EDUCATUM JSMT Vol. 12 SPECIAL ISSUE (2025)
ISSN 2289-7070 / e-ISSN 2462-2451(103-115)
https://ejournal.upsi.edu.my/index.php/EJSMT/index

Validity Assessment of An Integrated Realistic Mathematics Education and Project-based Inquiry Learning Module

Sri Rejeki[1, 2*], Mazlini Adnan[1], Che Nidzam Che Ahmad[1], and Budi Murtiyasa[2]

[1]Department of Mathematics, Universiti Pendidikan Sultan Idris,
35900, Tanjong Malim, Perak, Malaysia
[2]Department of Mathematics Education, Universitas Muhammadiyah Surakarta,
Jalan Ahmad Yani, Pabelan, Kartasura, Sukoharjo 57162, Jawa Tengah, Indonesia

**Corresponding author:* sri.rejeki@ums.ac.id

Received: 1 Jan 2025; **Accepted:** 25 March 2025; **Published:** 24 April 2025

To cite this article (APA): Rejeki, S., Adnan, M., Che Ahmad, C. N., & Murtiyasa, B. (2025). Validity Assessment of An Integrated Realistic Mathematics Education and Project-based Inquiry Learning Module. *EDUCATUM Journal of Science, Mathematics and Technology*, *12*, 103-115. https://doi.org/10.37134/ejsmt.vol12.sp.10.2025

To link to this article: https://doi.org/10.37134/ejsmt.vol12.sp.10.2025

Abstract

Text-based learning resources are critical for helping pupils learn mathematics. However, limited studies have been conducted on designing mathematics modules as text-based learning materials for Vocational High School (VHS) students. Hence, developing an integrated Realistic Mathematics Education (RME) and Project-based Inquiry (PIL) module could be an innovative solution. This study analyzes the validity assessment as a part of the developmental stage of developing the module. The validation process was conducted by a team of five experts in mathematics education, who used a questionnaire to assess the face and content validity. The questionnaire evaluated four key aspects of face validity: language, text, graphics, and presentation. In terms of content validity, it considered five crucial elements: suitability to the target population, implementation of each module activity based on the principles of RME and the phases of PIL, compatibility with the allocated time, ability to enhance student performance in terms of creativity and achievement, and potential to influence attitudes towards excellence, particularly in terms of student motivation. The data analysis was conducted using descriptive statistics and percentages. Based on the data analysis, the average score percentage for all face and content validity aspects is 91.6% and 89.8%, respectively. It is in a good category because those range from 84% to 98%. Therefore, all module aspects have high content validity and exceed 70%.

Keywords: Mathematics Education, Project-based Inquiry, Linear Programming

INTRODUCTION

In mathematics learning, modules are essential in providing a structured learning pace that caters to individual student needs. Mohd Nazri et al. [1] points out that modules set clear learning objectives, offer guidance for group or individual activities, provide feedback, and enable assessment of students' understanding. This ensures that all students, regardless of their learning speed or needs, have access to the same high-quality content and can achieve equitable learning outcomes.

Mathematics learning modules could integrate one or more learning methods, for instance, integrating the Realistic Mathematics Education (RME) approach and the Project-based Inquiry Learning (PIL) model [2]. The RME approach is a specific approach to mathematics learning developed in the Netherlands [3]. It focuses on using realistic contexts to make mathematics more meaningful and relatable to students. Moreover, the PIL model encourages students to participate in mathematics learning through project-based activities that engage them in both inquiry and creative thinking for a deeper understanding of mathematics concepts [4]. Integrating the approach and the model could create comprehensive learning, which is expected to enhance students' mathematics achievement and improve motivation and creativity.

Combining the RME approach and the PIL model offers an innovative method that addresses the limitations of standalone teaching methods. The RME approach, which emphasizes grounding mathematical concepts in realistic contexts, is particularly relevant in vocational high school mathematics education as it improves students' ability to apply mathematics practically [3]. The PIL model, on the other hand, challenges students' critical thinking and problem-solving skills through collaborative and inquiry-driven projects [4]. Integrating those two creates a synergistic impact. It provides vocational high school students with contextualized learning experiences that connect theoretical knowledge and practical application, which could improve students' problem-solving ability and deepen students' understanding of mathematical concepts [5]. Addressing cognitive and practical aspects of learning, the integrated RME and PIL offer innovative solutions to the challenges faced in vocational high school mathematics education.

Vocational high school students have lower mathematics achievement than senior high school students. They often experience difficulties in learning mathematics topics, one of which is linear programming, as it is learned directly from the abstract form and disconnects from mathematics concepts and real-world applications related to students' vocational fields [6]. Moreover, there are still limited contextualized learning experiences, which may cause students to complicate in applying the linear programming concept effectively in practical scenarios [7]. Addressing those challenges by integrated teaching approaches and models that connect mathematics to real-life problems can enhance vocational students' understanding and engagement [8]. Thus, the integration of RME and PIL is expected to improve students' mathematics achievement, motivation, and creativity.

