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Exploration of Students' Mathematical Literacy Abilities in Visualizing Division of Fraction

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ABSTRACT

This research aimed to determine how prospective mathematics teachers can visualize fractional division operations based on mathematical literacy skills. This research includes qualitative research with descriptive methods. This study was conducted on 3 students of the 3rd semester mathematics education program with high, medium and low mathematical abilities with good communication skills. Researchers gave three questions on literacy tests. The tests given include problems related to the division of integers by fractions, division of fractional numbers by integers and division of fractional numbers by fractional numbers. Interviews were conducted with all three subjects using the test results obtained. The results showed that all three subjects could understand and translate the questions and formulate what was asked of the questions. However, all three subjects encountered constraints when trying to visualize the form of division of fractions by fractional numbers. They just memorize division formulas like “multiplying and inverting”. From the results of the data analysis, it can be concluded that the literacy ability of the subject in visualizing the form of the division operation is still classified as low.

Keywords: Mathematical Literacy, Visualizing, Divison Fraction.

ABSTRAK

Tujuan penelitian ini adalah untuk mengetahui bagaimana calon guru matematika dapat memvisualisasikan bentuk operasi pembagian pecahan berdasarkan kemampuan literasi matematika. Penelitian ini termasuk penelitian kualitatif dengan metode deskriptif. Penelitian ini dilakukan terhadap 3 mahasiswa prodi pendidikan matematika semester 3 dengan kemampuan matematika tinggi, sedang dan rendah dengan kemampuan komunikasi yang baik. Peneliti memberikan 3 soal tes kemampuan literasi. Test yang diberikan meliputi soal terkait pembagian bilangan bulat oleh pecahan, pembagian bilangan pecahan oleh bilangan bulat dan pembagian bilangan pecahan oleh bilangan pecahan. Dari hasil test yang diperoleh, kemudian dilakukan wawancara terhadap ketiga subjek. Hasil penelitian menunjukkan bahwa dari ketiga subjek sudah dapat memahami dan menerjemahkan soal serta merumuskan apa yang ditanyakan dari soal. Namun ketiga subjek mengalami kendala saat mencoba memvisualisasikan bentuk pembagian pecahan oleh bilangan pecahan. Mereka hanya menghafalkan rumus pembagian seperti “mengalikan dan membalikkan ”. Dari hasil analisis data, dapat disimpulkan bahwa kemampuan literasi subjek dalam memvisualisasikan bentuk operasi pembagian masih tergolong rendah.

Keywords: Literasi Matematika, Visualisasi, Pembagian Pecahan.

INTRODUCTION

The success of learning Mathematics in the classroom is greatly influenced by the mastery of the material by the teacher. Many studies have focused on mastery of materials and management of learning in the school (Copur-Gencturk, 2019; Ismawati & Fina, 2020; Lee, 2017; Mulyono &

Hapizah, 2018;). The teachers convey learning material in the classroom, depending on their literacy skills. Literacy skills are very important as a provision for prospective teachers that must be mastered before teaching at the school. It will be an obstacle for a teacher with low literacy skills to convey ideas according to the level of student's language comprehension abilities. This is no exception to the delivery of mathematical concepts, which are often displayed in the form of mathematical symbols which are sometimes very difficult for students to understand (Fathani, 2016; Masjaya & Wardono, 2018; Matondang, 2023; Wardani et al., 2017). This is where literacy helps students understand or interpret these symbols. So, it can be said that mathematical literacy supports the success of mathematics learning in the classroom (Fajriati & Budi, 2022; Ridzkiyah & Kiki, 2021)

The author often finds that students in the first semester are still confused about explaining the concepts of integer operations. Of the four operations on Integers, they are easiest to explain the concept of addition with the help of a number line. An interesting thing that often becomes a problem for some students is when it comes to negative integers. Even from random observations of several students, several students could not explain the concept of subtracting negative integers and had difficulty visualizing dividing numbers. However, it is not uncommon in any mathematical material to often find a combination of all four basic mathematical operations, which include addition, subtraction, multiplication and division. Fatal consequences if a student does not master the material (Putri et al., 2020). They could answer the questions, but when asked to explain the process of finding their answers, they could not. This is related to understanding the language of mathematics. Students must learn vocabulary, symbols, and how to formulate an argument to communicate well. Suppose students do not understand the vocabulary or the meaning of the questions or tasks that must be completed. In that case, they will not be able to solve mathematics problems (Ernawati, 2021: 77). The ability to understand and process words is meant by literacy ability.

