

EMPOWERING MATHEMATICAL PROFICIENCY BY DEVELOPING ENRICHMENT BOOK IN THE TOPIC OF RATIONAL NUMBERS

Etika Ramadani¹, Sukardi²

^{1, 2*} Institut Teknologi Bandung, Bandung, Indonesia

*Corresponding author. Ganesha, 40132, Bandung, Indonesia.

E-mail: hallo.etik98@gmail.com¹⁾
shanedizzy6@gmail.com^{2*)}

Received 26 July 2023; Received in revised form 14 March 2024; Accepted 02 June 2024

Abstract

In Indonesia, there exists a significant gap in mathematical proficiency levels among students, evidenced by declining achievement rates over time and exacerbated by the COVID-19 pandemic, as revealed by recent studies and assessments such as PISA 2022. This research aims to develop an enrichment book in the topic of rational numbers that can enhance the mathematical proficiency level of junior high school students. This research uses the R&D approach which adopts the ADDIE model. The research instruments used in this study include validation sheets for subject matter expert, validation sheets for graphic expert, response questionnaire for teacher, pretest sheets, and posttest sheets. After the initial draft of the enrichment book was produced, the research continued with validating the book by a subject matter expert, a graphic expert, and a mathematics teacher. In the implementation phase, the validated and revised book was then tested on 29 seventh-grade students at Al Falah Junior High School, located in Dago region, Bandung city. Descriptively, the average score of students' pretest was 32.6%, while the average score of their posttest was 75.2%. The enrichment book has been shown to improve students' scores significantly according to the N-gain, meaning that it significantly enhances students' mathematical proficiency level. Based on the established categories, these results indicate that the developed enrichment book can enhance students' mathematical proficiency level.

Keywords: Enrichment book; mathematical proficiency; rational numbers

Abstrak

Di Indonesia, terdapat kesenjangan signifikan dalam tingkat kecakapan matematis siswa, yang diperparah oleh pandemi COVID-19, seperti yang dibuktikan oleh penurunan tingkat prestasi dari waktu ke waktu dan penilaian terbaru seperti PISA 2022. Penelitian ini bertujuan untuk mengembangkan buku pengayaan pada materi bilangan rasional yang dapat meningkatkan level kecakapan matematis untuk siswa SMP/MTs. Penelitian ini menggunakan pendekatan penelitian dan pengembangan dengan model ADDIE (analysis, design, development, implementation, and evaluation). Instrumen yang digunakan dalam penelitian ini meliputi lembar validasi ahli materi, lembar validasi ahli kegrafikaan, angket respons untuk guru, lembar tes awal, dan lembar tes akhir. Setelah dihasilkan draf awal buku pengayaan, kegiatan penelitian dilanjutkan dengan memvalidasi buku pengayaan oleh ahli materi dan kegrafikaan. Pada tahap implementasi, buku yang telah divalidasi dan direvisi kemudian diujicobakan kepada 29 orang siswa kelas VII di SMP Al Falah yang terletak di wilayah Dago, Kota Bandung. Secara deskriptif, rata-rata nilai tes awal siswa adalah 32,6%, sedangkan rata-rata nilai tes akhir siswa adalah 75,2%. Perhitungan N-gain memberikan kesimpulan bahwa buku pengayaan dinyatakan efektif dalam meningkatkan kecakapan matematis siswa secara signifikan. Berdasarkan kategori yang ditetapkan, hasil ini menunjukkan bahwa buku pengayaan yang dikembangkan ini dapat meningkatkan level kecakapan matematis siswa.

Kata kunci: Bilangan rasional; buku pengayaan; kecakapan matematis



This is an open access article under the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

INTRODUCTION

Nowadays, 21st-century skills have become a set of abilities that every individual, especially the younger generation, needs to possess in order to tackle various ongoing challenges. On the other hand, 21st-century skills cannot be achieved without efforts to enhance the various components that make them so complex. One of the components that needs to be developed in order to attain 21st-century skills is mathematical proficiency (Khalil & Alnatheer, 2020; Rizki & Priatna, 2019).

The success of an individual in learning mathematics can be seen through five strands of mathematical proficiency, namely: (1) conceptual understanding, (2) procedural fluency, (3) strategic competence, (4) adaptive reasoning, and (5) productive disposition outlined by National Research Council (Li, Howe, & Lewis, 2021). These five strands of mathematical proficiency are not separate but rather united in a complex interplay that represents a more comprehensive aspect (Yulian & Wahyudin, 2018; Hamid, Angkotasari, Jalal, Muhtadi, & Sukirwan, 2020). Both teachers and students need to reach a good level of mathematical proficiency because it represents the purpose of learning mathematics (Altarawneh & Marei, 2021; Elsayed, 2022).