The integration of RME and PIL has potential, but the current focus on assessing the validity of mathematics learning modules by integrating these two methods is limited. Most studies have concentrated on the validity of mathematics learning modules based on RME alone. For example, Sumandyana and Mahendra [9] delve into the validation of e-modules based on RME on linear programming topics. Similarly, Salsabila et al. [10] explore the validity of e-modules for teaching fractions based on realistic mathematics education. In the realm of PIL, there have been studies about the validity of modules that integrate PIL and STEM [4], [11].

Several studies have highlighted the significant effect of RME on students' skills, underscoring the potential of this approach. Haji, Yumiati, and Zamzaili [12] have shown how RME when combined with outdoor activities, can enhance students' productive disposition. RME, when supported by Geometer's Sketchpad, has also proven to be effective in improving students' critical and creative thinking [13]. The effect of RME on primary students' activeness and critical thinking is another area of potential that could inspire educators and researchers [14], [15]. The gap in the literature underscores the need for systematic evaluation of the validity of the integrated RME and PIL learning modules. This research has the potential to significantly impact the future of mathematics education, inspiring us to continue our work in this area.

This study assesses the validity of an integrated RME and PIL mathematics learning module. The validity evaluation focuses on face validity and content validity. Face validity is assessed based on the module's language, text, graphics, and presentation, with a specific focus on clarity, coherence, and appropriateness, which are crucial aspects in determining the module's effectiveness. Content validity evaluates the module's relevance to mathematics content and skills.

Considering the research gap, this study contributes to enriching the literature on innovative learning methods. Moreover, these findings offer practical implications for mathematics teachers in orchestrating learning activities based on realistic projects. Lastly, this study scaffolds future research on the development and validation of a mathematics learning module that integrates more than one learning method.

MATERIALS AND METHODS

Research Methodology

This paper is a part of a developmental study that applies design and developmental research (DDR), particularly in the design and development phase. The validation was conducted using a descriptive study approach involving five experts in mathematics education and mathematics learning module development. Three experts are the minimum number of panel evaluations [16]. However, this study involves five experts to ensure the comprehensive and credibility of the module evaluation. The experts consist of two certified vocational high school mathematics teachers, two certified mathematics lecturers who taught teaching school mathematics, and one practitioner of module development for the Indonesian national curriculum.

The data was collected using a questionnaire for face validity and content validity assessment using a 10-scale. The 10-scale questionnaire was chosen to increase the sensitivity and specificity of the responses. The questionnaire for face validity assessment consists of language, text, graphics, and presentation aspects. Whereas the content validity assessment ensures the module meets the criteria of meeting the target population, can be implemented perfectly, is compatible with the time allocated, and has the potential to significantly improve student performance in terms of mathematical creativity and achievement and change attitudes towards excellence in terms of student's learning motivation.

The face and content validity scores were analyzed using the Percentage Calculation Method (PCM). Based on Sidek and Jamaludin [17], the validity percentage is indicated as high for 70% and above. The experts also provided feedback and suggestions for the improvement of the module developed. This allows for multiple revisions based on feedback until the module meets the desired quality and implementation standards.

The Integrated RME and PIL Learning Module

The module follows the structure of learning modules as recommended by the Indonesian Ministry of Education and Culture. Moreover, the learning activities is following the principles of Realistic Mathematics Education and the phases of Project-based Inquiry Learning [2]. Figure 1 shows the integration of Project-based Inquiry Learning and Realistic Mathematics Education.

The principles of RME, which are activity, reality, level, interactivity, intertwinement, and guidance [18], emphasize the practical application of mathematics. The activity involves students' activeness in learning mathematics, reality uses significant realistic problems to develop students' knowledge, level uses models to bridge the gap between real-life and abstract mathematics, intertwinement connects various topics in and outside mathematics, interactivity focuses on social activities, and guidance prepares learning trajectories to support students' learning.

In addition, the PIL organized all educational activities by planning projects into four progressive stages: inquiry, exploration, experimentation, and reflection [4]. Inquiry entails asking students questions and helping them choose what to research; exploration entails using a variety of search techniques to find information and choosing appropriate materials for the projects; experimentation entails making and presenting the products; and reflection entails assessing the learning activities and talking to students about their interests, awareness, appreciation, and plans.

As depicted in Figure 1, the integration of RME principles into each PIL phase is paramount, underscoring the methods' significance and impact. The inquiry phase, for instance, incorporates the activity, reality, interactivity, intertwinement, and guidance principles, each playing a crucial role. Similarly, the exploration phase integrates the level and guidance principles, further highlighting the importance of the methods. The experimentation phase, too, incorporates the activity, interactivity, intertwinement, and guidance principles, emphasizing the method's impact. In the exploration phase, the principles of activity, interactivity, and guidance are integrated, reinforcing the importance of the method.