PISA in the OECD (2013: 28) states that Mathematical literacy is the ability of each individual to formulate, use and interpret mathematics in various contexts. In this case, the skills in question include mathematical reasoning and using mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena. So, mathematical literacy is used to solve every problem related to the use of mathematics in everyday life. This includes decision-making based on the solution to the issue at hand, accompanied by reasons for choosing the solution. In other words, mathematical literacy is closely related to every individual's life (Habibi & Suparman, 2020).

Furthermore, mathematical literacy requires students to communicate and explain the phenomena they encounter using mathematical concepts. The phenomena faced by each student are different, so each student has their uniqueness. This is confirmed by Fathani (2016); the process of developing mathematical literacy must pay attention to the uniqueness of student learners, which is their intelligence tendencies. Of course, it is a challenge for teachers to delve further into each student's literacy to create learning plans according to students' mathematical literacy abilities.

According to the OECD (2013), assessing students' mathematical literacy abilities includes the process, content and context of mathematics learning. So, the activities that emerge in the literacy process are as follows:

1. Able to formulate mathematical problems (A1)

Formulating the problem is the most essential thing in solving problems. How is it possible for students to solve problems without being able to go through this stage? The term "formulating" here is how students understand and translate the issues given into mathematical form. Students can formulate problems, meaning that students can solve problems in the real world using mathematical models with mathematical structures and in the form of representations.

2. Able to use concepts, facts, procedures and reasoning systematically (A2)
   In using mathematical concepts, facts, procedures and reasoning to solve problems, students perform the necessary mathematical methods to obtain results and find mathematical solutions. Mathematical literacy at this stage relates to how they reason to solve problems to conclude. Specifically, this process uses mathematical concepts, facts, procedures, and reasoning.
3. Able to interpret, apply and evaluate the results of mathematical processes (A3)
   This stage focuses on students' ability to think of mathematical solutions. In this case, students build solutions and communicate their arguments based on mathematical concepts to solve the given problem. Specifically, the activities involve interpreting, applying, and evaluating mathematical results.

Student literacy abilities show how students solve their problems using their mathematical skills. Problems arise in various situations and specific conditions. So, each student's mathematical skills must be activated about actual life realities where issues arise with mathematics as the expected solution. There are many studies on analyzing students' literacy abilities, which examine the exploration of students' problem solving skills based on the category of mathematical literacy processes (Astuti & Sabon, 2020; Chasanah et al., 2020; Hidayat, 2022; Oktaviyanthi & Agus, 2019; Prasetyani & Suparman, 2018). From some of these studies, students' literacy skills should be developed even better.

Some studies that examine student misconceptions in fractions include (Aksoy & Yazlik, 2017 Hansen et al., 2017; Lewis & Perry, 2017). The results of research regarding student misconceptions regarding the level of problem-solving in fraction operations material conducted by Sadiah et al. (2023) show that the types of student misconceptions are generalization, calculation and notation. A study showed that elementary and middle school students' understanding and misunderstandings regarding the concept of fraction operations concluded that students have the same misunderstanding as elementary school students regarding the concept of fractions (Bentley & Michael 2018).

Among the four operations with fractions, the division is considered the most challenging and problematic for students and teachers (Fuentes & Olmos, 2019; Gibim et al., 2023). Many teachers have difficulty using visual representation to explain division (Jansen & Hohensee, 2016). If this problem is not resolved immediately, it will become a problem in the future (Putri et al., 2020). From the explanation above, researchers are interested in examining students' literacy abilities in explaining the concept of dividing numbers related to whole numbers and fractions. At the same time, the results of this research can be used as reflection and consideration for policy decisions that will be implemented.

METHOD

This study uses qualitative and descriptive methods to describe students' mathematical literacy skills in visualizing fractional division operations. The analysis uses the honesty of research subjects' answers as data, not assumptions. So, the type of communication is the focus of this approach (Kristina, 2020). From this perspective, data reduction is also done by studying text words from interviews and observations. This research was conducted at the University of Madura, Mathematics Education study program, semester 3 of the 2023/2024 academic year. The research subjects were 3 students consisting of 1 subject with high mathematical ability, 1 subject with moderate mathematical ability category and 1 subject with low mathematical ability with good communication skills.

The main instrument of this research is the researcher herself. Meanwhile, supporting instruments consist of tests and interviews. The test determines students' literacy skills in answering test questions, including visualizing the form of number division operations.

