Research Article

Analysis of Students' Mathematical Communication Ability in Solving Algebra Problems by Considering Initial Ability and Habits of Mind

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Abstract.

Communication skills are one focus of learning mathematics. However, facts in the field show that students' mathematical communication skills are still relatively low. This study aims to describe the mathematical communication abilities of 7th-grade students at SMP Negeri 9 Surakarta in solving algebra problems, viewed from initial ability and habits of mind. It employs a qualitative method with a descriptive approach. The subjects of this study consist of 8 students selected by using a purposive sampling technique. We conducted data collection through questionnaires, tests, and interviews. The researchers tested the data validity using the triangulation method and analyzed them by reducing them on mathematical communication abilities, presenting them in descriptive form, and drawing conclusions. The result of data analysis showed that: 1) Students with high initial ability and high habits of mind can effectively explain mathematical ideas in writing, visually, and through mathematical models. 2) Students with high initial ability and low habits of mind are quite able to explain mathematical ideas in writing and can explain mathematical ideas in visual form but are less able to explain them through mathematical models. 3) Students with low initial ability and high habits of mind are quite able to explain mathematical ideas in writing and visually but are less able to explain them through mathematical models. 4) Students with low initial ability and low habits of the mind are less able to explain mathematical ideas in writing, quite able to explain mathematical ideas in visual form, and unable to explain them through mathematical models. This study provides new insights into students' mathematical communication abilities, helping schools, teachers, parents, and students improve these skills.

Keywords: mathematical communication ability, initial ability, habits of mind, algebra

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1. INTRODUCTION

Mathematics is one of the exact sciences that studies language so that students can communicate their ideas both verbally (orally) and non-verbally (writing)(1). According to the Ministry of National Education Regulation (Permendiknas), one of the goals of learning mathematics is to have the ability to communicate ideas using symbols, tables, or diagrams to clarify situations or problems. This goal aligns with the general

objective of mathematics education formulated by the National Council of Teachers of Mathematics (2), which states that one of the goals of learning mathematics is to learn to communicate (mathematical communication). Baroody explains two important reason why communication is a focus in mathematics education. First, mathematics essentially functions as a language for itself. Second, learning mathematics is a social activity that involves at least two parties: the teacher and the students, as well as interaction among the students (3).

Field facts show that mastery of mathematical abilities is still low. According to the Programme for International Student Assessment (PISA) report, students have not yet been able to achieve levels 4-6, which are related to mathematical communication (4). The low mathematical communication skills of Indonesian students are due to their inability to analyze and communicate mathematical ideas in mathematics learning [1,5]. The low mathematical communication skills of students are due to their inability to convey ideas, construct arguments well, and represent problems in the form of symbols, diagrams, or mathematical models (6).

In line with the preliminary study conducted by the researcher in class VIII of SMPN 9 Surakarta, it was found that most students had difficulty solving algebra problems in the form of word problems. The students' abilities to represent known information in mathematical models (equations and diagrams), use mathematical symbols, and perform algebra operations were lacking. Additionally, most of the learning conducted was teacher-centered, resulting in one-way communication from the teacher only. Consequently, students had little opportunity to speak and express their mathematical thoughts, hindering the development of communication skills as they were less able to communicate mathematical ideas during mathematics learning.

Mathematical communication skills refer to the ability of students to express and interpret mathematical ideas orally, in writing, in the form of tables, diagrams, figures, formulas, or demonstrations (7). This aligns with the opinions of Ramellan and Musdi, as cited in Ikhtiar et al. (2021), who states that mathematical communication is the process of students clearly expressing mathematical ideas to peers, teachers, and others, both orally and in writing (8). Indicators have also been developed by researchers, one of which is mentioned by the Ontario Ministry of Education, as cited in Hikmawati et al. (2019). There are three indicators of mathematical communication skills (9):

1. Written text: explaining mathematical ideas, situations, and relationships in writing. The written text includes:

a. Identifying known information in the problem.

b. Identifying what is being asked in the problem.

c. Writing the strategy ideas for solving the problem in their own words accurately and understandably.

d. Explaining ideas using mathematical terms.

2. Drawing: explaining mathematical ideas visually (Figures, tables, or diagrams). Drawing includes:

a. Presenting situations, ideas, or solutions to mathematical problems accurately and clearly in the form of drawings.

3. Mathematical expressions: explaining ideas, problem situations, Figures, or real objects into symbolic language, mathematical models/expressions. Mathematical expressions include:

a. Stating ideas and situations using mathematical models, and language/notation accurately and completely.

b. Using all available information in the problem accurately.

c. Concluding accurately.

The focus of this research is on:

1. Written text: including writing the information found in the problem, writing ideas or solutions to mathematical problems using their own words accurately, and constructing conclusions with correct arguments using their own words.

2. Drawing: presenting ideas, situations, and solutions to mathematical problems in the form of Figures, tables, or diagrams accurately.

3. Mathematical expression: presenting ideas and situations using mathematical models, evaluating ideas using symbolic/mathematical notation accurately.

Algebra is the generalization of arithmetic ideas related to statements with variables and unknown values to solve problems (10). Problems that can be solved with algebra are not only abstract issues but also everyday life problems in various contexts.

Initial mathematical ability is the cognitive skill that students have before they take the mathematics lessons to be given and is a prerequisite for students in learning new or advanced lessons (11). Students with good initial ability will understand the material more quickly compared to students who do not have initial ability during the learning process. This can help in the application of mathematical communication during mathematics learning. This aligns with the research conducted by (12), which shows that

there is a significant direct influence between initial ability and students' mathematical communication skills. Thus, mathematical communication skills, supported by students' initial ability, will be better realized.

Habits of mind are the characteristics of what someone does when faced with questions or problems whose solutions are not easily known (13). Habits of mind represent the highest level of educational outcomes. Research conducted by Gunawan cited Ilmi et al., (2022) concluded that there is an influence on the improvement of mathematical communication skills among students with high, medium, and low habits of mind. Students with high habits of mind show better improvement in mathematical communication skills than students with medium habits of mind. Students with medium habits of mind show better improvement than those with low habits of mind (14).

The habits of mind indicators used in this research are the 16 indicators developed by Costa & Kallick, as cited in (15), which include:

1. Persisting: perseveres in completing tasks and does not give up easily.

2. Managing impulses: thinks before acting, remains calm, and considers actions carefully.

3. Listening with understanding and empathy: Accepts others' viewpoints and shows empathy.

4. Thinking flexibly: open to changing thoughts based on additional information.

5. Metacognition: plans strategies and outlines steps for problem-solving.

6. Striving for accuracy: demonstrates greater caution in tasks, aiming for high standards and precise results.

7. Questioning and problem posing: uses questions as tools to aid in problem-solving.

8. Applying past knowledge to new situations: utilizes knowledge and experience to tackle new challenges.

9. Thinking and communicating with clarity and precision: strives for clear and accurate communication, both orally and in writing.

10. Gathering data through all senses: seeks and collects data using all senses-taste, touch, smell, hearing, and sight.

11. Creating, imagining, and innovating: approaches problem-solving from different perspectives.

12. Responding with wonderment and awe: works enthusiastically and joyfully, with a high level of curiosity.

13. Taking responsible risks: faces failure without fear and takes risks responsibly.

14. Finding humor: uses humor to diffuse tension within a group.

15. Thinking interdependently: enjoys group learning and is open to feedback from peers with critical viewpoints.

16. Remaining open to continuous learning: acknowledges there is much more to learn and is unafraid to seek further knowledge.

To the best of the author's knowledge, most previous studies on communication abilities have predominantly used quantitative research methods [7, 16, 3, 17]. Therefore, this study will analyze students' mathematical communication abilities using a qualitative method. Additionally, from previous research, the author has not found studies that discuss students' mathematical communication abilities in terms of initial ability and habits of mind. The importance of this study lies in its potential to provide new insights into students' mathematical communication abilities. This will aid various stakeholders, such as schools, teachers, parents, and students, in their efforts to enhance students' communication skills.

Based on the explanation, an analysis of students' mathematical communication skills in terms of initial ability and habits of mind in solving algebra problems is necessary. This research aims to describe the mathematical communication abilities of Grade VII students at SMP Negeri 9 Surakarta at various levels of initial ability and habits of mind in solving algebra problems.

2. METHOD

This research was descriptive qualitative research. Research using this method aims to describe the conditions that occur during the research. This research was conducted at SMP Negeri 9 Surakarta for the 2023/2024 academic year. The research subjects were seventh-grade on the algebra material. The sampling technique in this study is purposive sampling. The subjects of this study were 8 students of class VII.

During this research, the data collection methods were documentation, questionnaire, interview, and test. The data was collected by three instruments i.e. (1) a habits of mind questionnaire consisting of 28 statements, (2) a mathematical communication ability test consisting of three problems where each problem contains three questions to measure each indicator of mathematical communication ability, and (3) interview guidelines. Instrument validity in this research was content validity which was obtained

from expert judgment. The data procedure began by collecting initial ability data in the form of USBN mathematics scores, distributing habits of mind questionnaires, and testing mathematical communication ability to the subject of research. Grouping the initial mathematical ability levels of 7th-grade A students based on their USBN mathematics scores. The student's initial ability category and habits of mind category were adopted based on the category proposed by Annurwanda & Friantini presented in **Table 1** and **Table 2** (18).

