, q), namely (10000,500) and (30000,300), then we substitute them into equation (1). What can you get? Determine the values of a and b to get the demand function (1).

Mathematical tasks are given to students. After the students finished their assignments, the researcher conducted interviews. Interview questions focused on how students got ideas in

p-ISSN 2477-409X, e-ISSN: 2549-9084 and website: http://jurnal nasional.ump.ac.id/index.php/alphamath/

solving the task, connecting mathematical concepts, and experience completing the task. Through this question, the researcher will see how the competence and experience of students can support reasoning so that they can determine the type of reasoning carried out by students. While the students were working on the assignment, the researcher recorded (video) with the students' permission.

The stages of data analysis consist of reduction, presentation, interpretation, inference, and verification—data from answer sheets and transcripts of student interviews. At the data reduction stage, the answer sheets were analyzed to determine the flow of students' completion of the initial and expansion tasks. On the other hand, interview transcripts were analyzed, and any answers were selected that supported the students' reasons on the answer sheet. At the presentation stage, the data were described based on the initial and the expansion tasks. The data make to interpret to determine the type of mathematical reasoning.

Students' reasoning was identified using the Lithner (2008) framework, divided into imitative reasoning (remembering and algorithmic) and creative reasoning. Recall reasoning satisfies the criteria: strategy selection is based on remembering complete answers, strategy implementation consists only in writing it down. Algorithmic reasoning meets the criteria: the choice of strategy is to remember the solution algorithm. There is no need to create new solutions. The criteria of creative reasoning (1) creativity (students create sequences of reasoning that have not been experienced before or recreated); (2) plausibility (there are predictive arguments that support the choice of strategy and arguments for verification, explain why the application of strategies and conclusions are true or reasonable; (3) anchoring (arguments based on the intrinsic mathematical nature of the reasoning component.) Student competencies consist of mathematical and business economics.

The final stage of data analysis is inference and verification. The conclusion obtained is a description of the mathematical reasoning abilities of SMK students from the tenth and eleventh-grade are categorized into high, medium, and low mathematical abilities in completing mathematical tasks in the context of the law of demand problem. Verification of the results of data analysis was carried out to see the objectivity of the research results through focus group discussions with the mathematics teacher who taught the six students.

Results and Discussion

Students' answer sheets on the initial task show that students tend to choose learning experiences in the Business Economics Subject to complete the task. Students try to remember the formula to determine the demand function and then write it down. Various forms of formulas were written by each student, as shown in Figure 2.

Four students (ENF, LC, RMR, TA) only wrote down the formula. Based on the interview, it is known that the four students failed to understand the question. They assume that what is asked in the question is to write the formula. They are only fixated on remembering the formula. On the other hand, NO does not write anything on the answer sheet at all. He kept remembering the formula but still failed to remember it.

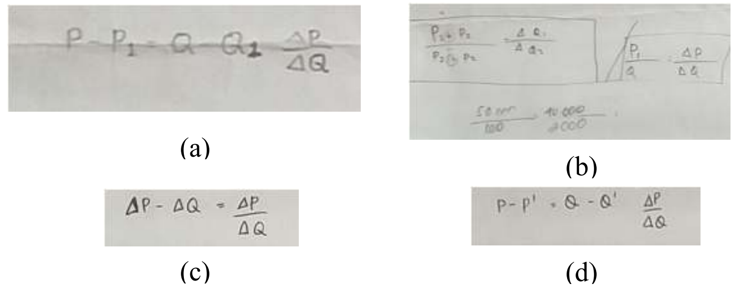

Figure 2. Respons: (a) ENF (b) LC (c) RMR (d) TA

If we observe the formulas in Figure 2, all students focus on the formula,

$$\frac{P-P_1}{Q-Q_1}=\frac{P_2-P_1}{Q_2-Q_1} \tag{2}$$

with $P_2-P_1=\Delta P$ dan $Q_2-Q_1=\Delta Q$.