Data collection techniques include: 1). Select 3 research subjects from 1 subject with high mathematical ability, 1 subject with moderate mathematical ability category and 1 subject with low mathematical ability, all three subjects having good communication skills, 2). Give a literacy test consisting of 3 questions covering the division of whole numbers by a fraction, the division of fractions by absolute numbers and the division of fractional numbers, 3). Interviews were conducted to explore the subject's literacy skills in visualizing the form of division of fractions. Meanwhile, the data analysis techniques used in this research include data reduction, which forms raw data much more scattered into smaller and simpler data while maintaining the structure of the research objectives. The display is no less important than the reduction process. Through this process, researchers can find more precise and more informative data. The third analysis, which is no less important than the previous two stages, is the conclusion, namely drawing conclusions and verifying the data. Whether this stage is optimal or not, the findings produced are greatly influenced by the two previous stages, data reduction and display, and the researcher's ability to discover the meaning of phenomena, events and objects encountered since the beginning of the research. Researchers also try to record explanations regarding causes, effects, propositions, and possible configurations (Sutikno & Prosmala, 2020).

RESULT AND DISCUSSION

Analysis of Subject with high mathematical ability (S1) literacy abilities

The first question in test, the Subject is asked to divide whole numbers by fractions. “Celine is baking a cake that requires $\frac{1}{2}$ gram of vanilla paste for each baking. She has 10 grams of vanilla paste. How many cake pans can it bake?” To answer this question, S1 has no difficulty in the literacy process. S1 understands and translates given problems related to everyday life problems, formulates them into mathematical models, and provides rational reasons for the answers obtained by the Subject. So that all mathematical literacy processes are queried overall.

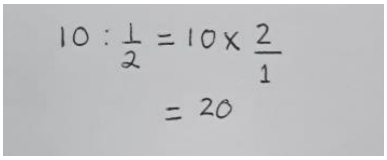

Figure 1. S1's Answer to Question Number 1

Based on Figure 1, S1 divides 10 (grams of available pasta) by half, to obtain the number of cakes that can be made. The result of the operation of dividing 10 by fractions of "half" is also appropriate. Here is a snippet of the interview with S1 explaining his answer to question number 1:

S1: "Half a gram of vanilla paste can be used to make one cake pan, so 10 grams divided in half yields 20 baking cakes"
R: "How do you operate 10 divided in half?"
S1: "By multiplying the opponent by half, 10 times 2 over 1 "
R : "Where does the concept of multiplying by this opponent come from?"
S1: "I don't know. I got this way from my Elementary School teacher."

S1 can operate by dividing 10 by half by the principle of "multiplying and inverting" the denominator. Further, the researcher tried to have the S1 visualize the question's requested division form. The results of the S1 work are as in the Figure 2.

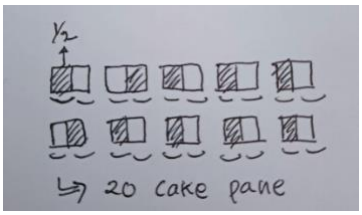

Figure 2. S1's Visualization on Question Number 1

From the figure above, the subject illustrates that 1 square in the image above is 1 gram of vanilla paste, of which half of the box can be used to make 1 cake pan. "I describe vanilla paste wrapped in each of these boxes as much as 1 gram. So that half of it can be used to make a cake pan, then out of these 10 boxes, there will be 20 pieces containing half a gram each". S1 solves this problem by creating the same group and repeating the same retrieval, and S1 more easily solves this problem in context (Ervin, 2017).

The second problem is not much different from the first, where the division is a fraction divided by an integer. "A swimming pool is open for $7\frac{1}{2}$ hours during the day. A rescue team guards the pool, and each rescue has a 2-hour work schedule. How many times is there a change of rescue squads in a day?". Figure 3 is results of S1's answer to question number 2:

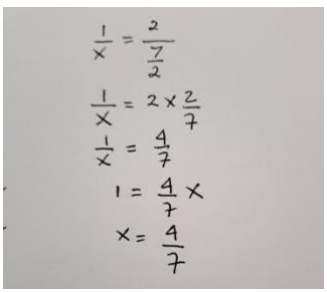

Figure 3. S1's Answer to Question Number 2

From the interview results, S2 answered that $7\frac{1}{2}$ hours divided by 2 hours is 4. As in the result of the answer S1 in the figure above, S1 is wrong in modeling in the mathematical form of the given statement.

S1: "I suppose the value of x is a quotient of $\frac{7}{2}$ by 2 ".
R: "Then *x* here represents what value?"
S1: "Here, the value of *x* is the number of rescuers turns. Since 1 rescuer has a guard time of 2 hours, the value of x is 7 divided by 2 "

From the above interview snippet, there appears to be an error in the writing of the mathematical model made by the subject. Subjects experienced errors in interpreting values from $7\frac{1}{2}$ hours. Subjects assume that $7\frac{1}{2}$ hours is equal to $\frac{7}{2}$. This includes interpretive errors in modelling into mathematical forms (Putri et al., 2020). Next, S1 is asked to try to visualize the division of the problem in question. At this stage, the subject can give a reasonable explanation accompanied by an image to facilitate the explanation (See Figure 4).