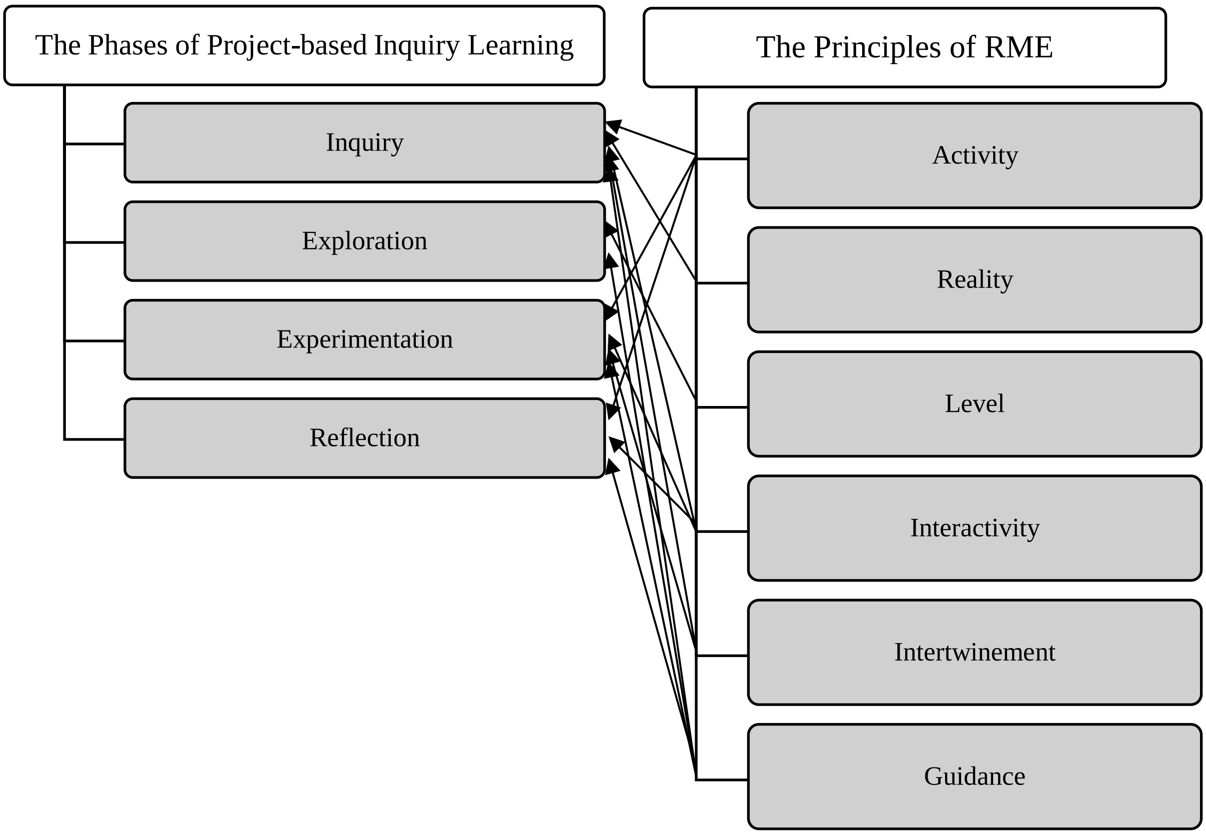

Figure 1: Framework of The Integrated Realistic Mathematics Education and Project-Based Inquiry Learning Module

The module developed is on linear programming for vocational high school mathematics learning. There are three projects that students must do: (1) restaurant menu, (2) simple machine production, and (3) laptop selling. The first project is about linear equation systems with two variables, and the second and the third projects are about minimization and maximization in optimization in linear programming, respectively. Table 1 describe an example of activities in the second project “simple machine production”. The project is closely related to vocational high school fields, particularly with the technical major.

