Development of E-Worksheet Based on Realistic Mathematics Education to Support Mathematical Literacy Skills of Junior High School Students

Novita Sari[1*], *Yunita* Prasetyawati[1], *Novika* Sukmaningthias[1], and *Ruth* Helen Simarmata[1]

[1]Mathematics Education Study Program, Universitas Sriwijaya, Jl. Raya Palembang - Prabumulih Km. 32 Indralaya, Ogan Ilir, 30662South Sumatera, Indonesia

Abstract. The results of the 2018 PISA show that students' mathematical literacy skills in Indonesia are quite low. This is because students are rarely given assignments in the form of mathematical literacy questions during learning, but students are only used to getting explanations and memorizing formulas. Another cause is that today's teaching materials tend to go directly to abstract mathematics by starting with the presentation of concepts and formulas and rarely contain literacy questions. This research aims to develop an e-worksheet based on the Realistic Mathematics Education Approach to support the valid and practical literacy skills of junior high school students. The development carried out refers to the Formative Evaluation type by Tessmer, which consists of the preliminary and prototyping stages (expert review, one-to-one, and small group). The research subjects were 8th graders in SMP Negeri 1 Talang Kelapa with 3 students (high, moderate, and low level) for the one-to-one phase and 6 students (high, moderate, and low level) for the small group phase. Questionnaires and interviews were used to collect data regarding the validity and practicality of the e-worksheet. The results showed that the e-worksheet based on a realistic mathematics education approach to support the mathematical literacy skills of junior high school students is valid, based on the expert review and one-to-one phases, and practical, based on the small group stage. Furthermore, this developed-e-worksheet can be used by teachers or other researchers in the field test phase to see the potential effects given.

1 Introduction

Mathematics is expected to be able to develop people thinking skills in real life and accelerate people's mastery of science and technology. One of the mathematics learning skills that certainly affects students' academic results is the skills to think critically, innovatively, and problems solving [1]. These skills are tested in the Program for International Student Assessment (PISA) and are related to mathematical literacy skills. This problem-solving process is often referred to as the mathematization process, while this mathematical skill is also known as mathematical literacy skills [2].

The person's skills to formulate, interpret, and use mathematics in various contexts of everyday life related to concepts, processes, facts, and instruments to describe, explain, and predict events and then help a person understand the role of mathematics in life. Participating actively and thoughtfully in 21st-century society is the definition of mathematical literacy [3]. Mathematical literacy is a very important thing, this is because mathematical literacy burdens students' skill to analyze, give logical reasons, and convey ideas effectively in solving mathematical problems they face [4]. In addition, these skills also support a person to know the role of mathematics in everyday life and in reaching the appropriate conclusions and judgments required in 21st-century society [5]. Mathematical literacy itself is included in one aspect of the Minimum Competency Assessment (AKM), which is the benchmark for the National Assessment, which, of course, the skills of mathematical literacy to be possessed by students [6].

But in fact, the results of the PISA show that Indonesian students have a low ability when taking PISA, which has been held every 3 years since 2000. From this survey, Indonesia is always in the last rank, and from this survey also, Indonesian students have low mathematical literacy skills. From the results of the 2018 PISA study [7], Indonesia ranks 72 out of 77 countries that participated in the test and with students with low mathematical literacy skills. The low results of students' mathematical literacy are a result of their difficulties working on PISA tasks including two-variable linear equation system content, namely: students have difficulty in building mathematical models; determining the right mathematical concepts to solve a problem; students have difficulty adjusting mathematical equations; they not understand the information contained in the problem; students have difficulty giving the right argument [8]. The low level of mathematics literacy among Indonesian students is caused by several things, including the lack of teachers who give assignments in the form of mathematical literacy questions to students during learning, where students are only accustomed to providing the concepts, formulations, and interpretations in the form of rote [9]. In addition, according to Hasanah et al., it is stated that when teaching a lot of teachers use conventional learning, where students contribute little to learning due

* Corresponding author: novitasari@fkip.unsri.ac.id

to their lack of interest in learning that is assisted by the teacher [10].