However, issues related to efforts in improving mathematical proficiency levels are common in various countries (Kandeel, 2021), including Indonesia. The fact is that Indonesian students can be considered unsuccessful in mathematics based on their measurable achievements (Beatty, Berkhout, Bima, Pradhan, & Suryadarma, 2021). Based on the research that examined the relationship between educational

attainment and mathematics learning outcomes of Indonesian children nationally in 2000 and 2014, a significant gap was found. The average mathematical achievement of seventh-grade students in 2014 was equivalent to the average achievement of 4th-grade students in 2000, especially in the topic of fractions. This is strengthened by data from the Programme for International Student Assessment (PISA) in 2022, which stated that Indonesia only achieved an average score of 366 in mathematics, a decline compared to PISA in 2018 (OECD, 2023).

This situation has been further exacerbated by the COVID-19 pandemic in Indonesia over the past two years (2020–2022). The shift to remote learning modalities, which has forced students to predominantly engage in self-directed learning at home, has resulted in most students experiencing learning loss (Komalawati, 2020; Parahita, Astutik, Ghufroudin, & Yuhastina, 2023; Maba, Widiastuti, Mantra, Suartama, & Sukanadi, 2023; Suyadi, Selvi, Sibawaihi, Zahroh, & Muassomah, 2023). Based on data on students' numeracy skills during the pandemic, out of 110 elementary school students, 87% of students were unable to perform basic division operations, 48% of students were unable to perform basic multiplication operations, 38% of students were unable to perform basic subtraction operations, and 17% of students were unable to perform basic addition operations (Widodo & Umar, 2022). These facts emphasize the need for various efforts by teachers in the classroom to help students understand rational numbers effectively, including engaging them in meaningful learning experiences (Hoof, Degrande, Ceulemans, Verschaffel, & Dooren, 2018).

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

On the other hand, rational numbers are indeed one of the most challenging topics in the elementary and secondary school curriculum (Depaepe, 2015). It is not only students who struggle with this topic but also prospective teachers and mathematics teachers themselves (Novita, et al., 2022). One of the reasons is the presence of gaps that arise due to inaccuracies in understanding the analogies between the properties of rational numbers and the properties of natural numbers previously learned (Dooren, Lehtinen, & Verschaffel, 2015). The difficulties students face in learning rational numbers necessitate teachers to find more effective solutions (Kiili, Moeller, & Ninaus, 2018; Depaepe, 2015).

Meanwhile, one of the resources that can be used to enhance students' knowledge and learning outcomes is textbooks (Hartagung, Sunaryo, & Fahdiran, 2018). Textbooks are commonly used in mathematics classrooms as a learning source. However, most textbook contents are too textual and lack relevance to daily life, which makes it difficult for students to learn effectively (Hartagung, Sunaryo, & Fahdiran, 2018). Meanwhile, enrichment books can enhance students' knowledge and improve their skills in science, technology, arts, and shape the character of students, educators, education, especially on mathematics learning in school (Pradyumnati, 2018). However, there is currently no enrichment book available that can accommodate the needs of students and teachers in comprehensively learning rational numbers.

Regarding the issues mentioned above, the development of an enrichment book in the topic of rational numbers for seventh-grade students in

junior high schools can be one of the contributing solutions to address the problem. Specifically, this enrichment book is designed to enhance students' mathematical proficiency. Therefore, this research will focus on the development of an enrichment book on rational numbers for seventh-grade students in junior high schools that can improve students' mathematical proficiency.

METHOD

This research uses the research and development (R&D) approach which adopts the analysis, design, development, implementation, and evaluation (ADDIE) model. As the name suggests, the ADDIE development model consists of five stages. Its systematic workflow is expected to make the developed enrichment book beneficial as intended by the researchers (Suryani, Setiawan, & Putria, 2018). The resulting product in this research was an enrichment book for junior high school students that comprehensively covers topic of rational numbers in order to enhance students' mathematical proficiency. Specifically, the enrichment book was developed with reference to the mathematics learning outcomes in Phase D (7th, 8th, and 9th grades) according to the Merdeka Curriculum syllabus. This research took place from November 2022 to May 2023 at Al Falah Junior High School, located in the Dago region, Bandung.

The sample used in this research consists of 29 students from Class VII A of Al Falah Junior High School (academic year 2022/2023), selected using the cluster random sampling technique from 6 available classes. The study also involved 1 subject matter expert, 1 graphic design expert, and 1 mathematics teacher, totaling three

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

validators. The research instruments used included the expert validation sheet for the subject matter expert, expert validation sheet for the graphic design expert, response questionnaire for teacher, pretest sheet, and posttest sheet.

According to the ADDIE model, in the analysis phase, the researchers identified the causes of performance gaps by considering resource limitations and motivation. The analysis phase in this study included several procedures that involve collecting information regarding the reasons for the development of the enrichment book. The relevant information was obtained through interviews with teachers and students from Al Falah Junior High School, as well as the analysis of the pretest results related to topic of rational numbers.