Table 1 An Example of Activities in The Module

The Project and The Learning Phases	**Translation**
Penyelesaian Proyek Realistik Buat rencana produksi mesin sederhana sesuai dengan kreasi kelompokmu. Buat rencana tersebut sekreatif mungkin, dengan langkah-langkah sebagai berikut: 1. Lakukan pencarian informasi di toko *online* terkait jenis-jenis mesin sederhana. 2. Tentukan jenis mesin yang akan diproduksi dengan dua kapasitas yang berbeda. 3. Lakukan pencarian informasi terkait dua komponen utama mesin tersebut. 4. Tentukan banyaknya bahan dan persediaan dari dua komponen utama mesin tersebut. 5. Lakukan perencanaan banyaknya produksi dengan menerapkan sistem pertidaksamaan linear dua variabel.	**Completion of Realistic Project** Create a simple machine production plan according to your group's creativity. Make the plan as creative as possible, with the following steps: 1. Search for information in online stores related to the types of simple machines. 2. Determine the type of machine to be produced with two different capacities. 3. Search for information related to the two main components of the machine. 4. Determine the number of materials and supplies for the two main components of the machine. 5. Plan the amount of production by applying a two-variable linear inequality system.
Mari Bertanya!	**<u>Let's Ask!</u>**
Ayo Menjelajah! <u>Rencana Penyelesaian proyek</u> Nama Mesin Sederhana: Pembagian Tugas Anggota Kelompok: 1. Anggota 1:	**<u>Let's Explore!</u>** **Project Completion Plan** Simple Machine Name: Group Member Task Division: 1. Member 1:
Saatnya Mencoba! a. Tentukan titik potong garis dari sistem pertidaksamaan linear dua variabel tersebut.	**<u>Time to Try!</u>** **a.** Determine the point of intersection of the lines of the two-variable linear inequality system.
Yuk Renungkan! a. Apakah solusi ini memenuhi semua fungsi kendala? <u>Jawab:</u> b. Apa arti solusi ini? <u>Jawab:</u>	**<u>Let's Think!</u>** a. Does this solution meet all constraint functions? b. What does this solution mean?

Table 1 shows an example of the project of simple machine production. Students must solve the project by completing the stages of PIL, namely inquiry (*Ayo Bertanya*), exploration (*Ayo Menjelajah*), experimentation (*Saatnya Mencoba*), and reflection (*Yuk Renungkan*). The principles of RME are integrated in the learning activities of each stage as described in Figure 1.

RESULTS AND DISCUSSION

The module draft that has been developed is evaluated for validity. The module validity consists of face validity and content validity based on the percentage of agreement among five experts using a questionnaire for module validity.

Assessment of the Face Validity

Assessment of the module's face validity ensures that the presentation, format, and language are appropriate and understandable for students at their level of thinking. The assessment is based on experts' agreement on language, text, graphics, and presentation.

1. Language

The expert assessment in terms of language includes language, spelling, punctuation, grammar, sentences, and terms. This assessment aims to ensure that the terms and language used are suitable for the target group. There are seven items for the language assessment aspect. Table 2 shows that the average percentage of experts' agreement on the language aspect is 93.1%. Regarding each item, the average of experts' agreement is more significant than 70%, with at least 86% for the language appropriateness on students' level of development and at most 100% for the use of punctuation marks. However, there are still comments, corrections, and suggestions regarding the sentences and language to be more understandable for students.

Table 2 Experts' Agreement in The Language Aspect

No.	Item	Score from the Experts					Score of each item	
		P1	P2	P3	P4	P5	Sum of the score	Percentage (%)
1	The use of language is appropriate to the students' level of development.	9	8	8	9	9	43	86
2	The writing of all words according to the general guidance for Indonesian spelling.	10	10	9	10	10	49	98
3	The use of punctuation marks follows the general guidance for Indonesian spelling.	10	10	10	10	10	50	100
4	Apply the Indonesian grammar correctly.	10	9	9	10	10	48	96
5	Use sentences that are easy to understand.	9	8	8	9	10	44	88
6	Use terms correctly.	9	9	8	10	10	46	92
7	Use terms consistently.	9	9	8	10	10	46	92
	Sum of the score	66	63	60	68	69	326	
	Percentage (%)	94.3	90	85.7	97.1	98.6		
	The average of percentage (%)							**93.1**

2. Texts

The experts' assessment from the perspective of the text includes the assessment from the aspects of texts and writings' size. This assessment ensures that the text and writing size are straightforward to read. There are five items for the aspect of text assessment. Table 3 shows the average percentage of experts' agreement on the text aspect is 92.4%. Regarding each item, the average of experts' agreement is more significant than 70%, with at least 88% for the language appropriateness for students' level of development and at most 96% for the use of punctuation marks. However, there are still comments, corrections, and suggestions in several parts, particularly regarding the font size and the writing structure, which are expected to lead to engaging discussions and potential improvements.

Table 3 Experts' Agreement in The Text Aspect

No.	Item	Score from the Experts					Score of each item	
		P1	P2	P3	P4	P5	Sum of the score	Percentage (%)
1	The writing display is clear.	9	10	9	10	10	48	96
2	The writing is easy to read.	10	9	9	10	10	48	96
3	Proportional font size.	8	9	8	9	10	44	88
4	The writing of every word is correct.	9	9	9	10	10	47	94
5	The structure of the writing is appropriate.	9	8	8	10	9	44	88
	Sum of the score	45	45	43	49	49	231	
	Percentage (%)	90	90	86	98	98		
	The average of percentage (%)							**92.4**

3. Graphics

The experts' assessment from the perspective of graphics includes assessing the suitability of graphics' display and function. This assessment ensures the appropriateness of graphics' appearance and function in supporting students' learning. There are ten items for the aspect of graphics assessment. Table 4 shows that the average percentage of experts' agreement on the text aspect is 89.4%. Regarding each item, the average of experts' agreement is more significant than 70%, with at least 84% for the appropriateness of color in the images and 94% for using images to help students understand concepts. However, there are still comments, corrections, and suggestions regarding the quality and color of the images, as well as their function in supporting students' attention and mathematical creativity.