Actions that can be taken to help students comprehend mathematical literacy and enhance it can be made by developing teaching materials that have been designed to be more innovative and effective with the help of current technological developments. Technological innovations used in education allow teaching materials to be made attractive and also practical [11]. In Rofiqoh's opinion, utilizing digital technology in the right teaching materials can have a positive impact on learning mathematics, and a mathematical approach to what is taught can help student learning outcomes increase [12]. Student worksheets are one of the teaching tools that can be applied in learning to improve student learning activities and help to find concepts, principles, and facts in learning mathematics [13]. Teaching materials that will be used are digital teaching materials containing practice questions equipped with learning videos contained in electronic worksheets (e-worksheets) that can make students learn anywhere and anytime with the help of technology.

Enhancing students' knowledge by utilizing educational resources in the form of e-worksheets, an approach is needed that helps students solve real-life problems related to mathematical literacy. This is following what is said in the OECD [3] that to understand and apply mathematical principles when solving problems related to mathematical literacy, it is better for learning to start with contextual problems in everyday life. One approach that can be used in this mathematical literacy is the Realistic Mathematics Education (RME) approach, which can support increasing students' critical thinking skills.

Realistic Mathematics Education is an approach that is reconstructed from the knowledge that a person has previously and is related to everyday life, helping lead students to understand mathematical concepts more meaningfully [14–16]. There are five characteristics of the RME approach, namely phenomenological investigation, progressive mathematization using models and symbols, use of students' contributions, interactivity, and intertwining [17]. From the research of Rupaidah & Agni [18] RME can support the material for the linear equation system in two variables material, which in its implementation uses a lot of real-world problems.

Several studies on e-worksheets have a positive impact on learning mathematics, including the research conducted by Lestari and Paydnya [19] stated that 8th graders students of SMP Widiatmika experienced an increase in mathematics learning achievement in each cycle after the use of blended learning and e-worksheet assistance. Another similar study presented by Janah [20] found a 15% increase in student learning outcomes when using the PBL (Problem-Based Learning) model with e-worksheets on the matrix material of grade 11 vocation students, as well as an increase in student learning activities when using the PBL learning model with e-worksheets. Aulia & Prahmana [21]conducted a study using the RME but developed an e-module of sequences and series material with the result that mathematical literacy among students improved by 32% on medium criteria.

In previous studies, there have been studies that developed e-worksheets, but the difference in this research is that e-worksheets are developed based on RME, provide mathematical literacy problems, and focused on linear equation systems in two variables material. This is important to do because the PISA test since 2015 has been computer-based so that at least students are used to using technology in learning activities. Furthermore, the purpose of this study is to develop an e-worksheet based on Realistic Mathematics Education to support students' mathematical literacy skills in junior high school which are valid and practical.

2 Methods

The development research approach was utilized in this study. The development model used is Tessmer model with a formative research design. There are two stages in the research procedure, namely preliminary stages and formative evaluation. In the formative evaluation, there are three stages, which are self-evaluation, expert review and one-to-one, small groups, and field test [22]. However, this study was limited to the small group stage to obtain an RME-based e-worksheet to support the mathematical literacy skills of junior high school students which are valid and practical.

2.1 Preliminary stage

At this stage, several sources of literature needed during the study were analyzed and considered as a basis to develop the product. After that, the researcher design a prototype based on the results.

2.2 Research subject

At this stage, the researcher conducted an assessment of several sources of literature needed during the study. After that, the researcher will design a prototype based on the results of the assessment of several sources that are considered suitable as reference sources.

2.3 Data Collection and analysis techniques

To obtain the data or information needed in this study, researchers used several data collection techniques, including validator questionnaire sheets, student response questionnaire sheets, and interviews. Data analysis was carried out on the questionnaire given regarding the appearance of the e-worksheet, the material provided, and student motivation after working on the questions contained in the e-worksheet. Interviews were used to get information about the needs of the developed e-worksheet. The interview was carried out in an unstructured and open way, and after that, it will be analyzed with qualitative descriptively.

The overall calculation of the questionnaire data per aspect from the student response questionnaire, media

expert validation questionnaire, and material expert validation questionnaire [23] follows this formula:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

The criteria used in the assessment of validators and student response questionnaires can be seen in Table 1 and Table 2 [24] below.

Table 1. Expert validator assessment criteria.

Percentage	Category
81% - 100%	Very Valid
61% - 80%	Valid
41% - 60%	Quite Valid
21% - 40%	Not Valid
0% - 20%	Very Invalid

Table 2. Criteria for interpretation of values.

Percentage	Category
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Quite Practical
21% - 40%	Not Practical
0% - 20%	Very Impractical

3 Results and discussion

The formative evaluation and preliminary stages are the two stages of this development. The following will provide explanations for each stage.