So that it can be written,

$$\frac{P-P_1}{Q-Q_1}=\frac{\Delta P}{\Delta Q} \text{ or } P-P_1=(Q-Q_1)\frac{\Delta P}{\Delta Q} \tag{3}$$

Based on the tracing, the formula in Figure 2 (sections a and d) is used to determine the given demand function in business economics. The formula adopts a formula to determine the equation of a straight line of two variables that students have learned at the junior high school level. In the interview section, the researcher also asked students about the idea of completing the task. The following are the answers from each ENF, LC, RMR, TA, and NO student.

ENF : "From the first time I read the questions, I was reminded of the business economics lesson because I had studied it. Then, what is being asked here is the formula, the formula for the demand function, so I just wrote the formula."

LC : "A business economics teacher taught this kind of problem."

RMR : "In my opinion, why am I answering this because as I recall, it was a class 10 lesson, learning about deltas, but I forgot the formulas".

TA : "I remember the demand formula that I learned in class X."

NO : "I'm confused as to what to do..., I forgot..."

Unlike his five friends, YL wrote down formulas and performed a series of mathematical procedures. Based on the recorded video, initially, YL wrote a formula like a formula in Figure 2b. Then he looks thoughtful and reminisces, then changes the "less" sign to "plus" on the left side of the formula. A few moments later, YL decided to change the formula. YL continued to look doubtful. In his doubts, YL decided to continue his work by applying the data into formulas. As seen in Figure 3, YL performs several mathematical procedures. Even though

p-ISSN 2477-409X, e-ISSN: 2549-9084 and website: http://jurnal nasional.ump.ac.id/index.php/alphamath/

there is a correct mathematical procedure, the inconsistent writing formulas have resulted in YL not completing the task.

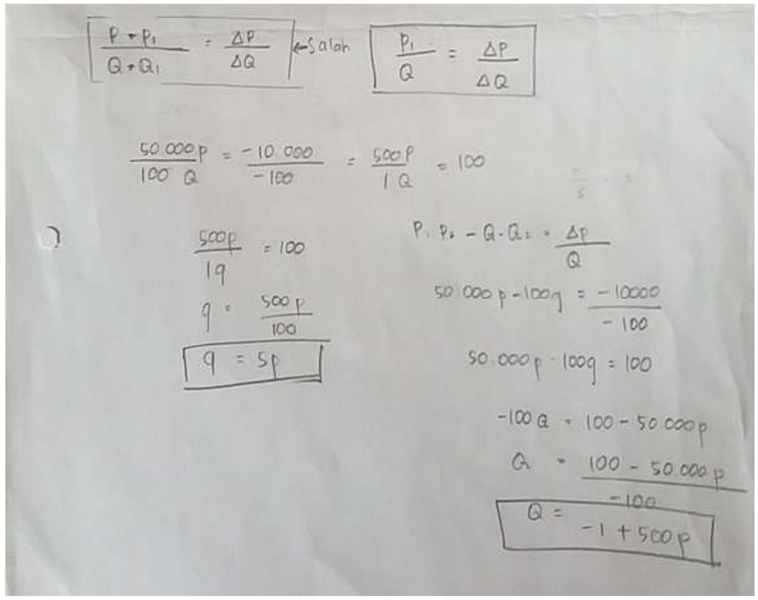

Figure 3. YL's response

Next, the researcher interviewed YL to find out the thinking process in solving the task. The following is an excerpt from the interview.

YL : "This P1 (referring to Table 1), which is the price per price of the first item when Rp 50,000 and Q when the number of requests is 100, then delta P is the difference between the initial price and the second price if delta Q is the difference between the number of requests for the first and the second number of requests. After counting, the number of requests is -1+500P".

Based on the worksheets and interviews, YL does not seem to understand the meaning of the demand function. However, YL can remember some mathematical procedures. YL tried hard to remember the completion procedure that the business economics subject teacher had given. Thus, YL's thought process is heavily influenced by business economics learning.