TABLE 1: Initial Ability Category.

Interval	Category
Score $\geq \mu_1$	High initial ability
Score $< \mu_1$	Low initial ability

Where μ_1: average USBN mathematics score

Grouping the levels of mathematical habits of mind for 7th-grade A students.

TABLE 2: Mathematical Habits of Mind Category.

Interval	Category
Questionnaire Score $\geq \mu_2$	High initial ability
Questionnaire Score $< \mu_2$	Low initial ability

Where μ_2: average questionnaire score

Based on the data of the initial ability and habits of mind questionnaire, students were divided into four groups according to the following criteria.

TABLE 3: Identify Table 1 and Table 2.

Kategori	Label
Hight Initial ability and High Habits of Mind	HH
Hight Initial ability and Low Habits of Mind	HL
Low Initial ability and High Habits of Mind	LH
Low Initial ability and Low Habits of Mind	LL

Then, the data on initial ability, data on habits of mind, and data on mathematical communication ability were analyzed by mathematics communication ability indicators. They were such as 1) Written text: including writing the information found in the problem, writing ideas or solutions to mathematical problems using their own words accurately, and constructing conclusions with correct arguments using their own words. 2) Drawing:

presenting ideas, situations, and solutions to mathematical problems in the form of Figures, tables, or diagrams accurately. 3) Mathematical expression: presenting ideas and situations using mathematical models, evaluating ideas using symbolic/mathematical notation accurately. The following is a rubric for analyzing answers to the mathematical communication skills test used by researchers.

Table 4: Rubric For Analyzing Answers to The Mathematical Communication Skills Test.

Indicators of Mathematical Communication	**Ability Results of Analysis of Answers to the Mathematical Communication Ability Test**			
	Able	**Quite Able**	**Less Able**	**Unable**
Explain mathematical ideas, situations and relationships in writing. (Written Text)	Students can explain the information contained in the question. Students can write mathematical ideas according to the problem. Students can write conclusions correctly.	Students can explain the information contained in the question. Students can write mathematical ideas according to the problem. Students can write conclusions correctly but the arguments are incorrect.	Students can explain the information contained in the question. Students can write down some mathematical ideas according to the problem Students are unable to write conclusions.	Students are unable to explain the information contained in the question. Students are not able to write mathematical ideas according to the problem. Students are unable to write conclusions.
Explaining mathematical ideas in visual form (drawings, tables, or diagrams)	Students can present problems in the form of pictures along with information about the sizes correctly.	Students can present problems in the form of pictures but the size information is not accurate.	Students can present problems in the form of images without size information.	Students can not present problems in the form of pictures.
Explaining ideas, and problem situations from Figures or real objects into symbols, mathematical models/expressions	Students are able to express situations using mathematical models. Students are able to evaluate ideas using mathematical formulas/notation correctly.	Students are able to express situations using mathematical models. Students are unable to evaluate ideas using mathematical formulas/notation.	Students are able to express some situations using mathematical models. Students are unable to evaluate ideas using mathematical formulas/notation.	Students are not able to express situations using mathematical models. Students are unable to evaluate ideas using mathematical formulas/notation.

3. RESULTS AND DISCUSSIONS

The study is undertaken to respond to the research query on how incorporating Fuzzy Multi-Criteria Decision Making (FMCDM) into Rapid Application Development (RAD)

influences the decision-making process and the overall quality of developing the Intellectual Property Information System. The specific focus is on the Intellectual Property Information System at the State Polytechnic of Banjarmasin.

3.1. Initial ability Data

The study was conducted in class VII A with a total of 28 students. Students were asked to fill out a form to record their USBN mathematics scores. The form was filled out online using Google Forms. The data was then processed, resulting in an average score of $\mu_1 = 82,33$. The grouping criteria for high and low initial ability were determined as follows:

Table 5: Initial Ability Grouping Criteria.

USBN Score Range	Category
$\mu_1 \geq 82,33$	High initial ability
$\mu_1 < 82,33$	Low initial ability

Based on the initial ability grouping, 15 students were classified as having high initial ability, and 13 students were classified as having low initial ability . The results of the initial ability grouping for class VII A students are shown in **Table 6**.

Table 6: Initial Ability Grouping Results for Class VII A Students.

Category	Student Initials	Number of Students
High	AGPR, AFA, C, FEP, JJS, KN, MRV, NH, QAZ, RPB, SMM, SUP, TAZ, WIM, YOCP	15
Low	AP, AZ, CTO, DJP, EMPV, FML, FPTS, GNCM, KCG, NNS, NSK, RANA, VEP	13
Total		28

3.2. Habits of Mind Data

Students were given a habits of mind questionnaire consisting of 28 items, with 18 positive statements and 10 negative statements. The Habits of Mind questionnaire was administered to 28 students of class VII A at SMP Negeri 9 Surakarta on Monday, April 29, 2024. The questionnaire was filled out in person, beginning with an explanation of how to complete it provided by the researcher.

The data was then processed, resulting in an average score of $\mu_2 = 86$. The grouping criteria for high and low habits of mind were determined as follows:

Table 7: Habits of Mind Grouping Criteria.

Score Range	Category
$\mu_2 \geq 86$	High habits of mind
$\mu_2 < 86$	Low habits of mind

Based on this grouping, 12 students were classified as having low habits of mind, and 16 students were classified as having high habits of mind. The results of the habits of mind grouping for class VII A students are shown in **Table 8**.

Table 8: Habits of Mind Grouping Results for Class VII A Students.

Category	Student Initials	Number of Students
High	AFA, C, DJP, EMPV, FML, FEP, KN, MRV, NSK, NNS, QAZ, RANA, SMM, SUP, TAZ, YOCP	16
Low	AP, AZ, AGPR, CTO, FPTS, GNCM, JJS, KCG, NH, RPB, VEP, WIM	12
Total		28

3.3. Initial ability and Habits of Mind

Based on the initial ability and habits of mind questionnaire results, the students were grouped as **Table 9**.

Table 9: Initial Ability and Habits of Mind Grouping Criteria.

Category	Label
Hight initial ability and high habits of mind	HH
Hight initial ability and low habits of mind	HL
Low initial ability and high habits of mind	LH
Low initial ability and low habits of mind	LL

Based on **Table 9, 10** students had the high initial ability and high habits of mind, 5 students had high initial ability and low habits of mind, 6 students had low initial ability and high habits of mind, and 7 students had low initial ability and low habits of mind. The results of the initial ability and habits of mind grouping for class VII A students are shown in **Table 10**.

TABLE 10: Initial ability and Habits of Mind Grouping Results for Class VII A Students.

Category	Student Initials	Number of Students	Label
High initial ability and high habits of mind	AFA, C, FEP, KN, MRV, QAZ, SMM, SUP, TAZ, YOCP	10	HH
High initial ability and low habits of mind	AGPR, JJS, NH, RPB, WIM	5	HL
Low initial ability and high habits of mind	DJP, EMPV, FML, NSK, NNS, RANA	6	LH
Low initial ability and low habits of mind	AP, AZ, CTO, FPTS, GNCM, KCG, VEP	7	LL

Based on **Table 10** two research subjects will be selected from each category, resulting in a total of 8 students as research subjects. The selection was based on USBN scores, habits of mind questionnaire results, and test results, which were discussed with the mathematics teacher. The students chosen as research subjects are as follows:

a. High initial ability and high habits of mind

1) Student with initials FEP, USBN score 97,25 and habits of mind score 95 labeled HH1.

2) Student with initials KN, USBN score 84,82 and habits of mind score 86, labeled HH2.

b. High initial ability and low habits of mind

1) Student with initials NH, USBN score 83,38 and habits of mind score 80 labeled HL1.

2) Student with initials WIM, USBN score 84,5 and habits of mind score 81 labeled HL2.

c. Low initial ability and high habits of mind

1) Student with initials NNS, USBN score 70,66 and habits of mind score 90 labeled LH1.

2) Student with initials RANA, USBN score 72 and habits of mind score 88 labeled LH2.

d. Low initial ability and low habits of mind

1) Student with initials AZ, USBN score 70,38 and habits of mind score 78 labeled LL1.

2) Student with initials CTO, USBN score 75,08 and habits of mind score 85 labeled LL2.

3.4. Analysis of Mathematical Communication Skillsbility and Habits of Mind

The presentation of the data analysis results in this study aims to provide an overview of the mathematical communication skills in each category of initial ability and habits of mind. The analysis was conducted on the test results of communication skills and interview data, followed by method triangulation on both data sets to obtain valid data.

Here is an explanation of the communication ability test questions and their indicators:

a. Written text: In question 1a the problem involves describing the number of tiles used to form a rectangular area using their language. In question 3b the problem involves writing a conclusion about the weight of fruits from the lightest to the heaviest.

b. Drawing: In question 2 b the problem involves presenting mathematical ideas in the form of a drawing with correct size annotations.

c. Mathematical expression: In question 1b and 1c the problem involves expressing the description of the number of tiles using a mathematical model and being able to find the solution for the number of tiles for a specific square size. In question 2a and 2c there was a problem of expressing the length and width of Mr. Anwar's land using a mathematical model and then evaluating the idea using formulas/mathematical notation correctly. In question 3a and 3c there was a problem of expressing the weight of the fruits using a mathematical model and then evaluating the idea using mathematical notation correctly to find the weight of the fruits.