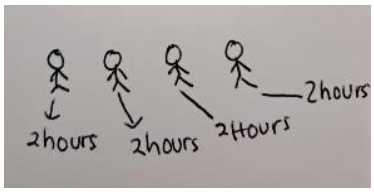

Figure 4. S1's vizualization on Question Number 2

So, in this problem, the subject could visualize the form of division according to the problem's request using an explanation in the form of a representative image. The subject was able to explain that of the $7\frac{1}{2}$ hours partitioned into 4 parts, of which the 3 parts were 2 hours each and the last as much as $1\frac{1}{2}$ hours, the subject was more accessible with a representation in which the divisor or dividend is an integer (Gibim et al., 2023). From this, it was revealed that the subject could visualize the form of the division of fractions by integers through all the processes of mathematical literacy activities. The last problem is a form of division of fractions by fractions, S1 answers the Figure 5.

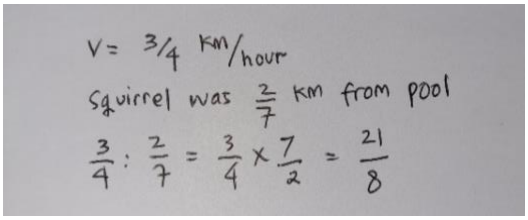

Figure 5. S1's Answer to Question Number 3

The results of the interview with S1 revealed that S1 had no difficulty understanding the form of problem number 3. S1 can interpret what is known and asked from the problem. Question number 3 reads, "A squirrel can walk $\frac{3}{4}$ of a kilometers in an hour. The squirrel is located $\frac{2}{7}$ kilometres from the pool. At that speed, how long would it take the Squirrel to reach the pool?". The subject may interpret that to determine the time required by the squirrel, divide the speed by the distance travelled.

S1: “From the problem, it is known that the speed of the squirrel is $\frac{3}{4}$ km per hour, so the time it takes for the squirrel to reach the pond is by dividing $\frac{3}{4}$ by $\frac{2}{7}$ ”.

Q: “So, how long does it take?“

S1: “ $2\frac{5}{8}$ hours “

Q: “How do you illustrate the form of $\frac{3}{4}$ divided by $\frac{2}{7}$ ”

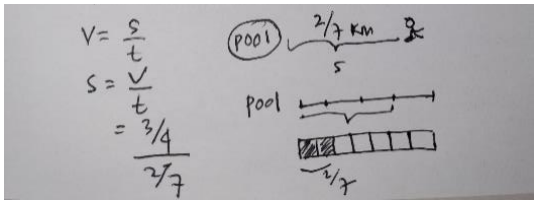

Figure 6. S1’s Answer to Question Number 3

Based on Figure 6, S1 tries to visualize that $\frac{3}{4}$ divided by $\frac{2}{7}$ It looks like in the image above. Subjects could imagine $\frac{3}{4}$ by partitioning a line into 4 parts and taking 3 of them. Likewise, with the $\frac{2}{7}$, the subject tried to describe the squirrel's position as far as $\frac{2}{7}$ from the pond. Yet I still can't visualize when $\frac{3}{4}$ is divided by $\frac{2}{7}$. From this, it follows that subjects could be represented with images for fractions but could not represent the division operation in question (Gibim et al., 2023). So overall, the literacy process of the three activities included in it can be passed by the S1. Still, at the visualizing stage, the subject has not yet been able to go through the literacy process properly. Subjects can visualize the shape of the fraction but cannot manipulate the form of the division operation in question (Wilkie & Roche, 2022). Thus, it can be concluded that S1 does not yet fully understand the concept of fractional division.

Analysis of Subject with moderate mathematical ability (S2) literacy abilities

Moving on to the second subject (S2), which is not much different from S1, for question number 1, the subject can still complete fraction division operations accompanied by pictorial illustrations.

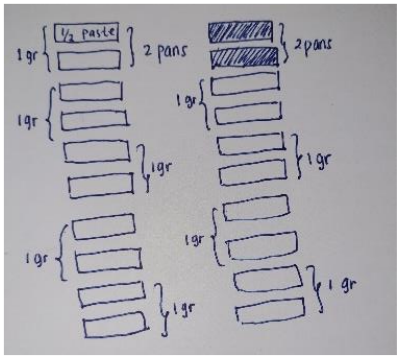

Figure 7. S2’s Answer to Question Number 1

Based on Figure 7, S2 illustrates that the cake pan is as rectangular as the image above, and each baking pan requires half a gram of pasta, so there are 20 rectangles with which to describe 10 grams of pasta. “Each baking sheet requires half a gram of pasta, so two baking sheets need 1 gram of pasta”. S2 Determination of the size of a unit fraction relative to a given unpartitioned whole by

iterating the unit fraction (making connected copies of it) to produce a continuous partitioned whole (Wilkie & Roche, 2022). So, in solving this problem, S2 goes through all the activities of the literacy process. However, when S2 was asked to explain the form of the operation of 10 divided by half, S2's answer was almost the same as S1's, which was “multiply 10 by 2 (the inverse of half)”. It is also not much different from solving the second problem by S2, as shown in the Figure 8.