In the design phase, the researchers employed a backward design method, which began by establishing learning objectives, determining assessments, and culminating in the design of the enrichment book. Specifically, the learning objectives related to the topic of rational numbers were based on the learning outcomes of the Merdeka Curriculum for students in Phase D (Kemendikbudristek, 2022), categorized according to the five strands of mathematical proficiency outlined by Li, Howe, and Lewis (2021).

The process of determining assessments was conducted to initiate the design of the pretest and posttest, which were designed with the same number of items and difficulty level. The scores obtained from both tests would have been used to measure students' mathematical proficiency before and after using the enrichment book. Meanwhile, the enrichment book was designed using Microsoft Publisher

2016, Microsoft Word 2016, Microsoft PowerPoint 2016, and Canva, operated on a laptop running Windows 11 operating system.

In the development phase, the research activities carried out to realize the enrichment book included creating the enrichment book, expert validation by the subject matter expert and graphic design expert, response by the teacher, and revision based on comments and suggestions from the validators. It's worth noting that the validation aspects of the enrichment book used by the researchers for the subject matter expert and graphic design expert referred to the evaluation instruments and review from the (Pusat Perbukuan, 2023). Meanwhile, the response aspect of the enrichment book by the teacher referred to the instruments according to Lestari (2013) and the Pusat Perbukuan (2023).

In the implementation phase, the revised enrichment book would have been used in classroom instruction to gather feedback from students. In this phase, the trial of the enrichment book was conducted with the students of Class VII A at Al Falah Junior High School. The learning sessions took place from May 4th to May 25th, 2023, consisting of 6 sessions. After sixth session, the posttest was administered to the students.

In the evaluation phase, two types of evaluation were conducted. First, formative evaluation was carried out by collecting data during the implementation phase, which was used for product refinement. Second, summative evaluation was conducted by collecting data from the pretest and posttest scores. The N-gain was performed on the pretest and posttest data to determine the effectiveness of the book. The calculations required for this will be done using the assistance of the

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

RStudio software with product version 2022.12.0+353.

Specifically, effectiveness of the book can be measured by the N-gain score obtained from each item of the pretest and posttest. The N-gain score, denoted by g , can be determined as follows:

$$g = \frac{\bar{x}_{po} - \bar{x}_{pr}}{100 - \bar{x}_{pr}} \# \quad (1)$$

where \bar{x}_{pr} and \bar{x}_{po} represents the average score of pretest and posttest of each item, respectively. Specifically, the effectiveness of the book can be categorized into three categories based on the N-gain score, as shown in Table 1.

Table 1. Categories of book effectiveness based on N-gain score

N-gain score (g)	Category
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Medium
$g < 0,3$	Low

To assess the extent to which the developed enrichment book can enhance students' mathematical proficiency, it is necessary to use scoring categories. Assume M is half of the maximum score plus the minimum score, S is one-sixth of the maximum score minus the minimum score, and X is the obtained score. Therefore, using Table 2, the scores obtained by students from the pretest and posttest can be categorized into 5 (five) proficiency levels as follows, adopted from norm-referenced assessment by Widiyanto (2018).

Table 2. Categories of students' mathematical proficiency levels

Score Interval	Category
$M + 1,5S < X \leq M + 3S$	Very high
$M + 0,5S < X \leq M + 1,5S$	High
$M - 0,5S < X \leq M + 0,5S$	Medium
$M - 1,5S < X \leq M - 0,5S$	Low
$M - 3S \leq X \leq M - 1,5S$	Very low

Since the minimum and maximum scores obtained from both the pretest and posttest are 0 and 100, respectively, we have $M = \frac{1}{2}(100 - 0) = 50$ and $S = \frac{1}{6}(100 - 0) = 16.7$. Based on these calculations, the adjusted score range for this research is provided in Table 3, with rounding performed to zero decimal places.

Table 3. Adjusted categories of students' mathematical proficiency levels

Score interval	Category
$75 < X \leq 100$	Very high
$58 < X \leq 75$	High
$42 < X \leq 58$	Medium
$25 < X \leq 42$	Low
$0 \leq X \leq 25$	Very low

RESULT AND DISCUSSION

This research was conducted systematically using the phases of the ADDIE model. Each phase will be described in detail regarding the research activities conducted. Researchers will also present the results of validation by experts and mathematics teacher, and the statistical analysis of scores from pretest and posttest done by students.

The research activities began with the analysis phase. In this phase, the researchers sought to gather information related to the conditions and situations of students and teachers at Al Falah Junior High School regarding their understanding of the topic of rational numbers. It is important to note that the school has implemented the Merdeka Curriculum, specifically for seventh-grade students. First, The researchers observed seventh-grade students in one of mathematics class taught by teachers at the school. This is used to identify students' weaknesses in learning rational numbers. Then, the researchers

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

administered a pretest to 29 students from Class VII A, focusing in the topic of rational numbers. After that, the researchers conducted interviews with several Mathematics teachers and students to gather more detailed information regarding their understanding of the topic of rational numbers.