Below is the analysis of the mathematical communication skills data for each subject in each category of initial ability and habits of mind.

a. Data Analysis for High Initial Ability and High Habits of Mind

1. Explaining mathematical ideas, situations, and relationships in written text

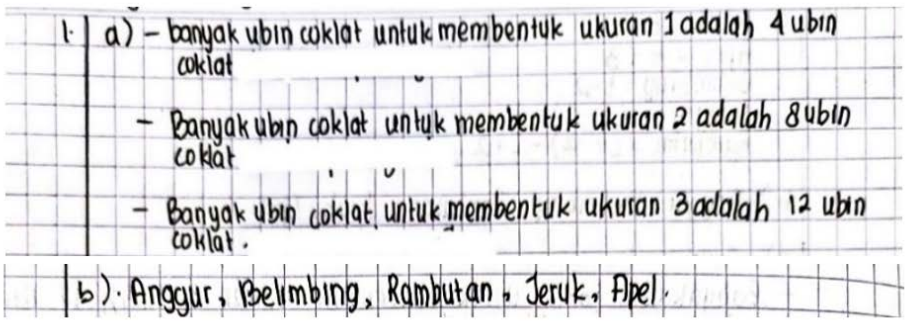


Figure 1: Result of Test Question 1a and 3b Subject HH1.

Based on the same analysis, the results of the communication ability test of subject HH2 were the same as subject HH1. Based on the test results and interview excerpts for question number 1a, it is evident that subjects HH1 and HH2 clearly understand the information in the question. They expressed the available information through a diagram accompanied by the sizes labeled as size 1, size 2, and size 3. They could write mathematical ideas according to the problem. Figure 3.1 in the diagram describes the number of tiles used to form a rectangular area. Subjects HH1 and HH2 could utilize the information in the diagram, resulting in the description that the number of tiles to form a rectangular area of size 1 is 4 tiles, size 2 is 8 tiles and size 3 is 12 tiles.

Based on the test results and interview excerpts for question number 3b, it can be seen that subjects HH1 and HH2 clearly understand the information in the question. Subjects HH1 and HH2 can explain the information known and what is being asked in the question. Subjects HH1 and HH2 could write a conclusion about the weight of the fruit from lightest to heaviest. Figure 1, shows how the subject wrote the order of the fruits from lightest to heaviest: grapes, starfruit, rambutan, orange, and apple. Based on this, it is evident that subjects HH1 and HH2 can explain mathematical ideas, situations, and relationships in written text.

2. Explaining mathematical ideas in visual form (drawings, tables, or diagrams)

Based on the same analysis, the results of the communication ability test of subject HH2 were the same as subject HH1. The test results and interview excerpts for question number 2b show that subjects HH1 and HH2 accurately presented the problem in the form of a drawing. We can observe this in Figure 2. The sketch of the shape is according to the problem. Subjects HH1 and HH2 were able to analyze the information in the question, recognizing that the shape of Pak Anwar's land is a rectangle. They assume bamboo with x. They were able to indicate the correct dimensions on the drawing, writing that the length of the land is $5x - 2$ and the width is $3x + 2$. Based on this, it is evident that subjects HH1 and HH2 can explain mathematical ideas in visual form (drawings, tables, or diagrams).

3. Explaining ideas, and problem situations from figures or real objects into symbols, mathematical models/expressions

Based on the same analysis, the results of the communication ability test of subject HH2 were the same as subject HH1. Based on the test results and interview excerpts for question number 1b, we can see that subjects HH1 and HH2 described the situation

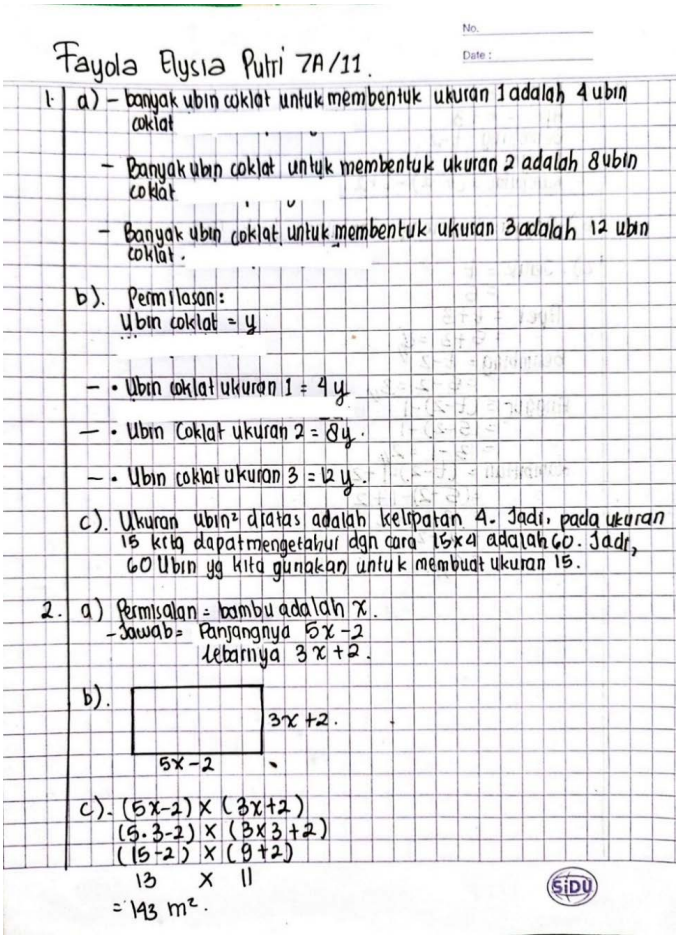


Figure 2: Result of Test Question 2b Subject HH1.

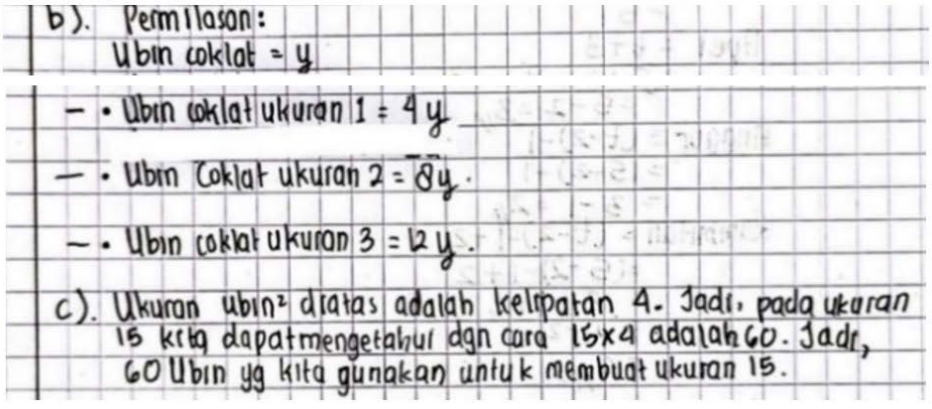


Figure 3: Result of Test Questions 1b and 1c Subject HH1.

using a mathematical model and evaluated the idea using mathematical notation correctly. Figure 3 shows this. The subjects first assumed the brown tiles. Then they wrote down the algebra form of the brown tiles at each size, size 1 is $4y$, size 2 is $8y$, and size 3 is $12y$. The subjects utilized the information in the question well, identifying the

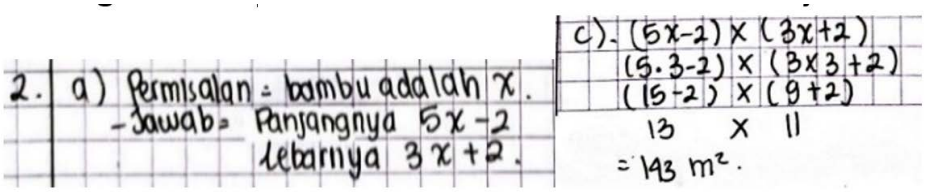


Figure 4: Result of Test Questions 2a and 2c Subject HH1.

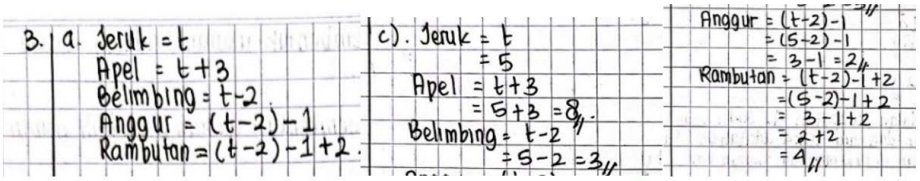


Figure 5: Result of Test Questions 3a and 3c Subject HH1.

difference in the number of tiles for each size, recognizing that the size of the tiles is a multiple of 4, and then using this to find that the number of tiles for size 15 is 60 tiles.

In test questions 2a and 2c, subjects HH1 and HH2 were able to create a situation using a mathematical model and evaluate the idea using formulas/mathematical notation correctly. It is evident from Figure 4. The subject first assumed the bamboo and then modeled the length and width of the land land as $5x - 2$ and $3x + 2$. Subjects HH1 and HH2 were able to evaluate the idea using the formula for the area of a rectangle, resulting in an area of $143m^2$.