Based on the facts that the researchers obtained, the six students have not been able to complete the given task. The tendency to remember the formulas given by the Business Economics teacher prevents students from using their reasoning creatively to complete assignments. Thus, students' reasoning can be categorized as imitative reasoning.

In the next stage, the researcher also gave an expansion of the task to the six students. This situation is an alternative to get the demand function. As described in the previous section, the expansion of the task is expected to inspire students that many mathematical tools can be used to obtain the demand function. Furthermore, students can understand the demand function from a mathematical point of view.

The task situation was chosen to relate the concept of a two-variable system of linear equations and the law of demand. Both concepts are studied in the same semester. In addition, the system of linear equations of two variables has also been studied at the junior high school level. Thus, the design of the extended task will be advantageous for both subjects to facilitate the hybrid nature in vocational mathematics as proposed by Bakker (2014). Pay attention to Figures 4 to 9. The pictures are the results of students' answers to the expansion of the task.

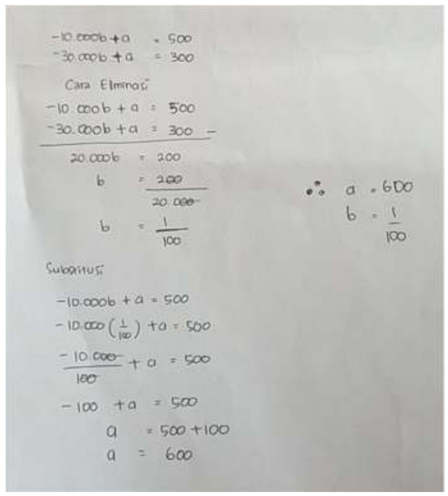

Figure 4. YL Task Expansion Response

Figure 4 shows that YL created a system of linear equations as instructed in the task. YL chose an elimination strategy. To get a solution, YL performs a series of procedures based on mathematical properties. Finally, YL managed to determine the values of a and b correctly. Based on the interview, YL has mastered the concept of a two-variable system of linear equations.

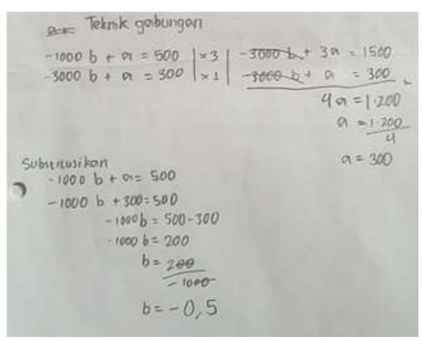

Figure 5. ENF Task Expansion Response

Figure 5 shows that ENF creates a system of linear equations as instructed in the assignment. Coefficients and constants do not match the questions given. The procedure for solving the

p-ISSN 2477-409X, e-ISSN: 2549-9084 and website: http://jurnal nasional.ump.ac.id/index.php/alphamath/

system of equations has not been carried out properly. Therefore, ENF cannot solve the problem correctly.

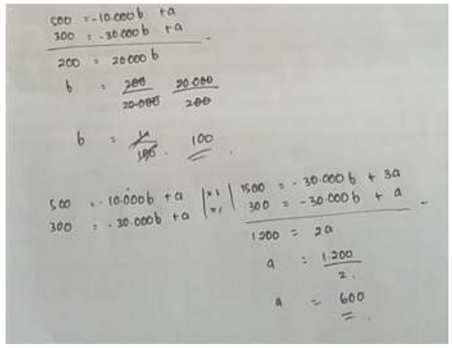

Figure 6. TA Task Expansion Response

Figure 6 shows that TA creates a system of linear equations as instructed in the task. However, TA made carelessness in carrying out the procedure so that the b value obtained was not correct. Based on the interview results, it is known that TA understands the concept of a system of linear equations.