In fact, the students demonstrated poor performance in the subject, as indicated by the pretest scores and interview results. The average percentage of the pretest scores was only 32.6%. Both students and teachers expressed the need for a handbook that provides problem-based contextual learning and includes numerous engaging examples and exercises.

In the design phase, the researchers utilized a backward design method, starting with establishing learning objectives, determining assessments, and designing the enrichment book. The learning objectives in this book are based on the mathematics learning outcomes in Phase D of the Merdeka Curriculum syllabus and the principles and standards documents of mathematics by the National Council of Teachers of Mathematics (NCTM) (NCTM, 2000), adapted to the five strands of mathematical proficiency. Specifically, the learning objectives can be seen in Table 4.

Table 4. Learning objectives for the topic of rational numbers

Strand of mathematical proficiency	Learning objectives
Conceptual understanding	<ol style="list-style-type: none"> 1. Restating the concept of fractions as part of a whole, division, measurement, operator, and ratio. 2. Restating the concept of equivalent fractions, both in the form of proper fractions, decimal fractions, and percentages, and comparing them in real-life contexts. 3. Restating fraction operations in real-life contexts.
Procedural fluency	<ol style="list-style-type: none"> 1. Applying the concepts and operations of proper fractions, decimal fractions, and percentages flexibly, accurately, efficiently, and appropriately in problem-solving. 2. Utilizing the properties of associativity, commutativity, distributivity, and inverse rules related to operations involving fractions. 3. Calculating percentages and their changes in relation to contextual problems.
Strategic competence	<ol style="list-style-type: none"> 1. Understanding the situations and conditions of problems related to proper fractions, decimal fractions, and percentages. 2. Determining the best solutions to problems involving proper fractions, decimal fractions, and percentages. 3. Verifying the correctness of alternative solutions used to solve problems related to proper fractions, decimal fractions, and percentages.
Adaptive reasoning	<ol style="list-style-type: none"> 1. Examining the validity of arguments by providing reasons or evidence related to statements related to the concepts and operations of fractions. 2. Drawing conclusions from statements related to the concepts and operations of fractions.

Strand of mathematical proficiency	Learning objectives
Productive disposition	1. Viewing the concepts and operations of fractions as a logical and useful field of knowledge. 2. Providing answers confidently and valuing one's own abilities.

The learning objectives outlined in Table 4 encompass various aspects of mathematical proficiency related to fractions. Conceptual understanding is fundamental, ensuring students grasp the core concepts of fractions as parts of a whole, division, measurement, operator, and ratio. Procedural fluency is emphasized by the objective of applying fraction concepts and operations flexibly, accurately, efficiently, and appropriately in problem-solving situations. Strategic competence involves understanding problem situations, determining the best solutions, and verifying their correctness. Adaptive reasoning is fostered through examining the validity of arguments related to fraction concepts and operations and drawing conclusions from statements. Finally, productive disposition emphasizes viewing fractions as a logical and useful field of knowledge and providing answers confidently.

The enrichment book developed in this research is titled "Cakap Bermatematika dalam Bilangan Rasional" (in English, "Mathematically Proficient in Rational Numbers"). The contents of this book are written in Indonesian language. The framework of the developed enrichment book includes a cover page, author's identity page, preface, table of contents, important information related to learning outcomes, introduction page, main content pages, bibliography, index, and author's biography. Specifically, the developed enrichment book consists of 4 chapters, all of which are included in

the main content pages. Chapter 1 discusses topics related to the basic concept of rational numbers in the form of proper fractions. Chapter 2 discusses topics related to operations on rational numbers in the form of proper fractions. Then, Chapter 3 discusses topics related to decimal fractions. Finally, Chapter 4 discusses topics related to percentages. Overall, the enrichment book consists of 149 pages (including the cover).

The designed enrichment book was then validated by an expert in the subject matter who was an experienced mathematics education practitioner. The aspects evaluated in the validation process include content appropriateness, language appropriateness, and presentation appropriateness, which are described in 17 Likert-scale statements with 4 response options. The validation results by the subject matter expert on the provided validation sheet can be seen in Table 6.

Table 6. Validation results of the enrichment book by the subject matter expert

Aspect	Number of statements	Average score
Content appropriateness	10	3.30
Language appropriateness	3	2.33
Presentation appropriateness	4	3.33

The subject matter expert validator also provided suggestions regarding the validated enrichment book. Firstly, the researchers was asked

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

to enhance the book by adding a self-reflection column at the end of each learning chapter, an index after the bibliography, and author's biography at the end of the book. The subject matter expert validator also requested the researchers to improve sentence structure, ensure the logical flow of the content, and increase the number of exercise questions. The researchers followed the advice of the subject matter expert by revising the developed book.

In addition to the subject matter expert validator, the enrichment book was also validated by a graphic design expert validator. The graphic design expert validator for this enrichment book was a visual communication designer at the Bandung Institute of Technology Career Center. The aspects evaluated in the validation process include book cover design, book content design, and book physical design, which are described in 14 Likert-scale statements with 4 response options. The validation results by the graphic design expert on the provided validation sheet can be seen in Table 7.