In test questions 3a and 3c, subjects HH1 and HH2 could create a situation using a mathematical model and evaluate the idea using mathematical notation correctly. Figure 5 demonstrates this. They first assumed the oranges and then modeled the weights of the apples, starfruits, grapes, and rambutans. They could evaluate the idea using mathematical notation to find the weights of the apples, starfruits, grapes, and rambutans. The weights obtained were 8 kg for apples, 3 kg for starfruits, 2 kg for grapes, and 4 kg for rambutans. Based on this, it is evident that subjects HH1 and HH2 can explian ideas, and problem situations from figures or real objects into symbols, mathematical models/expressions.

b. Data Analysis for High Initial Ability and Low Habits of Mind

1. Explaining mathematical ideas, situations, and relationships in written text

Based on the same analysis, the results of the communication ability test of subject HL2 were the same as subject HL1. In test question 1a, subjects HL1 and HL2 could write the mathematical idea according to the problem. Figures 6 show how the subject described the number of tiles used to form rectangular areas. Subject HL1 and HL2

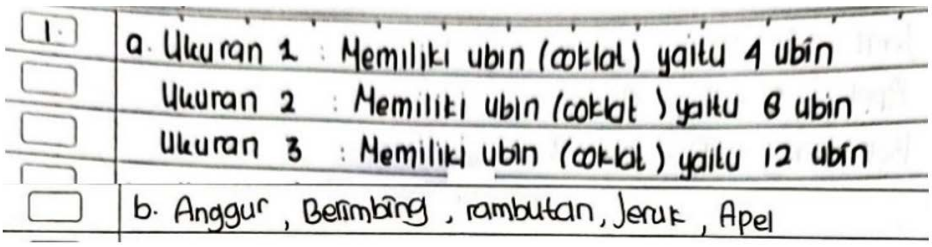


Figure 6: Result of Test Question 1a and 3b Subject HL1.

utilized the information in the diagram to describe that the number of tiles needed to form a rectangular area of size 1 is 4 tiles, size 2 is 8 tiles and size 3 is 12 tiles. Subjects HL1 and HL2 could write a conclusion about the weight of the fruits, from lightest to heaviest, but lacked precision in conveying the argument. The subjects explain the order of fruits from lightest to heaviest, which are grapes $(-3t)$, starfruit $(-2t)$, rambutan $(-1t)$, orange (t), and apple $(3t)$. This fruit order is correct, however, the reasoning is not accurate. Based on this, we can see that subjects HL1 and HL2 are quite able to explain mathematical ideas, situations, and relationships in written text.

2. Explaining mathematical ideas in visual form (drawings, tables, or diagrams)

Based on the same analysis, the results of the communication ability test of subject HL2 were the same as subject HL1. In test question 2b, subjects HL1 and HL2 could accurately present the problem as a drawing. It is evident from Figure 7 that this was possible. The sketch of the shape corresponds to the problem. Subject HL1 and HL2 could analyze the information in the question, recognizing that the shape of Mr. Anwar's land is a rectangle. Subjects correctly indicated the dimensions on the drawing, writing what the length of the land is $5y - 2$ and the width is $3y + 2$. Based on this, it is evident that subjects HL1 and HL2 can explain mathematical ideas in visual form (drawings, tables, or diagrams).

3. Explaining ideas, and problem situations from Figures or real objects into symbols, mathematical models/expressions

Based on the same analysis, the results of the communication ability test of subject HL2 were the same as subject HL1. In questions 1b and 1c, subjects HL1 and HL2 could express the situation using a mathematical model and evaluate the idea using mathematical notation correctly. Figure 8 shows that the subject first assumed the brown tiles. Subject HL1 assumes tiles with y and subject HL2 assumes tiles with e. Subject HL1 and HL2 utilized the information in the question well, identifying the difference in

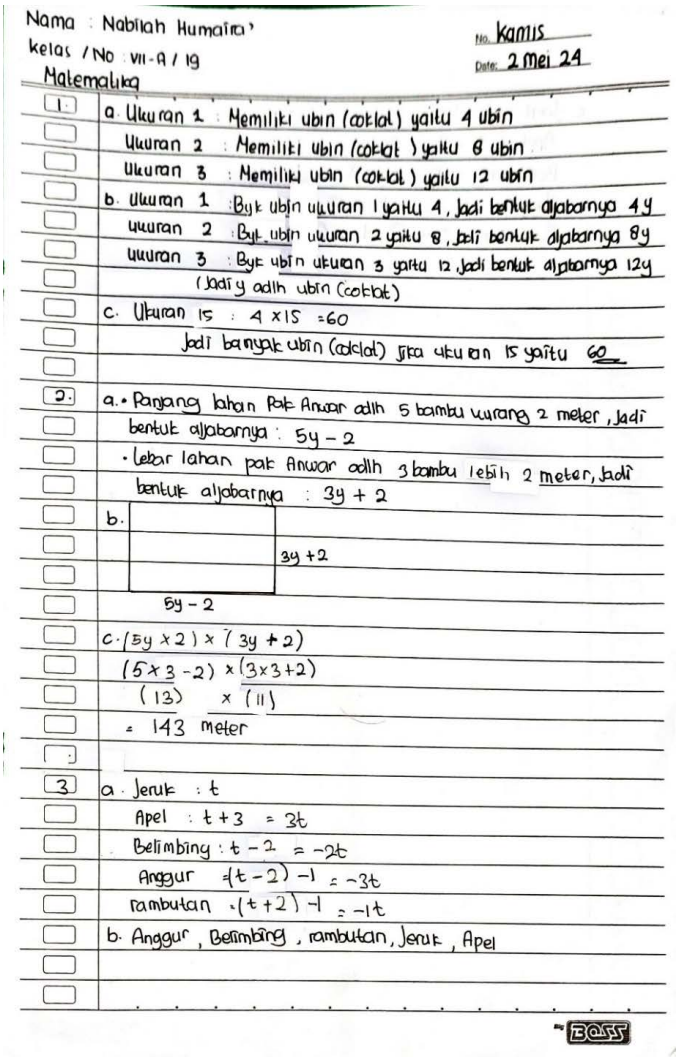
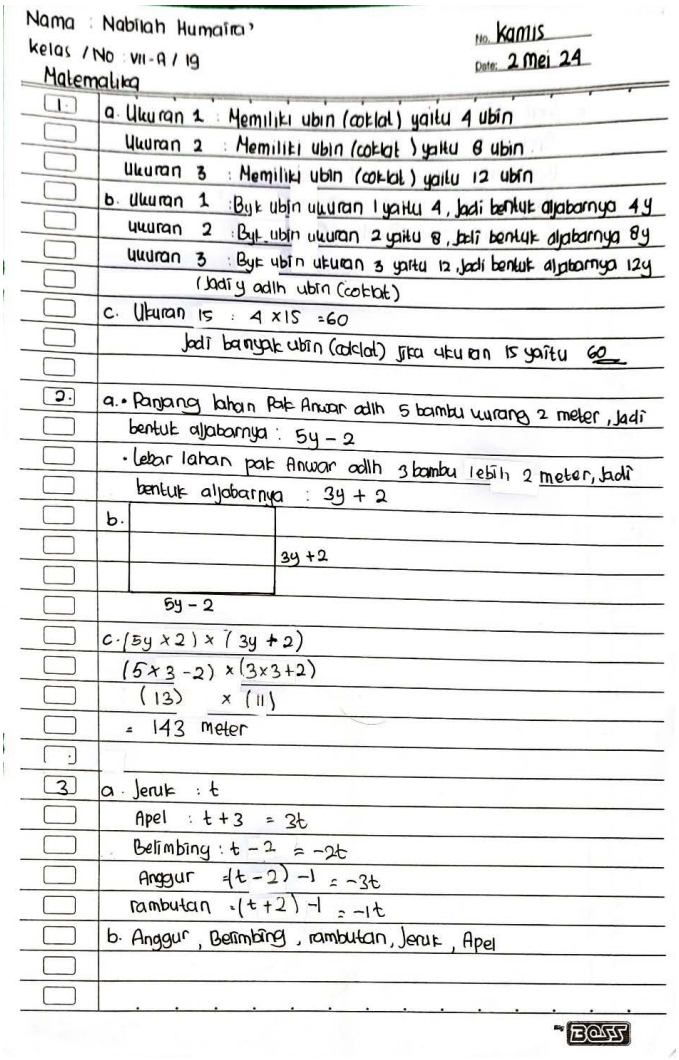


Figure 7: Result of Test Question 2b Subject HL1

the number of tiles for each size and recognizing that the tile size is a multiple of 4. This information was then used to find that the number of tiles for size 15 is 60 tiles.

In test questions 2a and 2c, subjects HL1 and HL2 were able to create a situation using a mathematical model and evaluate the idea using formulas/mathematical notation correctly. It is evident from Figure 9. The subject HL1 first assumed the bamboo and then modeled the length and width of the land as $5x - 2$ and $3x + 2$. Subjects HL1 and HL2 were able to evaluate the idea using the formula for the area of a rectangle, resulting in an area of $143m^2$.