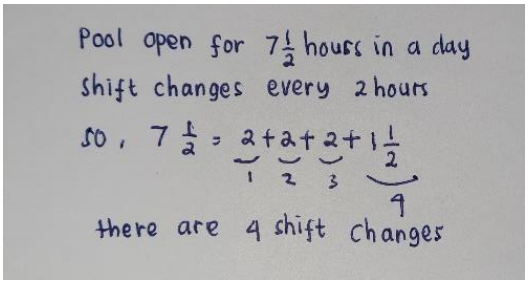

Figure 8. S2’s Answer to Question Number 2.

S2 Reproduces the whole from an improper fraction by partitioning the fraction to produce a unit fraction and iterating that fraction the appropriate number of times (Wilkie & Roche, 2022). S2 can go through all the processes of mathematical literacy activities. Here is S2's answer to question number 3.

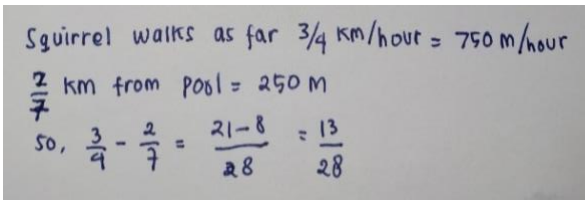

Figure 9. S2’s Answer to Question Number 3

Based on Figure 9, S2 can already create equations from velocity values in different units. However, there are errors in interpreting fractional forms to mathematical forms at the modelling stage (Putri et al., 2020). So, the process of understanding the problem of mastic has not been achieved by S2. “The speed of squirrels $\frac{3}{4}$ km per hour, to achieve a distance of 2 per seven ponds, then $\frac{3}{4}$ is reduced by $\frac{2}{7}$ “. Thus, the explanation of S2 resulted in errors in using the concepts and facts in the question. So, in this matter, S2 has not been able to go through the process of mathematical literacy activities.

Analysis of Subject with low mathematics ability (S3) literacy abilities

Figure 11 was created by S3 to visualize the form of the fraction 10 divided by two, as requested in question number 1. The subject can already understand the question request and describe what is known by the problem. S3 further explains, "If half a gram of pasta can be used to make 1 cake pan, then 1 gram of pasta can be used for 2 baking pans, and 10 grams of pasta means there are 20 baking pans”.

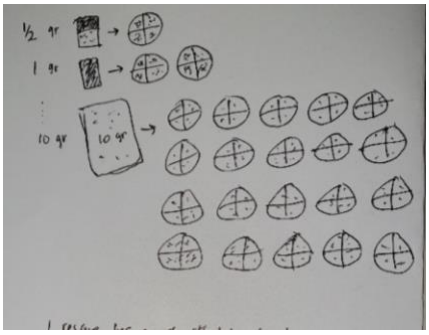

Figure 10. S3's Answer to Question Number 1

All literacy processes are appropriately passed, including the visualization stage. S3 has no constraints in explaining it. S3 partitions integers into unit fractions and iterates the unit fraction to reproduce the proper fraction the whole time (Wilkie & Roche, 2022). However, it is still consistent with S1 and S2. S3 also cannot explain the origin of "multiplying and reversing the denominator". For the second question, S3 was more comfortable explaining the answer he chose using verbal sentences (see Figure 11). S3 is reluctant to describe the visualization form of the answer to question number 2. Here, the subject uses the fingers of the hand to explain the value of $7\frac{1}{2}$ divided by 2 looks like this. "the first shift is 2 hours (while showing his fingers), the second shift is also 2 hours, the third is 2 hours, and the last is only 1 and a half hours, for a total of $7\frac{1}{2}$ hours". Here, subjects more readily associate fractional form with whole numbers (Gibim et al., 2023)

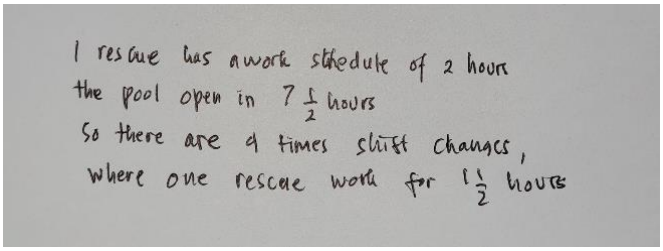

Figure 11. S3's Answer to Question Number 2

In the last question, S3 already understands the problem, but there are constraints during the process, namely when the process interprets, applies and evaluates the results of mathematical processes. As seen in Figure 12.