Table 7. Validation results of the enrichment book by the graphic design expert

Aspect	Number of statements	Average score
Book cover	4	3.25
Book content	6	3.50
Book physical	4	3.25

The graphic design expert validator also provided comments and suggestions regarding the validated enrichment book. The graphic design expert validator stated that the font and book illustrations were already good and suitable for explaining the content of each chapter. Furthermore, the graphic design expert validator also

suggested using thicker paper for printing the book to avoid shadows appearing on the book pages. All of these suggestions can improve the level of attractiveness and readability of mathematics book (Arroida & Retnawati, 2018).

The validated and revised enrichment book, based on the suggestions of the subject matter and graphic design expert validators, was then given to the Mathematics teacher at Al Falah Junior High School, for response. The response aspects include content, language, presentation, and graphic design appropriateness, which are described in 21 Likert-scale statements with 4 response options. The response results by the teacher on the provided response questionnaire can be seen in Table 8.

Table 8. Response results of the enrichment book by the teacher

Aspect	Number of statements	Average score
Content appropriateness	10	3.80
Language appropriateness	3	4.00
Presentation appropriateness	4	4.00
Graphic design appropriateness	4	4.00

The teacher also provided comments and suggestions regarding the assessed enrichment book. The researchers was requested to review the use of the variable symbol x in some exercise questions as it was considered less appropriate. Instead, the researchers was asked to use symbols such as an empty box or other symbols that would appear more concrete to the students, as incorporating concrete learning experiences may enhance students' understanding (Rusiman, et al., 2017).

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

This suggestion was made because the introduction to algebraic concepts begins after the completion of integer learning. The appearance of the

enrichment book can be seen in Figure 1.

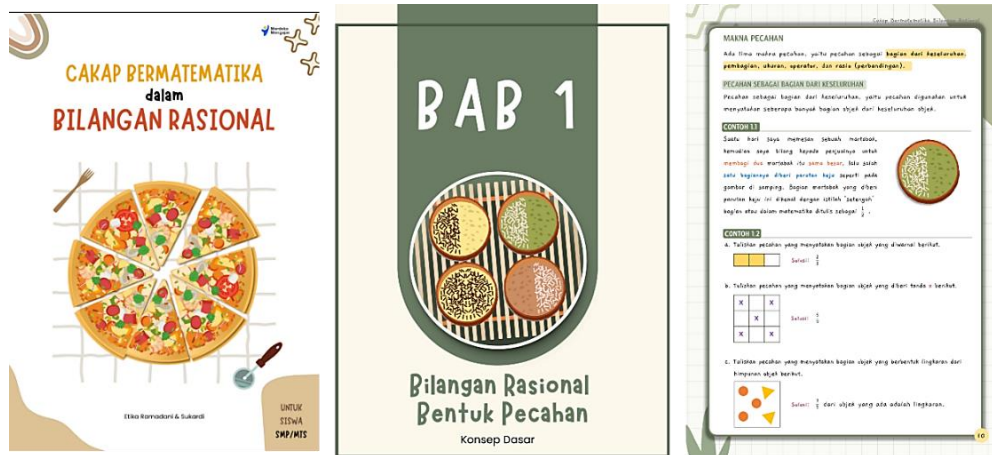


Figure 1. Appearance of the developed enrichment book

After the revisions were completed, the enrichment book was implemented in the teaching and learning process in class VII A of Al Falah Junior High School. The implementation took place from May 4th to May 25th, 2023, for a duration of 3 weeks or 6 sessions, specifically focusing in the topic of rational numbers. During the learning process, the students were divided into 7 study groups, with each group consisting of 4 to 5 students. Each student was provided with the enrichment book in both print and electronic (PDF) formats.

Broadly speaking, the implementation of the learning using the enrichment book involved activities such as studying the materials, engaging in performance-based and project-based activities, and working on exploration problems as presented in the enrichment book. Additionally, the students were given the opportunity to present their work ideas in front of the class. During the implementation of the learning process, the researchers as the developer of the enrichment book was

accompanied by the Mathematics teacher and two peer colleagues. After the final session, the researchers conducted the posttest. By engaging in various activities and discussions, students likely deepen their understanding of mathematical concepts beyond what is covered in traditional classroom settings (Rimm-Kaufman, E., Larsen, Curby, & Abry, 2015; Bear, et al., 2018; Alrajeh & Shindel, 2020).

Next, in the evaluation phase, the researchers conducted testing and interpretation of the data from the pretest and posttest scores to identify whether there was an improvement in the students' mathematical proficiency level in the topic of rational numbers. Furthermore, the researchers aimed to observe whether the developed enrichment book could improve students' mathematical proficiency level in that topic. The data from the pretest and posttest scores can be seen in Figure 2.