Table 4 Experts' Agreement in The Graphic Aspect

No.	**Item**	**Score from the Experts**					**Score of each item**	
		P1	**P2**	**P3**	**P4**	**P5**	**Sum of the score**	**Percentage (%)**
1	The use of figures in accordance with learning objectives.	8	9	9	9	10	45	90
2	Proportional image composition.	9	9	9	9	10	46	92
3	The images used are related to the corresponding texts.	8	10	9	9	10	46	92
4	The images used can attract students' attention.	8	9	8	9	9	43	86
5	The use of figures can stimulate students' mathematical creativity.	8	9	9	8	9	43	86
6	The use of images helps students understand concepts.	9	10	9	9	10	47	94
7	Proportional image size.	9	10	9	9	9	46	92
8	The use of color in the image is appropriate.	8	9	8	8	9	42	84
9	The images used are of good quality.	8	9	9	8	9	43	86
10	The arrangement of the images is appropriate.	9	9	9	9	10	46	92
	Sum of the score	84	93	88	87	95	402	
	Percentage (%)	84	93	88	87	95		
	The average of percentage (%)							**89.4**

4. Presentation

The experts' assessment from the presentation's perspective includes assessing the appropriateness of students' level of development, convenience of use, and attractiveness of the module. There are three items for the aspect of text assessment. Table 5 shows that the average percentage of experts' agreement on the text aspect is 91.3%. Regarding each item, the average of experts' agreement is more significant than 70%, with at least 90% for the attractiveness of module presentation and 92% for each for the appropriateness of students' level of development and the module's convenience of use. However, there are still comments, corrections, and suggestions regarding adding some components to increase the attractiveness of the module and provide some direction to make the module more user-friendly.

Table 5 Experts' Agreement in The Presentation Aspect

No.	Item	Score from the Experts					Score of each item	
		P1	P2	P3	P4	P5	Sum of the score	Percentage (%)
1	The module's presentation is appropriate to the students' level of development.	9	9	9	9	10	46	92
2	The module presentation is user-friendly.	8	10	9	9	10	46	92
3	Interesting module presentation.	8	9	9	9	10	45	90
	Sum of the score	25	28	27	27	30	137	
	Percentage (%)	83.3	93.3	90	90	100		
	The average of percentage (%)							**91.3**

Moreover, based on Figure 2, for the assessment of the module in terms of the face validity aspects, it was found that the average value of the overall percentage of agreement is 91.6%, and the validity coefficient is 0.92. From the study results, experts agreed with all aspects: language 93.15, text 92.45, graphics 89.4%, and presentation 91.3%. Therefore, based on the assessments of the module evaluation panel, the modules produced are good in terms of face validity based on the percentage of validity and the validity coefficient.

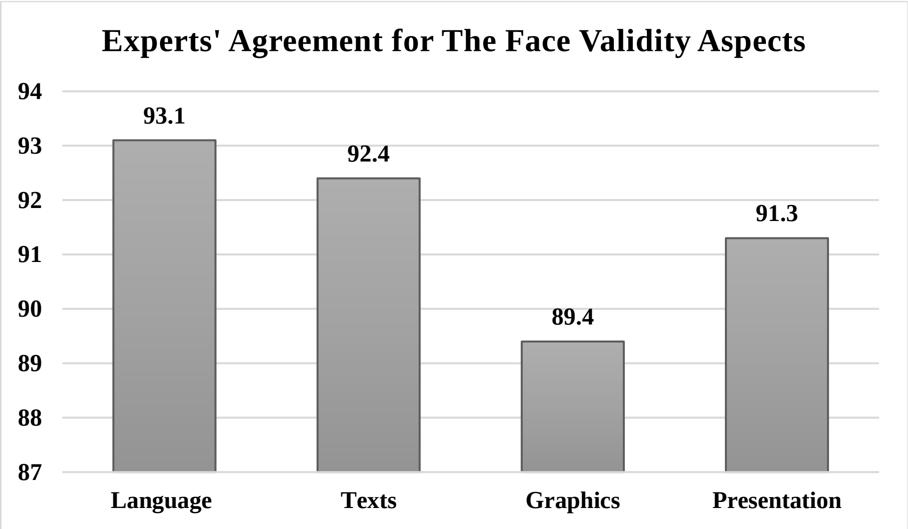

Figure 2: Experts' Agreement for The Face Validity Aspects

The graphics and presentation aspects are slightly lower than the other aspects, reflecting experts' suggestions and recommendations. For instance, in the graphics aspect, experts suggest enhancing the figures' resolutions and ensuring that all figures are used effectively. In terms of presentation, the most significant suggestion is to provide more guidance in the exploration and reflection, a key factor in ensuring the module's user-friendliness. Research has demonstrated that effective visual aids may greatly enhance learning outcomes by simplifying difficult concepts [19]–[21]. Therefore, to improve the module's usability and efficacy, it is crucial to offer explicit direction during the exploration and reflection stages.