In test questions 3a and 3c, subjects HL1 and HL2 were unable to create a situation using a mathematical model and failed to evaluate the idea using mathematical notation correctly. It is evident from Figure 10. The subject was unable to model the weight of each apple, starfruit, grape, and rambutan. Subject HL1 and HL2 also made errors in operating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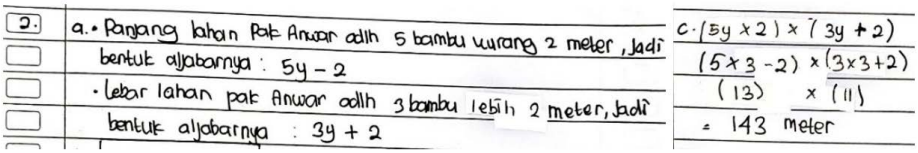
Matematika

1. a. Ukuran 1 : Memiliki ubin (coklat) yaitu 4 ubin
Ukuran 2 : Memiliki ubin (coklat) yaitu 8 ubin
Ukuran 3 : Memiliki ubin (coklat) yaitu 12 ubin
b. Ukuran 1 : Byk ubin ukuran 1 yaitu 4, jadi bentuk aljabarnya 4y
Ukuran 2 : Byk ubin ukuran 2 yaitu 8, jadi bentuk aljabarnya 8y
Ukuran 3 : Byk ubin ukuran 3 yaitu 12, jadi bentuk aljabarnya 12y
(Jadi y adlh ubin (coklat)
c. Ukuran 15 : 4 x 15 = 60
Jadi banyak ubin (coklat) jika ukuran 15 yaitu 60

2. a. • Panjang lahan Pak Anwar adlh 5 bambu kurang 2 meter, jadi bentuk aljabarnya : 5y - 2
• Lebar lahan pak Anwar adlh 3 bambu lebih 2 meter, jadi bentuk aljabarnya : 3y + 2
b. 3y + 2 ; 5y - 2
c. (5y x 2) x (3y + 2)
(5 x 3 - 2) x (3 x 3 + 2)
(13) x (11)
= 143 meter

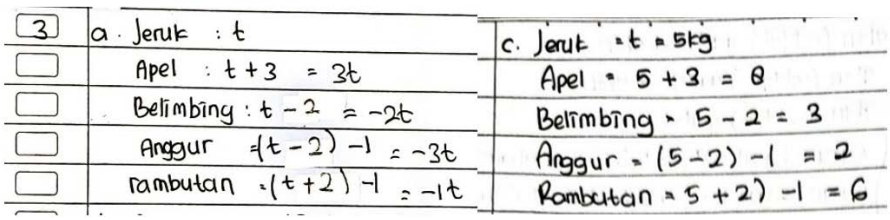
3. a. Jeruk : t
Apel : t + 3 = 3t
Belimbing : t - 2 = -2t
Anggur : (t - 2) - 1 = -3t
rambutan : (t + 2) - 1 = -1t
b. Anggur, Belimbing, rambutan, Jeruk, Apel

Figure 8: Result of Test Questions 1b and 1c Subject HL1.


2. a. • Panjang lahan Pak Anwar adlh 5 bambu kurang 2 meter, jadi bentuk aljabarnya : 5y - 2
• Lebar lahan pak Anwar adlh 3 bambu lebih 2 meter, jadi bentuk aljabarnya : 3y + 2

c. (5y x 2) x (3y + 2)
(5 x 3 - 2) x (3 x 3 + 2)
(13) x (11)
= 143 meter

Figure 9: Result of Test Questions 2a and 2c Subject HL1.


3. a. Jeruk : t
Apel : t + 3 = 3t
Belimbing : t - 2 = -2t
Anggur : (t - 2) - 1 = -3t
rambutan : (t + 2) - 1 = -1t

c. Jeruk = t = 5kg
Apel = 5 + 3 = 8
Belimbing = 5 - 2 = 3
Anggur = (5 - 2) - 1 = 2
Rambutan = 5 + 2) - 1 = 6

Figure 10: Result of Test Questions 3a and 3c Subject HL1.

algebra forms. The subject was unable to evaluate the idea using mathematical notation to find the weight of apples, starfruits, grapes, and rambutans.

Based on this, it is evident that subjects HL1 and HL2 were less able to express ideas and problem situations from figures or real objects into symbols, mathematical models, or expressions.

c. Data Analysis for Low Initial ability and High Habits of Mind

1. Explaining mathematical ideas, situations, and relationships in written text

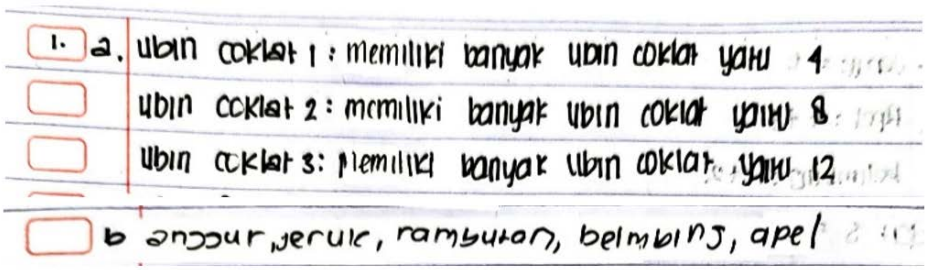


Figure 11: Test Result for Question 1a and 3b Subject LH1.

Based on the same analysis, the results of the communication ability test of subject LH2 were the same as subject LH1. In question 1a, subjects LH1 and LH2 successfully described the mathematical idea according to the problem. This can be seen in Figure 11, where they utilized the information in the Figure to describe the number of tiles used to form a rectangular area. Subject LH1 and LH2 used the information in the figure to describe that the number of tiles used to form a rectangular area of size 1 is 4 tiles, for size 2 is 8 tiles, and for size 3 is 12 tiles. However, LH1 failed to correctly conclude the weight of the fruits, from lightest to heaviest, listing them as grapes, oranges, rambutan, starfruit, and apple. This indicates that subject LH1 and LH2 are quite able to explain mathematical ideas, situations, and relations in writing.

2. Explaining mathematical ideas in visual form (drawings, tables, or diagrams)

Based on the same analysis, the results of the communication ability test of subject LH2 were the same as subject LH1. In question 2b, subjects LH1 and LH2 presented the problem in the form of a drawing, but inaccurately noted the dimensions. This is shown in Figure 12, where the sketch did not completely match the problem. Subjects LH1 and LH2 correctly analyzed that Mr. Anwar's land is rectangular but failed to indicate the dimensions correctly. Subject LH1 wrote the lengths as $5a + 2$ and the width as $3a + 2$. This indicates that subject LH1 and LH2 are quite able to explain mathematical ideas in visual form.

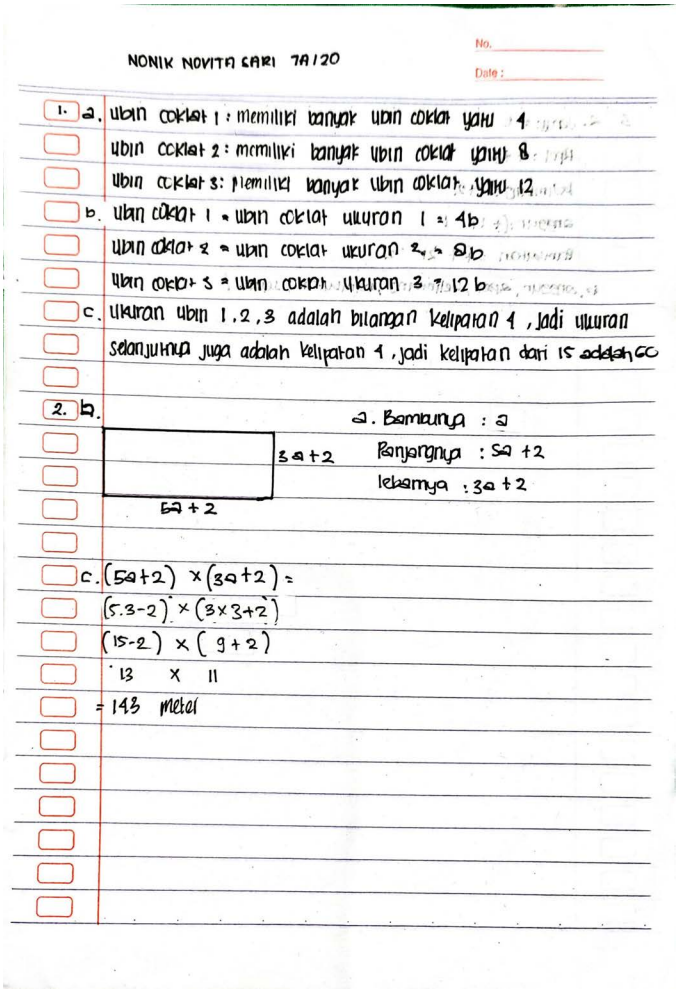


Figure 12: Test Result for Question 2b, Subject LH1.

3. Explaining ideas, and problem situations from Figures or real objects into symbols, mathematical models/expressions

Based on the same analysis, the results of the communication ability test of subject LH2 were the same as subject LH1. In question 1b, LH1 and LH2 effectively expressed the situation using a mathematical model and correctly evaluated ideas using mathematical notation, as shown in Figure 13. Subjects LH1 and LH2 correctly hypothesized about brown tiles and used the information to determine that the number of tiles for size 15 is 60.