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

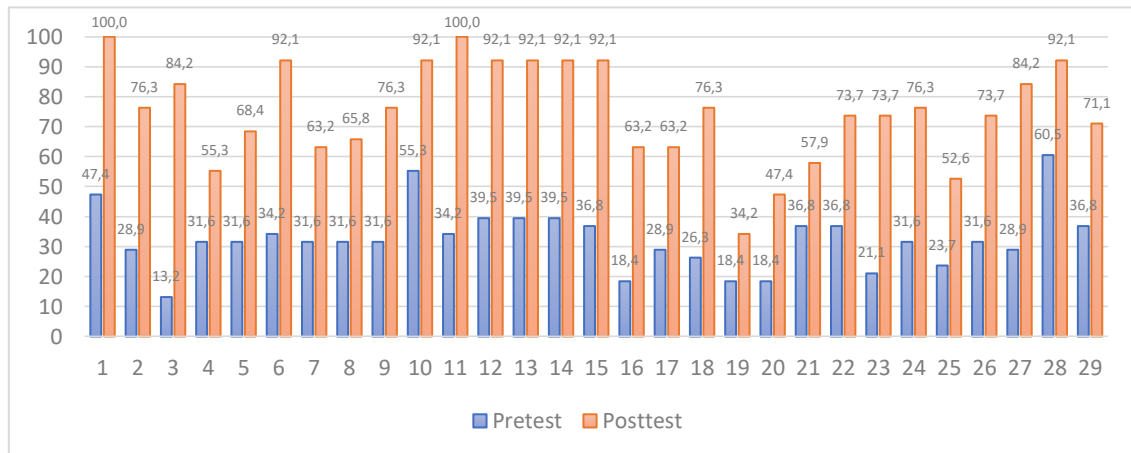


Figure 2. Student scores data during the pretest and posttest

The effectiveness level of the book, as measured by the mean of student scores for each test item in both tests, can be determined from the N-

gain scores shown in Table 9. As it shows, most students experienced a significant increase in scores based on question numbers.

Table 9. N-gain scores of each test item in both tests

Question number	Mean of pretest score	Mean of posttest score	N-gain score	Category
1	43.97	86.21	0.8	High
2	28.45	76.72	0.7	High
3	48.28	93.10	0.9	High
4	24.14	75.86	0.7	High
5	56.32	88.51	0.7	High
6	31.03	56.90	0.5	Medium
7	15.17	71.03	0.7	High
8	16.38	62.93	0.6	Medium
9	57.47	73.56	0.4	Medium
10	24.83	69.66	0.6	Medium

The enrichment book developed in this research has been validated by a subject matter expert, a graphic design expert, and a mathematics teacher at Al Falah Junior High School. The use of this enrichment book has statistically proven to improve students' proficiency levels, particularly in the topic of rational numbers. Therefore, it is expected that this enrichment book can be utilized as a learning resource, specifically for the topic of rational numbers. In addition, the developed enrichment book can be accessed online

through the link bit.ly/Buku_Pengayaan_Bilangan_Rasional.

The findings of this study suggest that the development and implementation of the enrichment book have a demonstrable impact on improving students' proficiency levels in the topic of rational numbers. Through careful observation and analysis, it was evident that students who engaged with the enrichment materials exhibited significant enhancements in their understanding and mastery of rational numbers

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

concepts. The structured approach provided in the enrichment book facilitated a deeper comprehension of fundamental principles, leading to improved problem-solving skills and overall mathematical proficiency among students (Awofala, 2017).

This conclusion aligns with previous research indicating the effectiveness of targeted instructional resources in bolstering student learning outcomes (Kristanto & Santoso, 2020; Basyal & Mainali, 2023). By offering a comprehensive and accessible resource tailored to the needs of learners, the enrichment book represents a valuable tool for educators seeking to enhance mathematical proficiency in their classrooms, contributing to the gradual increase of Indonesia's PISA scores in mathematics. Enhanced mathematical proficiency equips students with the necessary skills to tackle complex mathematical problems with greater confidence and accuracy (Go, 2023). As students become more proficient, they develop a deeper understanding of mathematical concepts and are better able to apply these concepts in various real-world contexts, such as science, engineering, economics, and finance.

The enrichment book indeed can improve students' mathematical proficiency in the topic of rational numbers. However, it should be noted that this enrichment book only covers one of the mathematics topics studied by junior high school students. Although discussed in detail, other enrichment books that accommodate different topics are certainly needed.

CONCLUSION AND SUGGESTION

This research has produced an enrichment book related to the topic of rational numbers for junior high school students that can improve students'

mathematical proficiency levels. The book was designed using the ADDIE model and has been validated by A subject matter expert, a graphic design expert and a mathematics teacher at Al Falah Junior High School. Based on the pretest and posttest conducted on 29 seventh-grade students at the school, the enrichment book has been shown to improve students' scores significantly according to the N-gain. This shows that the enrichment book can significantly enhance students' mathematical proficiency levels.