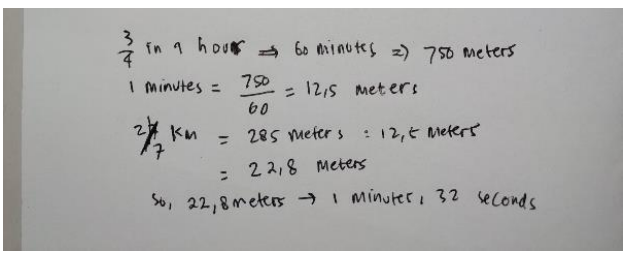

Figure 12. S3's Answer to Question Number 3

From S3's work, subjects could already write down equations where, within 1 minute, the subject could travel 12.5 meters and convert fractions of $\frac{2}{7}$ into decimal forms. However, there seems

to be an error in the final result provided (Putri et al., 2020). When asked to visualize the form of division meant by problem S3, I still can't.

DISCUSSION

For the division of a whole number by fraction, both S1, S2, and S3 can already operate the fractional form correctly and even visualise what a half's visualisation looks like with proper literacy. So, it can be said that this part does not become an obstacle to the subject. All subjects almost master the whole activity on mathematical literacy skills. This section is easier to understand because dividing the entire number is more straightforward to describe by the subject (Gibim et al. 2022). As well as the use of real-world concepts makes it easier for subjects to understand the concept of fractional division (Stohlmann et al., 2020). For the second question, where the form of division required by the problem, dividing fractions by whole numbers, is still the same as in the first question, the subject demonstrated literacy in the entire process. Still, by problem number 1, the whole subject could not convey how the concept of “multiplying and inverting” the fractional denominator and using the idea “Multiplication magnifies, division subtracts” from the multiplication and division operations in the original numbers (Uzel, 2018).

What is interesting to discuss is how the Subject can correctly perform fractional operations but cannot visualize or explain with proper mathematical literacy. The role of the teacher here is, of course, significant to expand the concept in the visualization of mathematical models or problem-solving exercises related to fractional division operations (Hsi Wu, 2021). Related to the concept of division of fractions, it is appropriate that teachers who explain the concept of fractional division first emphasize the basic concept of the fractional operation before giving the students a quick way. Mathematical literacy must be mastered and used appropriately to convey mathematical concepts to learners. Most students have not been able to visualize the shape of fractions divided by fractional numbers. They just memorized that dividing a fraction by a fraction is the same as multiplying and flipping a second fraction (Uzel, 2018). The provision of problem exercises and the proper use of mathematical literacy became the solution to this problem. Students must be able to represent problems in appropriate mathematical models and interpret them. The understanding of the concept of division is influenced by the child's level of development, which is still not fully developed at an early age. Students should be able to think abstractly and more complexly. However, to teach this concept of division, one must still begin by giving the basic concept of division from early childhood: introducing the principle of equality and the relationship between dividers and quotients (Ching & Kenneth, 2022).

CONCLUSION

From the research and discussion presented above, the authors can conclude that students' mathematical literacy is still limited when visualizing fractional forms, division of whole numbers by fractions or vice versa and division of fractions by fractional numbers. No one subject has been able to imagine using mathematical literacy exactly how the visual form of the test problem on dividing fractions by fractional numbers is. Of all the study subjects, S1, S2, and S3 stated that they had

never received an explanation of this section and simply memorized that fractional division is “multiplying and inverting” fractions. It is a consideration for us as educators to continue to hone the basic mathematical concepts of learners that absolutely must be queried by prospective mathematics teachers. Not only the provision of material but also more attention to the reasoning and thinking level of the learner. Of course, by developing their mathematical literacy skills so that they are ready to take the plunge as teachers.