In questions 2a and 2c, LH1 and LH2 failed to create a situation using a mathematical model and incorrectly evaluated ideas using mathematical formulas, as seen in Figure 14. The subject LH1 incorrectly modeled the length and width of the land but arrived at the correct area of $143m^2$.

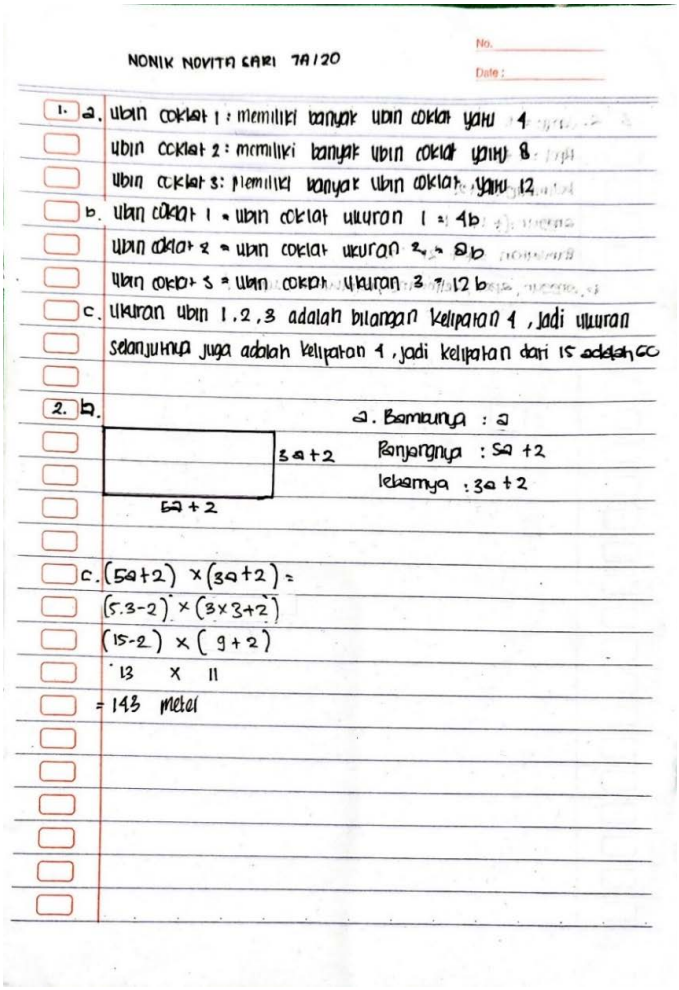


Figure 13: Test Result for Questions 1b and 1c, Subject LH1.

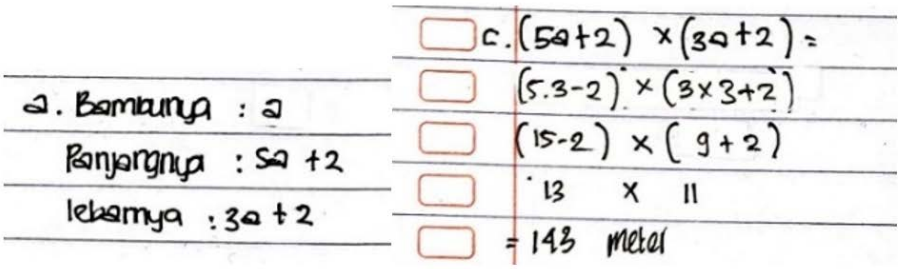


Figure 14: Test Result for Questions 2a and 2c, Subject LH1.

In questions 3a and 3c, subjects LH1 and LH2 were unable to create a situation using a mathematical model and failed to correctly evaluate the idea using mathematical notation. This can be seen in Figure 15. Subject LH1 and LH2 were unable to model the weights of apples, starfruit, grapes, and rambutan, and could not accurately evaluate the idea using mathematical notation.

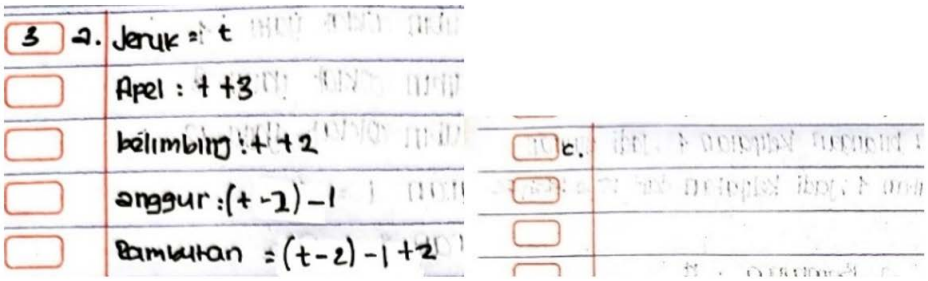


Figure 15: Test Result for Questions 3a and 3c, Subject LH1.

Based on this, it is evident that subjects LH1 and LH2 were less able to express ideas and problem situations from figures or real objects into symbols, mathematical models, or expressions.

d. Data Analysis for Low Initial Ability and Low Habits of Mind

1. Explaining mathematical ideas, situations, and relationships in written text

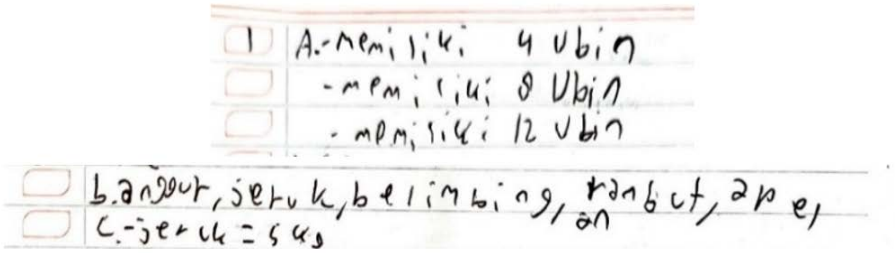


Figure 16: Results of Question 1a and 3b Test for Subject LL2.

Based on the same analysis, the results of the communication ability test of subject LL2 were the same as subject LL1. In question 1a, Subject LL1 and LL2 failed to utilize the given information to describe the number of tiles used to form rectangular areas, only listing the number of tiles without specifying the rectangle sizes.. Subject Subject LL1 and LL2 was unable to write a conclusion about the weight of the fruits from lightest to heaviest. The subject listed the order as grapes, oranges, starfruit, rambutan, and apples. Based on this, it is evident that subjects LH1 and LH2 were less able to explaining mathematical ideas, situations, and relations in writing (Written text).

2. Explaining mathematical ideas in visual form (drawings, tables, or diagrams)

Based on the same analysis, the results of the communication ability test of subject LL2 were the same as subject LL1. In the test for question 2b, subject LL1 and LL2 successfully presented the problem in a drawing, but inaccurately labeled the measurements. Subject LL2 incorrectly labeled the dimensions, using $5m - 2m = 3m$ for length and $3m + 2m = 5m$ for width. Based on this, it is evident that subject LH1 and LH2 were quite able to explain mathematical ideas visually (Drawing).

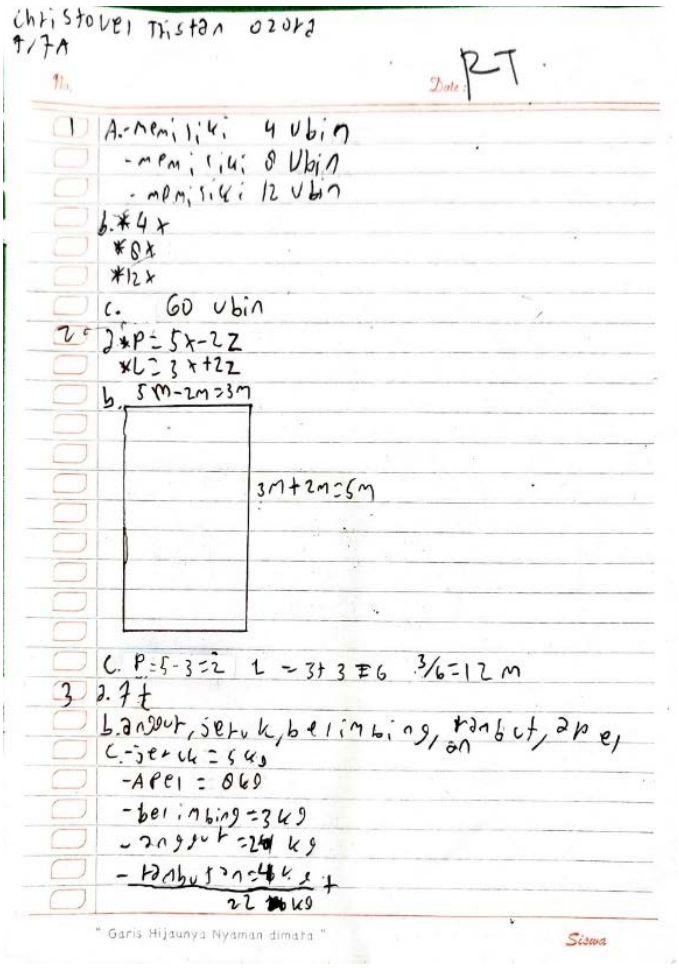


Figure 17: Results of Question 2b Test for Subject LL2.