Assessment of the Content Validity

The content validity of the module is measured based on 11 content validity items that have been adapted from the five criteria that have been proposed by Russell [22]. Those five criteria are: 1) meet the target population, which is grade ten of vocational high school students which covers the knowledge and the skills set in the curriculum specification; 2) can be implemented perfectly, which involves the implementation of each module activity, 3) is compatible with the time allocated, which is according to the schedule that has been set, 4) is able to improve student performance in terms of the mathematical creativity and achievement and 5) is able to change attitudes towards excellence in terms of students' learning motivation.

The content validity of the module was assessed using the module content validity calculation method proposed by Sidek and Jamaludin [17]. In this study, the content validity of the module was assessed by five expert panels using the module validity questionnaire developed based on the validity of Russell [22]. The percentage value obtained above 70 percent is considered to have mastered or reached a good level of validity [17], [23]. Table 6 shows the module validity score value given by each expert assessor for each validity question item.

Table 6 Experts' Agreement in The Content Validity Assessment

No.	Item	Score from the Experts					Score of each item	
		P1	P2	P3	P4	P5	Sum of the score	Percentage (%)
1	The contents of the module are appropriate to the research target population.	9	10	10	10	10	49	98
2	The module content is appropriate to the vocational high school student's academic development level.	9	10	10	9	10	48	96
3	The module's contents are following the Core Competencies and Basic Competencies.	9	10	9	10	10	48	96
4	The contents of the module are following the learning objectives.	8	9	8	9	9	43	86
5	The module's contents follow the scope of the Linear Program material at vocational high school.	8	9	8	8	9	42	84
6	Fill in the module according to the time allocation.	8	9	8	9	9	43	86
7	The module's contents follow the application of the Realistic Mathematics Education approach.	9	9	8	9	9	44	88
8	The module's contents follow the application of the Project-based Inquiry Learning model.	8	9	9	9	9	44	88
9	The module content can support increasing students' mathematics learning motivation.	9	10	9	9	10	47	94
10	The contents of the module can	8	9	8	9	9	43	86

continued

	support increasing students' mathematical creativity.							
11	The module content can support increasing students' mathematics learning achievement.	8	9	9	8	9	43	86
	Sum of the score	93	103	96	99	103	494	
	Percentage (%)	84.6	93.6	87.3	90	93.6		
	The average of percentage (%)							89.8

Table 6 describes the findings of content validity analysis based on module assessment activities. The highest validity value is 98% for the appropriateness of the module's contents to the research target population. At the same time, the lowest validity value is 84% for the suitability of the module's contents to the scope of linear programming topics in vocational high school education. Overall, the score percentage for all aspects is good, ranging from 84% to 98%. This value shows that the content validity of the module is good, which exceeds the minimum validity value of 70%, as suggested by Tuckman and Waheed [23]. In addition, the average value of the overall score of the module's content validity assessment is 89.8%. This value shows that all module aspects have high content validity and exceed 70%. Based on Russell's conditions [22], the module's validity is good. The high value of the module's validity is further strengthened by the finding of good value of face and content validity, which is included in the validity assessment questionnaire. These findings show that the module is valid and can be used to learn linear programming topics in vocational high school education.

Assessing validity is a crucial part of developing mathematics learning modules. Previous studies found that most RME-based modules or PIL-based modules were highly valid [4], [24], [25]. It emphasizes the clarity of content, which is related to face validity [10], [26], [27]. Furthermore, the content validity relates to integrating the RME principles or the PIL phases and how the module engages students in meaningful mathematics activities to support their cognitive and affective competencies [24], [28], [29]. The validation stage continued with iterative revision based on experts' feedback. It is to ensure the quality of the module and readiness to be applied in a pilot study for a practical assessment, ensuring that you are well-prepared for the next steps.

CONCLUSION

The integrated RME and PIL learning modules integrate the RME approach principles and the PIL model phases. Based on an evaluation of face validity from five experts, it was found that the average value of the overall percentage of agreement is 91.6%. From the study results, experts agreed with all aspects: language 93.15, text 92.45, graphics 89.4%, and presentation 91.3%. Therefore, based on the assessments of the module evaluation panel, the modules produced are good in terms of face validity based on the percentage of validity. Regarding the content validity, the score percentage for all aspects is good, ranging from 84% to 98%. This value shows that the content validity of the module is good.