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REFERENCES

Aksoy, N. C., & Yazlik, D. O. (2017). Student errors in fractions and possible causes of these errors. *Journal of Education and Training Studies*, 5(11), 219–233. https://doi.org/10.11114/jets.v5i11.2679

Astuti, D. Y., & Sabon W.K.A.Z. (2020). Analisis Kemampuan Literasi Matematika Mahasiswa dalam Penyelesaian Soal Higher Order Thinking Skills (HOTS) ditinjau pada Level 5 PISA. *ASIMTOT,* 2(2), 91–101. https://journal.unwira.ac.id/index.php/ASIMTOT

Bentley, B., & Michael J. B. (2018). College Students’ Understanding of Fraction Operations. *International Electronic Journal Of Mathematics Education*, 13(3), 1306-3030. https://doi.org/10.12973/iejme/3881

Chasanah, A. N., Wicaksono, A. B., Nurtsaniyah, S., & Utami, R. N. (2020). Analisis Kemampuan Literasi Matematika Mahasiswa Pada Mata Kuliah Statistika Inferensial Ditinjau dari Gaya Belajar. *Edumatica,* 10(2), 45-56. https://doi:10.22437/EDUMATICA.V10I2.10621

Ching, B. H.-H., & Kong, K. H. C. (2022). Development of children's informal understanding of division through sharing: Contributions of reasoning demands and problem situations. *Early Childhood Research Quarterly, 59,* 228–242. https://doi.org/10.1016/j.ecresq.2021.12.013

Copur-Gencturk, Y., Plowman, D., & Bai, H. (2019). Mathematics teachers’ learning: identifying key learning opportunities linked to teachers’ knowledge growth. *American Educational Research Journal*, 56(5), 1590– 1628. https://doi.org/10.3102/0002831218820033

Ernawati. (2021). *Problematika Pembelajaran Matematika*. Sigli: Yayasan Penerbit Muhammad Zaini.

Ervin, H.K. (2017). Fraction multiplication and division models: A practitioner reference paper. *International Journal of Research in Education and Science (IJRES)*, 3(1), 258-279. http://www.ijres.net

Fajriati, N., & Budi, M. (2022). Kemampuan Literasi Matematika Siswa Menggunakan Multimedia Interaktif. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 7(1), 945-957. https://doi.org/10.31004/cendekia.v7i1.2219

Fathani, A.H. (2016). Pengembangan Literasi Matematika Sekolah dalam Perspektif Multiple Intelligences. *Edu Sains: Jurnal Pendidikan Sains dan Matematika*, 4(2), 136-150. https://doi.org/10.23971/eds.v4i2.524

Fuentes, M., & Olmos, P. (2019). La comprensión de la relación inversa en la división en edades tempranas. *REDIMAT – Journal of Research in Mathematics Education*, 8(3), 267-292. http://dx.doi.org/10.17583/redimat.2019.4546

Gibim, G.F.B., Rifo, L., Climent, N., & Ribeiro, M. (2023). Fraction Division Representation-Experience in a Teacher Education Course Focused on the Reference Unit. *Journal of Research in Mathematics Education,* 12(3), 193-209. http://dx.doi.org/10.17583/redimat.13020

Habibi, H., & Suparman, S. (2020). Literasi Matematika dalam Menyambut PISA 2021 Berdasarkan Kecakapan Abad 21. *JKPM (Jurnal Kajian Pendidikan Matematika)*, 6(1), 57-64.