3.1 Preliminary stage

This phase starts with analytical activities and product designs based on the findings of the needs analysis that the teacher has been provided with. The researcher engaged in activities such as analyzing the curriculum, the needs, and student characteristics.

The findings of the curriculum analysis are the school using the curriculum 2013 for grade 8. The results of this analysis are: 1) the teacher has employed RME-based instructional materials; 2) the teacher rarely gave mathematical literacy problems during learning; 3) it is necessary to raise students' mathematical literacy skills; 4) teachers have not used e-worksheets in learning; 5) teachers need more innovative teaching materials. Based on the results of the analysis of student characteristics, students need teaching materials that can be studied anywhere, either using a laptop or an Android.

After consulting with the mathematics teacher, it was decided that the test subjects for the one-to-one and small group phases would be 9 non-subject students in the field test, which are 3 students for the one-to-one phase and 6 students for the small group phase. The students are selected to represent low, moderate, and high-level students. From these analyses, the RME-based e-worksheet, which was later expected to be able to support students' mathematical literacy skills was designed. The RME-based e-worksheet contains mathematical literacy problems with the material of a linear equation system in two variables. Each e-worksheet is started with real-world problems. There are also given some questions that lead students to construct knowledge they already have to solve the problems.

3.2 Formative evaluation

The stages were carried out sequentially at this level by the researchers, starting with the stage of self-evaluation, and expert review along with one-to-one and small groups.

3.2.1 Self-evaluation

During this process, the researcher made the first prototype of the e-worksheet and instrument of research from the aspect of construct, language, and content. The e-worksheet was developed using the Fliphtml5 Flipbook Maker application, which is equipped with various features that make it easier to visualize a learning media. Based on the results of the self-evaluation, the researcher made slight changes to the cover design and content design in the e-worksheet.

The changes made can be seen in Figure 1 and Figure 2 below.

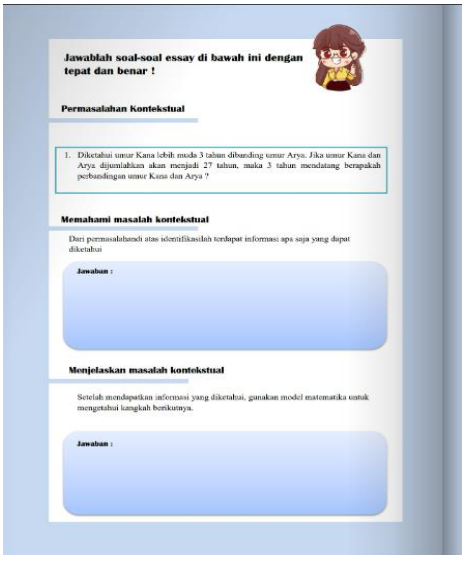

Fig. 1. Before the revision

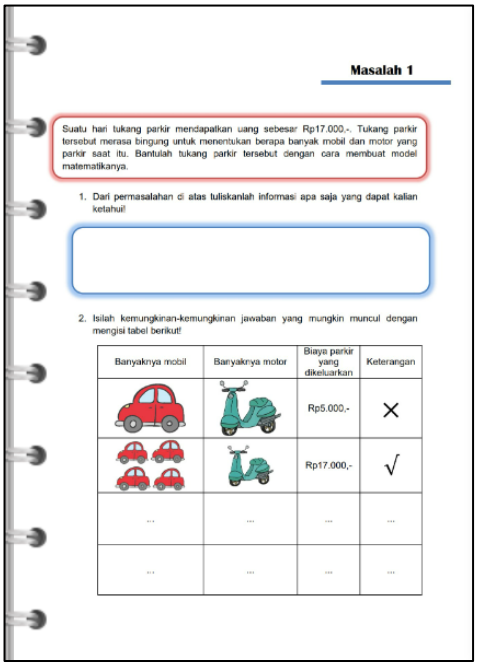

Fig. 2. After the revision

In Figure 1, real-world problems used is about the relation between the age of two people. After self-evaluation, a probability table was added in order to provoke students to estimate the possible values of a two-variable linear equation problem as can be seen in Figure 2. Besides that, the goal of using a probability table is to help students come up with models from linear equations of two variables. This way is part of one of the RME principles, namely self-developing models and their characteristics, namely using models. Thus, the problem was changed to parking rate so it was more real than before. In addition, the design of the e-worksheet was changed to be simpler. Question numbers are also given to make it easier when discussing.