These findings offer practical implications for mathematics teachers in orchestrating learning activities based on realistic projects to bridge abstract mathematics concepts and realistic applications. Moreover, the module could serve as a blueprint for innovative learning relevant to vocational high school settings. This study opens exciting possibilities for future research, providing a foundation for developing and validating a mathematics learning module that integrates multiple learning methods involving RME and PIL. Furthermore, future studies should focus on pilot testing of the module in various classroom settings to assess the effectiveness of students' motivation, creativity, and achievement. Adapting the module design to other mathematics topics is also recommended.

ACKNOWLEDGEMENTS

We thank the Universitas Muhammadiyah Surakarta, Indonesia, for the research funding and Universiti Pendidikan Sultan Idris, Malaysia, for the conference funding.

REFERENCES

[1] A. R. Mohd Nazri *et al.*, "Development of folktales digital story module as basic literacy learning for indigenous children in rural preschool," *J. Phys. Conf. Ser.*, vol. 1529, no. 4, pp. 1–7, 2020, doi: 10.1088/1742-6596/1529/4/042044.

[2] S. Rejeki, M. Adnan, C. N. Che Ahmad, and B. Murtiyasa, "An integrated RME and PIL mathematics module for technical vocational high school learning: A need analysis," *Eur. J. Educ. Pedagog.*, vol. 4, no. 2, pp. 161–167, 2023, doi: 10.24018/ejedu.2023.4.2.485.

[3] M. van den Heuvel-Panhuizen, "Seen through other eyes—opening up new vistas in realistic mathematics education through visions and experiences from other countries," in *International reflections on the Netherlands didactics of mathematics: Visions on and experiences with realistic mathematics education*, 2020, pp. 1–20.

[4] A. Mazlini, P. Marzita, M. T. Nor'ain, M. Siti Mistima, and C. H. Ng, "Integrating STEM education through Project-Based Inquiry Learning (PIL) in topic space among year one children," *Turkish Online J. Des. Art, Commun.*, vol. 296, no. 1, pp. 1383–1390, 2018, doi: 10.1088/1757-899X/296/1/012020.

[5] A. Kurniawati, S. Wardani, and M. Asikin, "The effectiveness of the problem based learning model with a realistic mathematics education approach to problem solving ability," *Int. J. Res. Rev.*, vol. 10, no. 1, pp. 491–497, 2023, doi: 10.52403/ijrr.20230156.

[6] R. Kenney, T. An, S. H. Kim, N. A. Uhan, J. S. Yi, and A. Shamsul, "Linear programming models: Identifying common errors in engineering students' work with complex word problems," *Int. J. Sci. Math. Educ.*, vol. 18, no. 4, pp. 635–655, 2020, doi: 10.1007/s10763-019-09980-5.

[7] G. Hall, "Integrating real-world numeracy applications and modelling into vocational courses," *Adults Learn. Math. An Int. J.*, vol. 9, no. 1, pp. 53–67, 2014, [Online]. Available: https://files.eric.ed.gov/fulltext/EJ1068221.pdf.

[8] Y. D. Arthur, E. K. Owusu, S. Asiedu-Addo, and A. K. Arhin, "Connecting mathematics to real life problems: A teaching quality that improves students' mathematics interest," *IOSR J. Res. Method Educ.*, vol. 8 Ver. II, no. 4, pp. 65–71, 2018, doi: 10.9790/7388-0804026571.

[9] I. W. Sumandya and I. W. E. Mahendra, "Developing vocation based mathematics e-module in linear program material," *Int. J. Psychosoc. Rehabil.*, vol. 24, no. 6, pp. 1741–1752, 2020, doi:) https://doi.org/10.37200/ijpr/v24i6/pr260168.

[10] N. Salsabila *et al.*, "Validity of e-modules for teaching fractions through realistic mathematics education with the context of sacrifice worship (ibadah kurban)," *Al Khawarizmi J. Pendidik. dan Pembelajaran Mat.*, vol. 8, no. 1, pp. 69–80, 2024, [Online]. Available: https://jurnal.ar-raniry.ac.id/index.php/alkhawarizmi/article/view/22850/9703.

[11] C. H. Ng and A. Mazlini, "Integrating STEM education through Project- Based Inquiry Learning (PIL) in topic space among year one pupils," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 296, no. 1, pp. 0–6, 2018, doi: 10.1088/1757-899X/296/1/012020.

[12] S. Haji, Y. Yumiati, and Z. Zamzaili, "Improving students' productive disposition through realistic mathematics education with outdoor approach," *JRAMathEdu (Journal Res. Adv. Math. Educ.*, vol. 4, no. 2, pp. 101–111, 2019, doi: 10.23917/jramathedu.v4i2.8385.