https://doi.org/10.30998/JKPM.V6I1.8177
Hansen, N., Jordan, N. C., & Rodrigues, J. (2017). Identifying learning difculties with fractions: A longitu- dinal study of student growth from third through sixth grade. *Contemporary Educational Psychology*, 50, 45–59. https://doi.org/10.1016/j.cedpsych.2015.11.002
Hidayat, F. (2022). Level Kemampuan Literasi Mahasiswa dalam Menyelesaikan Masalah Matemaqtika Materi Statistik. *Journal Of Mathematics Education,* 3(2), 135-146. https://doi.org/10.32332/linear.v3i2.5737
Hsi Wu, H. (2021). Misconceptions about the long division algorithm in school mathematics. *Journal of Mathematics Education at Teachers College*, 11(2), 1-12. https://jmetc.columbia.edu.
Ismawati, Y., & Fina, H. (2020). Kemampuan Guru Dalam Perencanaan Dan Pelaksanaan Pembelajaran Serta Pengaruhnya Terhadap Problematika Belajar Matematika Siswa. *Jurnal Karya Pendidikan Matematika*, 7(2), 40-46. https://doi.org/10.26714/jkpm.7.2.2020.40-46
Jansen, A., & Hohensee, C. (2016). Examining and elaborating upon the nature of elementary prospective teachers' conceptions of partitive division with fractions. *Journal of Mathematics Teacher Education,* 19(6), 503-522. https://doi.org/10.1007/s10857-015- 9312-0
Kristina. (2020). *Belajar Mudah Metodologi Penenlitian Kualitatif*. Jakarta: Rumah Media.
Lee, M. Y. (2017). Pre-service teachers' flexibility with referent units in solving a fraction division problem. *Educational Studies in Mathematics*, 96, 327-348. https://link.springer.com/journal/10649
Lewis, C., & Perry, R. (2017). Lesson study to scale up research-based knowledge: A randomized, con- trolled trial of fractions learning. *Journal for Research in Mathematics Education*, 48(3), 261–299. https://doi.org/10.5951/jresematheduc.48.3.0261
Masjaya & Wardono. (2018). Pentingnya Kemampuan Literasi Matematika untuk Menumbuhkan Kemampuan Koneksi Matematika dalam Meningatkan SDM. PRISMA, *Prosiding Seminar Nasional Matematika*, 1, 568–574. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/20196
Matondang, K., Risna, M.B.H., & Daulay, L.A., Agustina Daulay. (2023). Analisis Kemampuan Literasi Matematika Siswa. *OMEGA: Jurnal Keilmuan Pendidikan Matematika*, 2(3), 142-148. https://ejurnal.univamedan.ac.id/index.php/jkpm/index
Mulyono, B., & Hapizah. (2018). Pemahaman Kosep dalam Pembelajaran Matematika. *KALAMATIKA Jurnal Pendidikan Matematika*, 3(2), 103-122. https://www.researchgate.net/publication/328648696_PEMAHAMAN_KONSEP_DALAM_PEMBELAJARAN_MATEMATIKA
OECD. (2013). PISA 2012 assessment and analytical framework: mathematics, reading, science, problem solving and finacial literacy. Finlandia: OECD Publishing.
Oktaviyanthi, R., & Agus, R. N. (2019). Eksplorasi kemampuan pemecahan masalah mahasiswa berdasarkan kategori proses literasi matematis. *Jurnal Pendidikan Matematika*, 13(2), 163-184. https://doi.org/10.22342/JPM.13.2.7066.163-184
Prasetyani & Suparman. (2018). Literasi Matematika dan Kemampuan Berpikir Tingkat Tinggi Mahasiswa kaitannya dengan Soal PISA. *Prosiding Semnas UMP*. 12 Mei 2018. https://api.semanticscholar.org/CorpusID:150205359
Putri, J.I., Bagus, A.S., & Riris, S.S. (2020) Analysis of Difficulty Learning Operations to Calculate Multiplication and Division during the Pandemic (Covid-19) in Elementary Schools. *DIDAKTIKA Jurnal Pendidikan Sekolah Dasar*. 3(2). 129–138. https://journal.uny.ac.id/index.php/didaktika
Ridzkiyah, N & Kiki, N.S.E. (2021). Analisis Kemampuan Literasi Matematis Siswa SMA dalam Menyelesaikan Soal Program for International Student Assessment (PISA). *Jurnal Ilmiah Pendidikan Matematika*, 6(1), 1-13. https://doi.org/10.26877/JIPMAT.V6I1.8237
Rosyidah, Awal. N.K., Mohammad A.M., & Itsna. O. (2020). Miskonsepsi Matematika Mahasiswa PGSD Pada Penyelesaian Operasi Hitung Bilangan Bulat. *Jurnal Ilmiah KONTEKSTUAL*, 2(1), 15-21. http://jurnal.umus.ac.id/index.php/kontekstual
Sadiah, D.S., Ekasatya., & Aldila, A.(2023). Miskonsepsi siswa ditinjau dari tingkat penyelesaian masalah pada materi operasi pecahan. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu (PME),* 2(1), 31-44. https://doi.org/10.31980/powermathedu.v2i1.2718
Stohlmann, M., Yichen, Y., Xing, H., & Travis, O. (2020). Fourth to Sixth Grade Teachers' Invented Real World Problems and Pictorial Representations for Fraction Division. *International Electronic Journal Of Mathematics Education*, 15(1), 2-16. https://doi.org/10.29333/iejme/5939
Sutikno, M. S., & Prosmala, H. M. (2020). *Penelitian Kualitatif*. Lombok: Holistica.
Uzel, D. (2018). Investigation of Misconceptions and Errors about Division Operation in Fractions. *Universal Journal of Educational Research,* 6(11), 2656-2662. http://www.hrpub.org DOI:

10.13189/ujer.2018.061131
Wardani, A. K., Zulkardi, & Hartono, Y. (2017). Pengembangan Soal Matematika Model PISA Level 5 untuk Program Pengayaan SMP. *Jurnal Pendidikan Matematika RAFA*, 6(1), 1-18. https://doi.org/10.19109/jpmrafa.v3i1.1438
Wilkie, K. J., & Roche, A. (2022). Primary teachers' preferred fraction models and manipulatives for solving fraction tasks and for teaching. *Journal of Mathematics Teacher Education*, 2(6), 703–733. https://doi.org/10.1007/s10857-022-09542-7