3.2.2 Expert review dan one-to-one

At this stage, the first prototype will be validated by two material expert validators and two media expert validators. For the one-to-one stage, it was tested on three students, which represent students in the low, moderate, and high levels.

Table 3. The identity of experts as validators

	Name	Department and Affiliations
Material Expert	Elika Kurniadi, S.Pd., M.Sc.	Mathematics Education Study Program, Universitas Sriwijaya
Material Expert	Navel O. Mangelep, M.Pd.	Mathematics Education Study Program, Manado State University
Media Expert	Zuli Nuraeni, M.Pd.	Mathematics Education Study Program
Media Expert	Jeri Araiku, M.Pd.	Mathematics Education Study Program

The validation process was carried out face-to-face when validating with Mrs. Elika, and via WhatsApp when validating with Mr. Navel. The validation process was carried out with Ms. Zuli and Mr. Jeri face-to-face. The material expert reviewed in terms of content, construct, and language. Moreover, the media expert reviewed the display, software engineering, and visual communication. In the one-to-one stage, the researcher conducted a trial with three students with high, moderate, and low levels directly. Table 4 shows the comments and decisions made after the revision obtained during the expert review and one-to-one.

Table 4. Comments from experts and students on a one-to-one phase

Respondent	Comments	Revision Decisions
Material Expert	Look again at the numbers in the problem.	The number in the question has been changed from 5 to 6.
	Look again at the use of probability tables.	The word has been corrected to "fill in the possible correct answers in the following table".
	Complete the SPLDV general form.	The general form of the SPLDV has been completed with a description according to the book.
	Use pictures that relate to the problem.	Added the appropriate image.
	The formulation of the questions is in accordance with the PMR principles and can develop students' mathematical literacy skills related to SPLDV. It just needs a little technical improvement in the writing of sentences, the placement of tables, and the size of the images used. So that it can help students better understand the intent of the questions or activities given in building mathematical facts, principles, and procedures.	Maintained.
	The word "with filling" is changed to "on".	The word has been corrected to

Respondent	Comments	Revision Decisions
	The word possible "many" is changed to "lots of".	"fill in the possible correct answers in the following table".
	Tables are loaded on the same page so that students do not scroll back and forth between pages.	The table has been fixed to a single page.
	We recommend that you use the passive voice as "the weight and price of each package for each animal feed ingredient is shown in the following table".	The sentence has been corrected to "the weight and price of each package for each animal feed ingredient is shown in the following table".
Media Expert	The closing cover sentence should be replaced.	The cover sentence is changed to "great job" in e-worksheet one and "good job" in e-worksheet two.
	The parking information image should be enlarged	The parking information image has been enlarged.
	Learning videos in the e-worksheet can be played properly.	Maintained.
One-to-one	In e-worksheet one problem two, "What is the difference between table one and table two?".	In problem two of the first e-worksheet, table one has been corrected to become "possible money earned" in table two changed to "possible number of cars and motorcycles".

The conclusion of that both assessments are said to be suitable for use after revision. Furthermore, during the one-to-one stage, the student's actions as they worked on the questions provided can be seen in Figure 3 below.

Fig. 3. Students working on e-worksheet questions at the one-to-one stage

In the one-to-one stage, students work on the problems contained in the e-worksheet using their smartphones. Students are asked to provide comments and suggestions after they finish working on the questions given, which will later be used as a reference in improving the e-worksheet.

After the product was validated and tested in the one-to-one stage, the improvements were done based on comments from material experts, media experts, and students in the one-to-one stage. Here some of the improvements can be seen in Figure 4 to Figure 5 below.