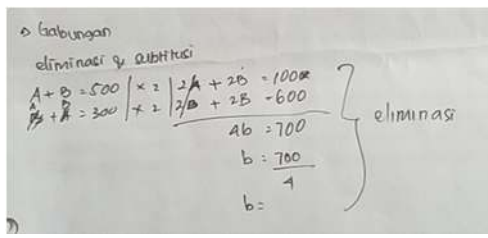

Figure 7. LC Task Expansion Response

Figure 7 shows that LC has not been able to create a system of linear equations according to the context of the problem. The figure also shows that LC has not mastered the concept of linear equations in two variables. Based on the interview, LC has not mastered the concept of a system of linear equations.

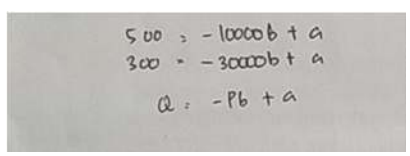

Figure 8. RMR Task Expansion Response

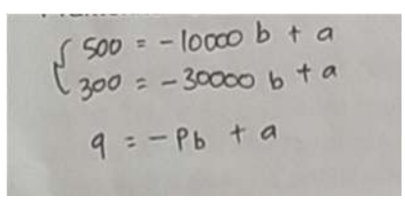

Figure 9. NO Task Expansion Response

Figures 8 and 9 show that RMR and NO appear to create a system of linear equations as ordered in the assignment. RMR and NO do not perform any procedures on the answer sheet. Based on the interview, it is known that RMR forgot about the concept of linear equations because they had not studied it for a long time.

Characteristics characterized by students in completing the expansion task are algorithmic type imitative reasoning. The solution to the expansion problem can easily adopt the procedure for solving a two-variable system of linear equations. Characteristics characterized by students in completing the task is algorithmic reasoning. Lithner (2008) states that the implementation of strategies with algorithmic reasoning is easy for students. The cause of incorrect answers is the carelessness of students in carrying out a series of procedures.

Some things are forgotten by students in solving problems because all students are fixated on determining the values of *a* and *b*. they forgot the original purpose of the problem, which was to determine the formula for the demand function based on the data in Table 1. They forgot to apply the values of *a* and *b* in equation (1).

The researcher also tried to ask about the form of function (1) of the six students. "Can you explain the relationship form function (1) and the law of demand?". RMR said that the demand function is linear. TA states that a represents the slope and b represents the point of intersection of the graph. YL states that the demand function is influenced by the price offered. ENF, LC, and NO do not provide any explanation.

Finally, the researcher asked the students to get views about the task situation and the extent of the task. Here are the answers from each student.

LC : "I prefer to solve tasks with a two-variable system of linear equations."

YL : "Doing the first task must remember the formula, while the latter is easier because it works with a two-variable linear equation system."

ENF : "If it's done, in my opinion, the first question is easier because it uses the available formula."

TA : "If the first one has to remember the formula, if the formula is wrong, the next work will be wrong. The second one is easy because you just have to follow the instructions."

NO : "I can't solve all the problems. I'm confused. Can't remember anything."

RMR : "Both are difficult."

The results of student answers and interviews that have been presented show that students with high, medium and low abilities tend to do imitative reasoning. Initial questions aimed at exploring students' creative reasoning abilities still tend to produce imitative reasoning lines. It can be identified from students remembering formulas and remembering solution algorithms. In solving tasks, students tend to use their experience derived from the Business Economics subject. Reasoning based on experience is known as established experiences (Lithner, 2000, 2003), reasoning based on existing experience from the learning environment, which may be mathematically shallow. It shows that the experience gained from the learning environment

p-ISSN 2477-409X, e-ISSN: 2549-9084 and website: http://jurnal nasional.ump.ac.id/index.php/alphamath/

greatly affects students' reasoning. It is in line with the research results of Fatimah et al. (2019), which states that agricultural vocational students who are given problems in horticultural agribusiness help students reasoning in solving tasks. The context of the task by students' experience and knowledge supports students' mathematical reasoning (Fatimah & Prabawanto, 2020; Khoeriyah & Ahmad, 2020). It is clear that the task's context according to the student's environment affects reasoning in completing a task.