[13] D. Dhayanti, R. Johar, and C. M. Zubainur, "Improving students' critical and creative thinking through realistic mathematics education using geometer's sketchpad," *J. Res. Adv. Math. Educ.*, vol. 3, no. 1, p. 25, 2018, doi: 10.23917/jramathedu.v3i1.5618.

[14] D. A. Erlina and S. Sutarni, "Peningkatan aktivitas belajar siswa melalui pembelajaran Realistic Mathematics Education (RME)," *J. Cendekia J. Pendidik. Mat.*, vol. 08, no. 01, pp. 454–463, 2024.

[15] M. F. Aprilianto and S. Sutarni, "Peningkatan kemampuan berpikir kritis dengan pembelajaran matematika berbasis Realistic Mathematic Education (RME) pada siswa Sekolah Dasar," *J. Basicedu*, vol. 7, no. 1, pp. 807–815, 2023, doi: 10.31004/basicedu.v7i1.4643.

[16] Y. Muhamad Saiful Bahri, "ABC of content validation and content validity index calculation," *Educ. Med. J.*, vol. 11, no. 2, pp. 49–54, 2019, doi: 10.21315/eimj2019.11.2.6.

[17] M. N. Sidek and A. Jamaludin, *Pembinaan modul: Bagaimana membina modul latihan dan modul akademik*. Serdang: Universiti Putera Malaysia, 2005.

[18] M. Van Den Heuvel-panhuizen and P. Drijvers, *Encyclopedia of mathematics education*. Dordrecht: Springer Science+Business Media, 2014.

[19] A. Renkl and K. Scheiter, "Studying visual displays: How to instructionally support learning," *Educ. Psychol. Rev.*, vol. 29, no. 3, pp. 599–621, 2017, doi: 10.1007/s10648-015-9340-4.

[20] E. Bobek and B. Tversky, "Creating visual explanations improves learning," *Cogn. Res. Princ. Implic.*, vol. 1, no. 1, pp. 1–14, 2016, doi: 10.1186/s41235-016-0031-6.

[21] C. Buckley and C. Nerantzi, "Effective use of visual representation in research and teaching within higher education," *Int. J. Manag. Appl. Res.*, vol. 7, no. 3, pp. 196–214, 2020, doi: 10.18646/2056.73.20-014.

[22] J. D. Russell, "The standard problem: Meaning and values in measurement and evaluation," *Educ. Meas. Issues Pract.*, vol. 1, no. 1, pp. 5–10, 1974.

[23] B. W. Tuckman and M. A. Waheed, "Evaluating an individualized science program for community college students," *J. Res. Sci. Teach.*, vol. 18, no. 6, pp. 489–495, 1981, doi: 10.1002/tea.3660180603.

[24] S. R. Achmad and Suparman, "Design of e-module with RME approach to improve the creative thinking ability of students," *Int. J. Sci. Technol. Res.*, vol. 9, no. 3, pp. 5228–5233, 2020.

[25] M. Divia and Y. Fitri, "Module development using the Realistic Mathematics Education (RME) model for class X TAV students of SMK Negeri Padang [Pengembangan modul dengan menggunakan model Realistic Mathematics Education (RME) pada siswa kelas X TAV SMK Negeri Padang]," *JANGKA J. Pendidik. Mat. Eksakta*, vol. 1, no. 2, pp. 49–57, 2021, [Online]. Available: https://doi.org/10.31933/jangka.v1i2.489.

[26] Risnawati, Z. Amir, and D. Wahyuningsih, "The Development of Educational Game as Instructional Media to Facilitate Students' Capabilities in Mathematical Problem Solving," *J. Phys. Conf. Ser.*, vol. 1028, no. 1, 2018, doi: 10.1088/1742-6596/1028/1/012130.

[27] R. E. N. Afrianti and A. Qohar, "Contextual-based e-module development on class XI linear programming topic [Pengembangan e-modul berbasis kontekstual pada materi program linear kelas XI]," *J. Edukasi Mat. dan Sains*, vol. 7, no. 1, p. 22, 2019, doi: 10.25273/jems.v7i1.5288.

[28] C. Hikayat, Suparman, Y. Hairun, and H. Suharna, "Design of realistic mathematics education approach to improve critical thinking skills," *Univers. J. Educ. Res.*, vol. 8, no. 6, pp. 2232–2244, 2020, doi: 10.13189/ujer.2020.080606.

[29] D. A. Putri, V. D. Susanti, and D. Apriandi, "Development of RME-based modules to improve the mathematical literacy skills of class XI SMK students [Pengembangan modul berbasis RME untuk meningkatkan kemampuan literasi matematika siswa kelas XI SMK]," *Prima Magistra J. Ilm. Kependidikan*, vol. 1, no. 2, pp. 138–146, 2020, doi: 10.37478/jpm.v1i2.470.