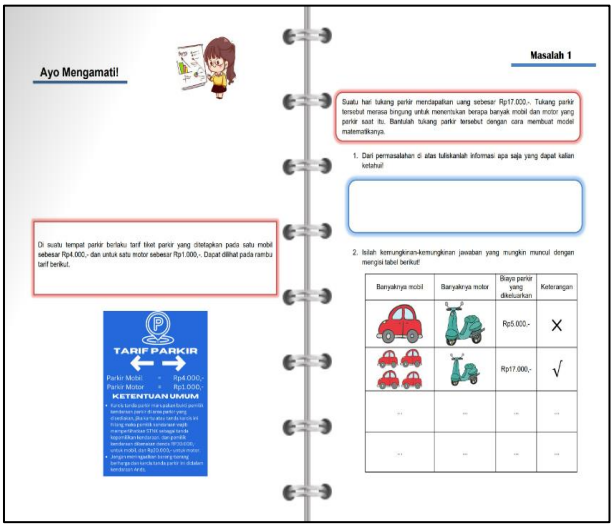

Fig. 4. Before the revision

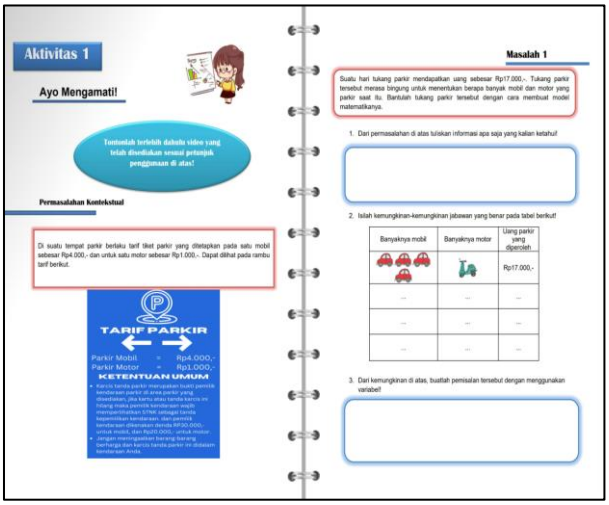

Fig. 5. After the revision

The revision from Figure 4 to Figure 5 was by adding posters with clearer information stated to improve learning so students clearly see the information. After that, the probability table was fixed with the instructions that students were asked to look for the correct possibilities and deleted the checklist in the last column. In addition, the general form of the linear equation system in two-variable in the middle of the ellipse shape has been improved and can be seen in Figure 6 and Figure 7 below.

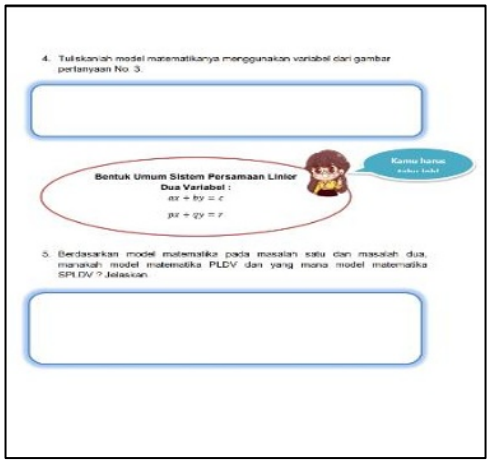

Fig. 6. Before the revision

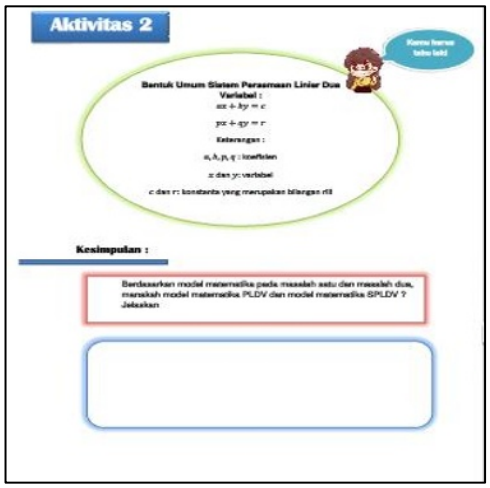

Fig. 7. After the revision

In the general form of a two-variable linear equation system, the researcher adds information from what is written in reference books, which are suggestions from material expert validators. In the section using the appropriate image, the improvements can be seen in Figure 8 and Figure 9 below.