Learning environments can provide long-term or short-term benefits for students. Imitative learning produces short-term benefits, while creative learning will produce long-term learning (Lithner, 2008). The learning environment can affect competence. Competence is the ability to understand, assess, perform, and use mathematics in various mathematical contexts and situations (Niss, 2003). Competence emphasizes the integration of knowledge, skills, and attitudes (Abrantes, 2001). The knowledge of the law of demand can be integrated into mathematics learning, such as the situation in this task. This kind of integration provides an experience that students can do and use mathematics in various contexts.

It is time for learning in vocational high schools to prioritize integration and assembling various subject competencies to support students in facing the rapidly and unexpectedly changing world of work. The merging of strengths (knowledge, experience, and practice comprehensively) is intended to avoid fragmentation when theory and practice are developed separately (Acedo & Hughes, 2014). In addition, mutual integration between subjects will train students to face "black box" situations that require students to quickly and precisely decide the strategies used to solve them.

In this study, we can see that the learning environment greatly affects students' competence. Student competence affects the thinking process. Finally, the thought process will affect students' reasoning.

Conclusion

The mathematical task situation designed in this study's law of demand problem can only lead to imitative reasoning. In the initial questions, students with high, medium, and low mathematical abilities only remember the formulas given in business economics lessons. Most students are unaware of how the formula for the demand function that they have memorized is implemented in a given task. Only one student from grade ten has high mathematical ability who can solve the problem and get the right solution. In the expansion of the assignment, all students can create a two-variable linear system of equations. Students with moderate and low abilities do not understand the complete procedure and make careless in carrying out the procedure, so they cannot complete it properly. Students with high mathematical ability tend to be able to solve it correctly.

As an implication of this research, the development of learning in vocational high schools should continue to be carried out considering the challenges of the growing world of work that require students' adaptation in solving various problem contexts in the workplace. Therefore, mathematics as a national content subject studied in all areas of expertise must strive for students to adapt to the field of expertise with the competencies they have. Mathematical reasoning is one way to make it happen by strengthening mathematical concepts.

Students will benefit through task design that connects mathematical competencies in areas of expertise because these two competencies will interpret each other. The design of mathematical tasks with imitative reasoning in the context of students' areas of expertise can be the beginning of playing vocational mathematics as a transition between mathematics and the field of expertise. However, the development of tasks for creative reasoning is a further effort that must be realized immediately to help students face an increasingly complex world of work.

References

Abrantes, P. (2001). Mathematical competence for all: Options, implications, and obstacles. *Educational Studies in Mathematics*, *47*(2), 125–143. https://doi.org/10.1023/A:1014589220323

Acedo, C., & Hughes, C. (2014). Principles for learning and competencies in the 21st-century curriculum. *Prospects*, *44*(4), 503–525. https://doi.org/10.1007/s11125-014-9330-1

Aruka, Y. (2015). The Historic Design of the Demand Law and Its Reconstruction. In *Evolutionary Foundations of Economic Science. Evolutionary Economics and Social Complexity Science, vol 1* (1st ed., pp. 35–64). Springer.