This research specifically aims to enhance students' mathematical proficiency levels in the topic of rational numbers. Therefore, future research can explore the development of instructional media that can improve students' mathematical proficiency levels in other mathematical topics while adhering to the guidelines and framework of the Merdeka Curriculum.

REFERENCES

- Alrajeh, T. S., & Shindel, B. W. (2020). Student engagement and math teachers support. *Journal on Mathematics Education*, 11(2), 167–180.
<https://doi.org/10.22342/jme.11.2.10282.167-180>
- Altarawneh, A. F., & Marei, S. T. (2021). Mathematical proficiency and preservice classroom teachers instructional performance. *International Journal of Education and Practice*, 9(9), 354–364.
<https://doi.org/10.18488/journal.6.12021.92.354.364>
- Arroida, A. K., & Retnawati, E. (2018). Analysis of mathematics textbook for grade X (high school) [in Bahasa]. *Jurnal Pedagogi Matematika*, 7(3).

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

- <https://doi.org/10.21831/jpm.v7i3.10785>
- Awofala, A. O. (2017). Assessing senior secondary school students' mathematical proficiency as related to gender and performance in mathematics in Nigeria. *International Journal of Research in Education and Science (IJRES)*, 3(2), 488–502. Retrieved from <https://www.ijres.net/index.php/ijres/article/view/242/pdf>
- Basyal, D., & Mainali, B. R. (2023). Mathematics textbook: motivation, experiences, and didactical aspect from authors' perspectives. *Research in Mathematics Education*, 25(3), 323–341. <https://doi.org/10.1080/14794802.2022.2086608>
- Bear, G. G., Yang, C., Chen, D., He, X., Xie, J. S., & Huang, X. (2018). Differences in school climate and student engagement in China and the United States. *School Psychology Quarterly*, 33(2), 323–335. <http://dx.doi.org/10.1037/spq0000247>
- Beatty, A., Berkhout, E., Bima, L., Pradhan, M., & Suryadarma, D. (2021). Schooling progress, learning reversal: Indonesia's learning profiles between 2000 and 2014. *International Journal of Educational Development*(85), 1–16. doi:<https://doi.org/10.1016/j.ijeducdev.2021.102436>
- Depaepe, F. (2015). Teachers' content and pedagogical content knowledge on rational numbers: A comparison of prospective elementary and lower secondary school teachers. *Teaching and Teacher Education*, 47, 82–92. <https://doi.org/10.1016/j.tate.2014.12.009>
- Dooren, W. V., Lehtinen, E., & Verschaffel, L. (2015). Unraveling the gap between natural and rational numbers. *Learning and Instruction*, 1–4. <https://doi.org/10.1016/j.learninstruc.2015.01.001>
- Elsayed, S. A. (2022). The effectiveness of learning mathematics according to the STEM approach in developing the mathematical proficiency of second graders of the intermediate school. *Education Research International*. <https://doi.org/10.1155/2022/5206476>
- Go, M. C. (2023). Enhancing mathematical proficiency assessment: Insights from mathematics teachers. *Science International*, 35, 773–780.
- Hamid, H., Angkotasan, N., Jalal, A., Muhtadi, D., & Sukirwan. (2020). Students' mathematical proficiency in solving calculus problems after Maple implementation. *J. Phys.: Conf. Ser.*, 1613 012025. Yogyakarta.
- Hartagung, R. T., Sunaryo, S., & Fahdiran, R. (2018). Development of knowledge enrichment book "From Stellar Evolution to Gravitational Waves" for high school students. *Prosiding Seminar Nasional Fisika (E-Journal)*. <https://doi.org/10.21009/03.SNF2018.01.PE.10>
- Hoof, J. V., Degrande, T., Ceulemans, E., Verschaffel, L., & Dooren, W. V. (2018). Towards a mathematically more correct understanding of rational numbers: A longitudinal study with upper elementary school