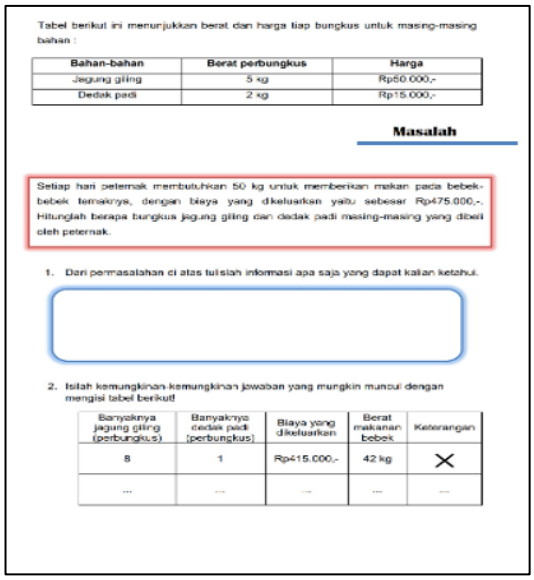

Fig. 8. Before the revision

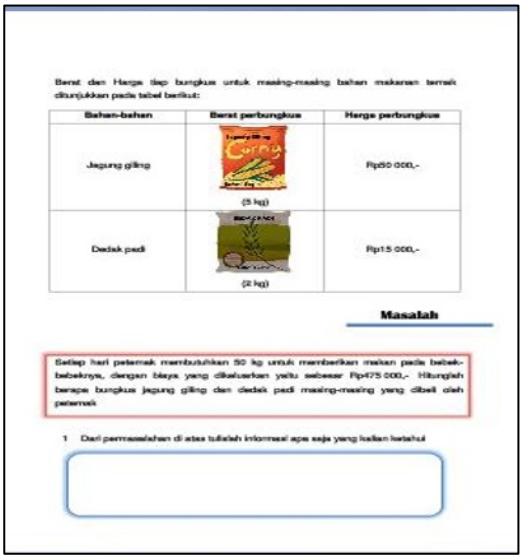

Fig. 9. After the revision

Previously, in this section, without any images, the researcher just entered the information that was already known in the table. However, according to the advice of the validator, the researcher provided an appropriate image to use to facilitate the understanding of the information offered by students.

Furthermore, questionnaires, which were given to material experts, are based on three aspects, namely content, construction, and language. The questionnaires given to media experts are based on three aspects, namely display, software engineering, and visual communication. By giving 15 questions to material experts and media experts, the validity percentage of the RME-based e-worksheet can be seen in the following table.

Table 4. Percentage of total validity scores obtained by each material expert

No.	Validator	Score	Category
1	Elika Kurniadi, S.Pd., M.Sc.	74.7%	Valid
2	Navel O. Mangelep, S.Pd., M.Pd	81.3%	Very Valid
Average score		**78.0%**	**Valid**

Table 5. Percentage of total validity scores obtained by each media expert

No.	Validator	Score	Category
1	Zuli Nuraeni, S.Pd., M.Pd	93.3%	Very Valid
2	Jeri Araiku, S.Pd., M.Pd	90.6%	Very Valid
Average score		**91.9%**	**Very Valid**

continue to discuss with their groups when looking for answers. Students also write their answers on their papers.

The results of the research described above show that the e-worksheet based on a realistic mathematics education approach to support students' mathematical literacy skills is valid and practical. However, the responses of students who admitted to having difficulties when learning mathematics, this was in line with research conducted by Heriyadi & Prahmana, which stated that students had difficulty generalizing and utilizing information when learning mathematics [23].

Furthermore, the use of e-worksheets during the learning process generated a positive response. Based on the results of this research, the results obtained from the validation provided by the material experts were 78.0% and those from the media experts were 91.9%, both in the "valid" category. And the results obtained from the student response questionnaire were 73.9% in the "practical" category. From these results, it can be concluded that the developed e-worksheet is valid and practical. In accordance with research conducted by Wijayanti et al., research from Aulia & Prahmana, research from Dewantara et al., and research from Wahyuni et al., which found that the use of teaching materials developed was said to be valid, practical, and suitable for use [24–27].

4 Conclusion

The e-worksheet based on the RME to support students' mathematical literacy skills from the validation results by experts was obtained by 78.0% from material experts and 91.9% from media experts, both in the "valid" category. From the results of the evaluation of the student response questionnaires, they obtained an average score of 73.9% with a "practical" category. So that the e-worksheet based on the RME is valid and practical.

Acknowledgement

The research of this article was funded by DIPA of the Public Service Agency of Universitas Sriwijaya 2022. SP DIPA-023.17.2.677515, on December 13, 2021. In accordance with the Rector' Decree Number: 0110/UN9.3.1/SK/2022, On April 28, 2022".