Bakker, A. (2014). Characterizing and developing vocational mathematical knowledge. *Educational Studies in Mathematics*, *86*(2), 151–156. https://doi.org/10.1007/s10649-014-9560-4

Bakker, Arthur, Groenveld, D., Wijers, M., Akkerman, S. F., & Gravemeijer, K. P. E. (2014). Proportional reasoning in the laboratory: An intervention study in vocational education. *Educational Studies in Mathematics*, *86*(2), 211–221. https://doi.org/10.1007/s10649-012-9393-y

Boesen, J., Lithner, J., & Palm, T. (2010). The relation between types of assessment tasks and the mathematical reasoning students use. *Educational Studies in Mathematics*, *75*(1), 89–105. https://doi.org/10.1007/s10649-010-9242-9

Fatimah, A. T., & Prabawanto, S. (2020). Mathematical understanding and reasoning of vocational school students in agriculture-based mathematical tasks. *Journal for the Education of Gifted Young Scientists*, *8*(2), 701–712. https://doi.org/10.17478/JEGYS.702884

Fatimah, A. T., Pramuditya, S. A., & Wahyudin, W. (2019). Imitative and creative reasoning for mathematical problem solving (in context horticultural agribusiness). *Journal of Physics: Conference Series*, *1157*(4). https://doi.org/10.1088/1742-6596/1157/4/042092

FitzSimons, G. E. (2014). Commentary on vocational mathematics education: Where mathematics education confronts the realities of people's work. *Educational Studies in Mathematics*, *86*(2), 291–305. https://doi.org/10.1007/s10649-014-9556-0

FitzSimons, G. E., & Björklund Boistrup, L. (2017). In the workplace mathematics does not announce itself: towards overcoming the hiatus between mathematics education and work. *Educational Studies in Mathematics*, *95*(3), 329–349. https://doi.org/10.1007/s10649-017-9752-9

Inglar, T. (2014). Proficiency forms and vocational pedagogical principles. *JISTE*, *18*(2), 30–40. https://files.eric.ed.gov/fulltext/EJ1087570.pdf

Johnson, H. L., Coles, A., & Clarke, D. (2017). Mathematical tasks and the student: navigating "tensions of intentions" between designers, teachers, and students. *ZDM - Mathematics Education*, *49*(6), 813–822. https://doi.org/10.1007/s11858-017-0894-0

Khoeriyah, D. A. N., & Ahmad, A. (2020). Penerapan Model Pembelajaran Problem Solving Dengan Pendekatan Saintifik Pada Kemampuan Penalaran Matematis Siswa Kelas VIII B SMP Negeri 1 Padamara. *AlphaMath : Journal of Mathematics Education*, *6*(1), 62. https://doi.org/10.30595/alphamath.v6i1.7943

Lithner, J. (2000a). Mathematical reasoning and familiar procedur. *International Journal of Mathematical Education in Science and Technology*, *31*(1), 83–95.

p-ISSN 2477-409X, e-ISSN: 2549-9084 and website: http://jurnal nasional.ump.ac.id/index.php/alphamath/

https://doi.org/10.1080/0020739950260101

Lithner, J. (2000b). Mathematical reasoning in task solving. *Educational Studies in Mathematics*, *41*(2), 165–190. https://doi.org/10.1023/A:1003956417456

Lithner, J. (2003). Students' mathematical reasoning in university textbook exercises. *Educational Studies in Mathematics*, *52*(1), 29–55. https://doi.org/10.1023/A:1023683716659

Lithner, J. (2004). Mathematical reasoning in calculus textbook exercises. *Journal of Mathematical Behavior*, *23*(4), 405–427. https://doi.org/10.1016/j.jmathb.2004.09.003

Lithner, J. (2008). A research framework for creative and imitative reasoning. *Educational Studies in Mathematics*, *67*(3), 255–276. https://doi.org/10.1007/s10649-007-9104-2

Lithner, J. (2017). Principles for designing mathematical tasks that enhance imitative and creative reasoning. *ZDM - Mathematics Education*, *49*(6), 937–949. https://doi.org/10.1007/s11858-017-0867-3

Nicol, C. (2002). Where's the math? prospective teachers visit the workplace 1. *Educational Studies in Mathematics*, *50*, 289–309.

Niss, M. (2003). Mathematical Competencies and the Learning of Mathematics : the Danish Kom Project. *Proceedings of the 3rd Mediterranean Conference on Mathematical Education*, 115-124.