3. Explaining ideas, and problem situations from Figures or real objects into symbols, mathematical models/expressions

Based on the same analysis, the results of the communication ability test of subject LL2 were the same as subject LL1. In questions 1b and 1c, Subject LL2 failed to model the situation mathematically and evaluate ideas using notation correctly, directly writing $4x$, $8x$, $12x$ without any explanation. Subject LL2 did not use the problem information effectively to determine the number of tiles for size 15, instead estimating 60 tiles from a drawing.

In questions 2a and 2c, Subject LL1 and LL2 failed to model the situation mathematically or evaluate ideas using the correct formulas. Subject LL2 could not accurately model the length and width of the land mathematically, incorrectly calculating the area as 12 square meters.

In questions 3a and 3c, Subject LL1 and LL2 could not model the weight of various fruits or evaluate the ideas correctly using mathematical notation. This is shown in

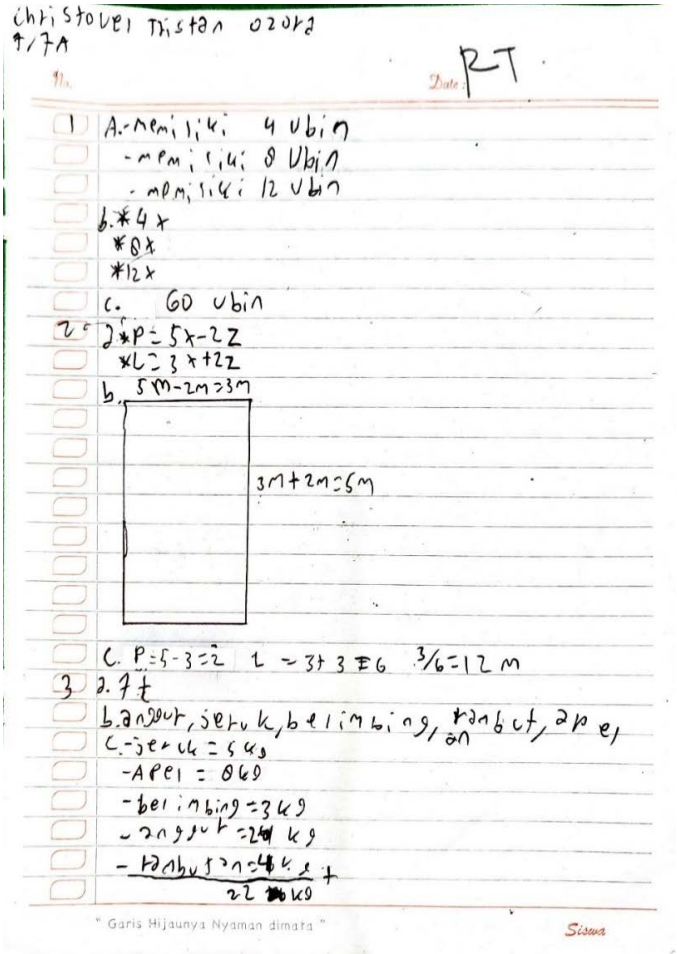


Figure 18: Results of Questions 1b and 1c Test for Subject LL2.

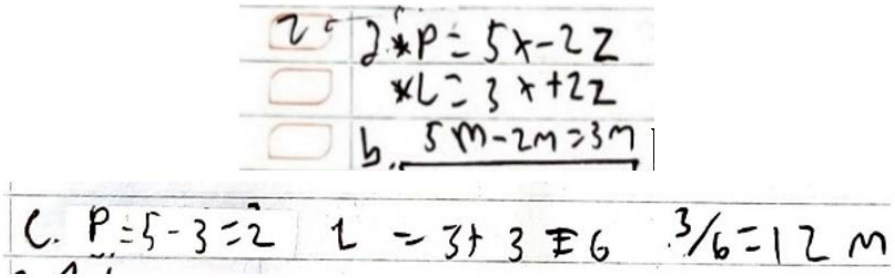


Figure 19: Results of Questions 2a and 2c Test for Subject LL2.

Figure 40 Subject LL1 and LL2 only wrote $7x$. During the interview, it was revealed that $7x$ was derived from the total weight of the known fruits. The subject was unable to evaluate the idea to find the weight of the fruit. Based on these observations, Subject LL1 and LL2 were unable to explain ideas, problem situations, or real-world objects into symbols, mathematical models, or expressions.

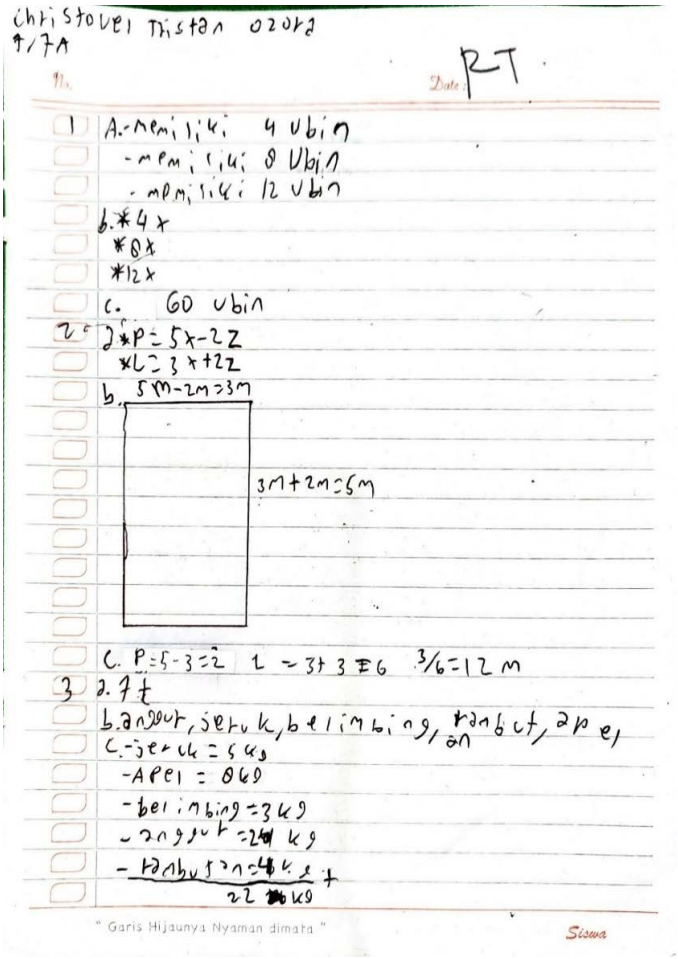


Figure 20: Results of Questions 3a and 3c Test for Subject LL2.

Based on the analysis of data on students' mathematical communication abilities in solving algebra problems at different levels of initial ability and habits of mind, the following discussion is presented.

1. Mathematical Communication Ability of Students with High Initial Ability and High Habits of Mind

The data analysis shows that students with high initial ability and high habits of mind tend to be able to explain mathematical ideas, situations, and relationships in written text. These students can clearly articulate mathematical ideas in problem-solving in a written form that is easy to understand. They can use information from diagrams to describe the number of tiles for each size. They can conclude the sequence of fruits as asked in the problems. These students understand the concept of algebra forms well enough to connect available information to solve problems related to the fruit sequence. Students with high initial ability and high habits of mind tend to effectively explain mathematical ideas in written problem-solving.

Students with high initial ability and high habits of mind also tend to be able to present mathematical ideas visually (through pictures, tables, or diagrams). They can analyze information from the problems well and represent the problem visually, such as in diagrams of plots of land. They can model the algebra form of the length and width of the land and annotate the diagram with measurements.

Furthermore, students with high initial ability and high habits of mind tend to be able to translate ideas, problem situations, or real objects into symbolic language or mathematical models/expressions. They can model situations involving tiles, the dimensions of plots of land, and the weight of fruits. They can evaluate ideas using the formula for the area of a rectangle to find the area of the land. They also evaluate ideas using algebra operations to determine the number of tiles for specific sizes and the weight of the fruits. This is in line with the results of study (19), which shows that students with high initial ability have met the three indicators of mathematical communication ability when viewed from students' initial ability. It is also in line with the result of study (20), which states that students with high habits of mind have achieved level 4 written mathematical communication ability, fulfilling all indicators of mathematical communication skills.

2. Mathematical Communication Ability of Students with High Initial Ability and Low Habits of Mind

The data analysis indicates that students with high initial ability but low habits of mind tend to adequately explain mathematical ideas, situations, and relationships in written text. These students can somewhat explain mathematical ideas in problem-solving in written form. They can use information from diagrams to describe the number of tiles for each size and write conclusions about the sequence of fruits, although their arguments may not be entirely accurate. A lack of understanding of algebra operations can affect their ability to argue conclusions related to the sequence of fruits. Students with high initial ability and low habits of mind tend to adequately explain mathematical ideas in written problem-solving.

Students with high initial ability and low habits of mind tend to be able to present mathematical ideas visually (through pictures, tables, or diagrams). They can analyze information from the problems well enough to represent the problem visually, such as in diagrams of plots of land. They can model the algebra form of the length and width of the land and annotate the diagram with measurements.