References

1. E. Sulistiani, M. Masrukan, *Pentingnya Berpikir Kritis dalam Pembelajaran Matematika untuk Menghadapi Tantangan MEA*, in Prosiding Seminar Nasional Matematika X Universitas Semarang, 29 October 2016, Semarang, Indonesia (2016)
2. R. Sukmawati, *Hubungan Kemampuan Literasi Matematika Dengan Berpikir Kritis Mahasiswa,*in Prosiding Seminar Nasional dan Pendidikan Matematika Universitas Muhammadiyah Surakarta, Surakarta, Indonesia (2018)
3. OECD, *PISA 2018 Mathematics Framework*, Paris, OECD Publishing, (2019)
4. V. Geiger, M. Goos, H. Forgasz, ZDM – Math. Educ. **47,** 531 (2015)
5. N. Sari, Z. Nuraeni, N. Sukmaningthias, J. Elem. **8**, 631 (2022)
6. W. Widianti, N. Hidayati, J. Pembelajaran Mat. Inov. **4**, 27 (2021)
7. OECD, *21st-Century Readers: Developing Literacy Skills in a Digital World*, Paris, PISA, OECD Publishing (2021)
8. M. N. Prabawati, J. Penelit. Pendidik. dan Pengajaran Mat. **7**, 117 (2021)
9. N. Sari, N. Sukmaningthias, Z. Nuraeni, R. H. Simarmata, U. Hasanah, K. N. Anggraini, *Developing Mathematical Literacy Task in Multiplication and Division of Algebraic Expression,* in Proceedings of the International Conference of Mathematics and Mathematics Education (I-CMME 2021), 23 -25 August 2021, 6-27 October 2021, Surakarta, Indonesia, (2021)
10. U. Hasanah, N. Sari, N. Sukmaningthias, Z. Nuraeni, *Mathematical Literacy Skills of Junior High School Students Through Blended Learning Based on Indonesian Realistic Mathematics Education Approach*, in Proceeding The 2nd National Conference Mathematical Education 2021 (NaCoME 2021), 24 August 2021, Palembang, Indonesia (2022,)
11. Mitha Frilia, Hapizah, E. Susanti, S. Scristia, J. Gantang **5**, 191 (2020)
12. I. Rofiqoh, D. Puspitasari, Z. Nursaidah, Lentera Sriwij. J. Ilm. Pendidik. Mat. **2**, 41 (2020)
13. N. Wijayanti, T. A. Arigiyati, F. Aulia, S. A. Widodo, J. Medives J. Math. Educ. IKIP Veteran Semarang **5**, 245 (2021)
14. Z. Zulkardi, R. Ilma, J. Pendidik. Math., **4** (2013)
15. L. Ulandari, Z. Amry, S. Saragih, Int. Electron. J. Math. Educ. **14**, 375 (2019)
16. E. Zakaria, M. Syamaun, Math. Educ. Trends Res. **2017**, 32 (2017)
17. I. Sartika, J. Pendidik. Dasar **3**, 101 (2019)
18. A. Rupaidah, A. Danaryanti, EDU-MAT J. Pendidik. Mat. **1**, 10 (2013)
19. N. L. P. K. W. Lestari, I. P. A. A. Payadnya, JKPM J. Pendidik. dan Kebud. Mission **14** (2022)
20. N. Ismayanti, *Efektifitas Model Pembelajaran Problem Based Learning Terhadap Hasil Belajar IPS di SDN 234 Inpres,* in The National Association of State Conservation Agencies, (2020)
21. E. T. Aulia and R. C. I. Prahmana, J. Elem. **8**, 231 (2022)
22. M. Tessmer, *Planning and Conducting Formative Evaluations*, London, Kogan Page (1993)
23. A. Asyhari and H. Silvia, J. Ilm. Pendidik. Fis. Al-Biruni **5**, 1 (2016)
24. H. F. Milala, E. Endryansyah, J. Joko, A. I. Agung, Pendidik. Tek. Elektro **11**, 195 (2022)
25. H. Heriyadi, R. C. I. Prahmana, AKSIOMA J. Progr. Stud. Pendidik. Mat. **9**, 395 (2020)
26. Misbah, D. Dewantara, S. M. Hasan, S. Annur,

Unnes Sci. Educ. J. **7**, 19 (2018)
27. S. Wahyuni, L. K. Rizki, A. S. Budiarso, P. D. A. Putra, E. Narulita, J. Penelit. Pendidik. IPA **7**, 723 (2021)