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

- learners. *Learning and Individual Differences*, 61, 99–108. <https://doi.org/10.1016/j.lindif.2017.11.010>
- Kandeel, R. A. (2021). Learners' mathematics proficiency levels on PISA 2018: A comparative study. *International Journal of Instruction*, 14(3), 393–416. <https://doi.org/10.29333/iji.2021.14323a>
- Kemendikbudristek. (2022). *Achievement of Learning in the Merdeka Curriculum [in Bahasa]*. Jakarta: Kemendikbudristek.
- Khalil, I., & Alnatheer, M. (2020). Developing a learning unit in light of the integration between the mathematical proficiency and the 21st century skills. *Proceeding in the 14th International Technology, Education and Development (INTED) 2020 Conference*, (pp. 2501–2506). <http://dx.doi.org/10.21125/inted.2020.0761>
- Kiili, K., Moeller, K., & Ninaus, M. (2018). Evaluating the effectiveness of a game-based rational number training - In-game metrics as learning indicators. *Computers & Education*, 120, 13–28. <https://doi.org/10.1016/j.compedu.2018.01.012>
- Komalawati, R. (2020). Management of the implementation of diagnostic tests in primary schools post remote learning to identify learning loss [in Bahasa]. *Jurnal EDUPENA*, 1(2), 135–148. Retrieved from <https://ejournal.edupena.id/index.php/jurnaledupena/article/download/33/19/23>
- Kristanto, Y. D., & Santoso, E. B. (2020). Towards a mathematics textbook for supporting 21st century learning: The student perspective. *J. Phys: Conf. Ser.* 1657 012037. <https://doi.org/10.1088/1742-6596/1657/1/012037>
- Lestari, I. (2013). *Development of Competency-based Teaching Materials [in Bahasa]*. Padang: Akademia Permata.
- Li, Y., Howe, R. E., & Lewis, W. J. (2021). *Developing Mathematical Proficiency for Elementary Instruction*. Cham: Springer. <https://doi.org/10.1007/978-3-030-68956-8>
- Maba, W., Widiastuti, I. A., Mantra, I. B., Suartama, I. K., & Sukanadi, N. L. (2023). Learning loss: Impact of the COVID-19 pandemic on the students' psychosocial condition. *Journal of Education and e-Learning Research*, 10(2), 209–214. <https://doi.org/10.20448/jeelr.v10i2.4543>
- NCTM. (2000). *Principles and Standards for School Mathematics*. Reston: NCTM.
- Novita, R., Herman, T., Suryadi, D., Dasari, D., Putra, M., & Fitra, R. (2022). The analysis of conceptual and procedural knowledge of prospective elementary school teachers in rational numbers [in Bahasa]. *Jurnal Nasional Pendidikan Matematika (JNPM)*, 6(2), 384–402. <https://dx.doi.org/10.33603/jnpm.v6i2.7056>
- OECD. (2023). *PISA 2022 Results: Indonesia*. Retrieved from <https://www.oecd.org/publication/pisa-2022-results/webbooks/dynamic/pisa-country-notes/c2e1ae0e/pdf/indonesia.pdf>

DOI: <https://doi.org/10.24127/ajpm.v13i2.8448>

- Parahita, B. N., Astutik, D., Ghufonudin, G., & Yuhastina, Y. (2023). Learning loss experience and control motive by zillennial generation in Indonesia. *International Journal of Evaluation and Research in Education*, 12(1), 346–356. <https://doi.org/10.11591/ijere.v12i1.23824>
- Pradyumnati, R. M. (2018). *Pengembangan buku pengayaan matematika SMA peminatan IPA guna memfasilitasi kemampuan pemecahan masalah matematika [in Bahasa]*. Yogyakarta: State University of Yogyakarta.
- Pusat Perbukuan. (2023). *Book Review 2023 [in Bahasa]*. Jakarta: Pusat Perbukuan. Retrieved from <https://bntp.buku.kemdikbud.go.id/instrumen>
- Rimm-Kaufman, S. E., E., B. A., Larsen, R. A., Curby, T. W., & Abry, T. (2015). To what extent do teacher–student interaction quality and student gender contribute to fifth graders’ engagement in mathematics learning? *Journal of Educational Psychology*, 107(1), 170–185. <https://doi.org/10.1037/a0037252>
- Rizki, L. M., & Priatna, N. (2019). Mathematical literacy as the 21st century skill. *J. Phys.: Conf. Ser.* 1157 042088. <http://dx.doi.org/10.1088/1742-6596/1157/4/042088>
- Rusiman, M. S., Mohamad, M., Him, N. C., Kamardan, M. G., Othaman, S., Shamsuddin, M. H., . . . Aziz, N. (2017). The use of concrete material in teaching and learning mathematics. *ARPJN Journal of Engineering and Applied Sciences*, 12(8), 2170–2174.
- Suryani, N., Setiawan, A., & Putria, A. (2018). *Inovative Learning Media and Its Development [in Bahasa]*. Bandung: PT Remaja Rosdakarya.
- Suyadi, S., Selvi, I. D., Sibawaihi, Zahroh, U., & Muassomah. (2023). Children's future adversity: Learning loss risk during online learning in COVID-19 pandemic. *International Journal of Instruction*, 16(2), 457–478. <https://doi.org/10.29333/iji.2023.16225a>
- Widiyanto, J. (2018). *Evaluasi Pembelajaran*. Madiun: UNIPMA Press.
- Widodo, A., & Umar, U. (2022). Does learning loss affect students’ numeracy skills? [in Bahasa]. *Jurnal Sekolah PGSD FIP UNIMED*, 6(2), 1–6. <https://doi.org/10.24114/js.v6i2.33371>
- Yulian, V. N., & Wahyudin. (2018). Analysing categories of mathematical proficiency based on Kilpatrick opinion in junior high school. *J. Phys.: Conf. Series*, 1132 012052. <https://doi.org/10.1088/1742-6596/1132/1/012052>