However, students with high initial ability and low habits of mind tend to be less able to translate ideas, problem situations, or real objects into symbolic language or mathematical models/expressions. They can model situations involving tiles and the dimensions of plots of land but struggle with modeling the weight of fruits. These students can evaluate ideas using the formula for the area of a rectangle to find the area of the land and use algebra operations to determine the number of tiles for specific sizes but not the weight of the fruits.

This is in line with the results of study (21), found that not all high ability subjects would meet all indicators of mathematics communication ability. The subjects had excellent activity scores, but they did not perform actively. According to a study conducted by Boaler J. in his book Mathematical Mindsets, low habits of mind can prevent students from reaching their full potential in mathematics even though they have high initial abilities (22).

3. Mathematical Communication Ability of Students with Low Initial Ability and High Habits of Mind

The data analysis shows that students with low initial ability and high habits of mind tend to adequately explain mathematical ideas, situations, and relationships in written text. These students can somewhat explain mathematical ideas in problem-solving in written form. They can use information from diagrams to describe the number of tiles for each size and write conclusions about the sequence of fruits, although their arguments may not be entirely accurate. Students with low initial ability and high habits of mind tend to adequately explain mathematical ideas in written problem-solving.

Students with low initial ability and high habits of mind tend to be able to present mathematical ideas visually (through pictures, tables, or diagrams). They can analyze information from the problems well enough to represent the problem visually, such as in diagrams of plots of land. However, they struggle to model the algebra form of the length and width of the land and annotate the diagram with measurements.

Students with low initial ability and high habits of mind tend to be less able to translate ideas, problem situations, or real objects into symbolic language or mathematical models/expressions. They can model situations involving tiles but struggle with modeling the dimensions of the land and the weight of fruits. These students cannot evaluate ideas using the formula for the area of a rectangle to find the area of the land. They can use algebra operations to determine the number of tiles for specific sizes but not the weight of the fruits. This is in line with the results of study (19), which shows that students

with low initial abilities have not been able to meet the three indicators of mathematical communication skills.

4. Mathematical Communication Ability of Students with Low Initial Ability and Low Habits of Mind

The data analysis indicates that students with low initial ability and low habits of mind tend to struggle with explaining mathematical ideas, situations, and relationships in written text. These students can somewhat explain mathematical ideas in problem-solving in written form. They can use information from diagrams to describe the number of tiles for each size but cannot write conclusions about the sequence of fruits. Students with low initial ability and low habits of mind tend to struggle with effectively explaining mathematical ideas in written problem-solving.

Students with low initial ability and low habits of mind tend to be able to present mathematical ideas visually (through pictures, tables, or diagrams). They can analyze information from the problems well enough to represent the problem visually, such as in diagrams of plots of land. However, they struggle to model the algebra form of the length and width of the land and annotate the diagram with measurements.

Students with low initial ability and low habits of mind tend to be unable to translate ideas, problem situations, or real objects into symbolic language or mathematical models/expressions. They struggle with modeling situations involving tiles, the dimensions of the land, and the weight of fruits. These students cannot evaluate ideas using the formula for the area of a rectangle to find the area of the land. They also struggle with using algebra operations to determine the number of tiles for specific sizes and the weight of the fruits.

This is in line with the results of study (19), which shows that students with low initial abilities have not been able to meet the three indicators of mathematical communication skills. Students with low initial abilities will find it more difficult to acquire new knowledge and relate it to their previous knowledge.

4. CONCLUSION

Basen on the result and data analysis can be concluded that students with high initial ability and high habits of mind can explain mathematical ideas in writing, explain mathematical ideas in visual form, and explain ideas into mathematical models/mathematical expressions. Students with high initial ability and low habits of mind are quite able to

explain mathematical ideas in writing, can explain mathematical ideas in visual form, but are less able to explain ideas in mathematical models/mathematical expressions. Students with low initial ability and high habits of mind are quite able to explain mathematical ideas in writing, quite able to explain mathematical ideas in visual form, but are less able to explain ideas in mathematical models/mathematical expressions. Students with low initial ability and low habits of mind are less able to explain mathematical ideas in writing, quite able to explain mathematical ideas in visual form, and unable to explain ideas into mathematical models/mathematical expressions.

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References

[1] Fauziah I, Maarif S, Pradipta TR. Peningkatan Kemampuan Komunikasi Matematis Dan Self Regulated Learning Siswa Melalui Model Problem Based Learning (PBL). J Anal. 2018;4(2):90–8.

[2] NCTM. Principles and Standards for School Mathematics. United States of America: The National Council of Teachers of Mathematics, Inc.; 2000.

[3] Fitriani S. Nurhanurawati, Coesamin M. Pengaruh Kemampuan Awal dan Motivasi Belajar Terhadap Kemampuan Komunikasi Matematis Siswa. Jurnal Pendidikan Matematika. 2021;9(1):31–41.

[4] OECD. Pisa 2022 Results The State of Learning and Equity in Education. Vol. I. 2022. 1–4 p.

[5] Ariawan R, Nufus H. Hubungan Kemampuan Pemecahan Masalah Matematis dengan Kemampuan Komunikasi Matematis Siswa [The Original Research of Mathematics]. THEOREMS. 2017;1(2):82–91.

[6] Deswita R, Kusumah YS. Peningkatan Kemampuan Komunikasi Matematis Siswa Melalui Model Pembelajaran CORE dengan Pendekatan Scientific. Edumatika : Jurnal Riset Pendidikan Matematika. 2018;1(1):35.

[7] Anggriani A, Septian A. Peningkatan Kemampuan Komunikasi Matematis dan Kebiasaan Berpikir Siswa Melalui Model Pembelajaran IMPROVE. IndoMath. Indonesia Mathematics Education. 2019;2(2):105.

[8] Ikhtiar MA, Sudirman S, Hidayanto E. Komunikasi Matematis Tulis Siswa dalam Pemecahan Masalah Matematika [Jurnal Ilmiah Pendidikan Matematika]. JIPM. 2021;10(1):14.

[9] Hikmawati NN, Nurcahyono NA, Blkist PS. Kemampuan Komunikasi Matematis Siswa Dalam Menyelesaikan Soal Geometri dan Balok. Jurnal Educatio FKIP UNMA. 2019;8(1).

[10] Permatasari D, Harta I. Kemampuan Berpikir Aljabar Siswa Sekolah Pendidikan Dasar Kelas V Dan Kelas VII: Cross-Sectional Study. Jurnal Pendidikan dan Kebudayaan. 2018;3(1):99–115.

[11] Razak F. Hubungan Kemampuan Awal Terhadap Kemampuan Berpikir Kritis Matematika Pada Siswa Kelas Vii Smp Pesantren Immim Putri Minasatene. Mosharafa. Jurnal Pendidikan Matematika. 2017;6(1):117–28.

[12] Salahudin I. Pengaruh Kemampuan Awal dan Motivasi Belajar Terhadap Kemampuan Komunikasi Matematis Siswa. Jurnal Penelitian Matematika dan Pendidikan Matematika. 2018;1(2).

[13] Dwirahayu G, Kustiawati D, Bidari I. Pengaruh Habits of Mind Terhadap Kemampuan Generalisasi Matematis. JPPM. 2018;11(2):91–104.

[14] Ilmi A, Monica S, Lazwardi A. Habits of Mind Dan Kemampuan Komunikasi Matematis Peserta Didik Smp Pada Materi Segiempat Dan Segitiga. EMTEKA: Jurnal Pendidikan Matematika. 2022;3(1):19–30.

[15] Handayani AD. Mathematical Habits of Mind : Urgensi dan Penerapannya dalam Pembelajaran Matematika. Jurnal Math Educator Nusantara. 2015;01(02):223–30.

[16] Cahyani K, Masruroh A. Pengaruh Kemampuan Awal dan Kecerdasan Emosional Terhadap Kemampuan Komunikasi Matematis [Seminar Nasional Sains]. SINASIS. 2020;1(1):462–71.

[17] Noer SH, Gunowibowo P, Triana M. Pengaruh Kecerdasan Emosional dan Kemampuan Awal Tergadap Kemampuan Komunikasi Matematis Siswa Dalam Pembelajaran Online. AKSIOMA. 2022;11:1482–92.

[18] Annurwanda P, Friantini RN. Efektivitas Penerapan Metode Round Table dan Ekspositori Terhadap Prestasi Belajar Matematika Ditinjau dari Kemampuan Awal. Riemann. Research of Mathematics and Mathematics Education. 2019;1(1):1–13.

[19] Azmi S, Baidowi B, Hikmah N, Tyaningsih RY, Kurniawan E. Analysis of students' mathematics communication ability based on cognitive styles and mathematical knowledge. Jurnal Pijar Mipa. 2022;17(2):231–8.

[20] Alisyah SN. Kartono, Asih TSN. The Effectiveness of Numbered Head Together with the Written Corrective Feedbacks on Mathematics Communication Skills Achievement. Proceedings of the 6th International Conference on Science, Education and Technology (ISET 2020). 2022;574(15):189–99.

[21] Syukria A, Johar R, Marwan. Kemampuan Komunikasi Matematis dan Habits of Mind Mahasiswa pada Materi Lintasan Terpendek Menggunakan Algoritma Floyd Warshall. Jurnal peluang. 2013;1(2):71–80.

[22] Boaler J. Mathematical Mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. 2nd ed. Jossey-Bass; 2022.