Journal of Engineering Science and Technology
Special Issue on ISCoE2024 Vol. 20 No. 3 (2025) 177 - 184

DESIGNING A STEM-RME-BASED MATHEMATICS E-MODULE TO ENHANCE HIGH SCHOOL STUDENTS' NUMERACY

VENI SAPUTRI, YAYA SUKJAYA KUSUMAH*, T. TURMUDI, AL JUPRI

Universitas Pendidikan Indonesia, Bandung, Indonesia
*Corresponding Author: yayaskusumah229@gmail.com

Abstract

This study designed and developed a mathematics e-module to enhance numeracy skills among senior high school students. The research employed Analyse, Design, Develop, Implement, and Evaluate (ADDIE) model, including field observations, questionnaires, interviews, literature reviews, and numeracy tests. The results indicated that the Science, Technology, Engineering, and Mathematics (STEM) and Realistic Mathematics Education (RME)-based mathematics e-module is valid and falls within the good category. The e-module proved effective because its strong contextualization of materials and alignment with STEM-RME concepts enhance students' numeracy skills. Additionally, because it includes interactive features, such as instructional videos for conceptual understanding and interactive quizzes accessible through designated buttons, it actively engages students. These findings suggest that STEM-RME-based e-modules can serve as an effective alternative learning resource, facilitating students' numeracy development and improving their overall mathematical competence.

Keywords: E-module, Mathematics, Numeracy, RME, STEM.

1. Introduction

Mathematics is essential for developing problem-solving and analytical skills, particularly in Science, Technology, Engineering, and Mathematics (STEM). However, many students struggle with numeracy, which is crucial for applying mathematical concepts in real life [1-6]. The Realistic Mathematics Education (RME) approach enhances mathematical understanding by emphasizing contextual learning [7, 8]. Integrating STEM and RME into an e-module can create an interactive learning experience that strengthens numeracy skills. Previous studies showed STEM-based learning for improving critical thinking and problem-solving by linking mathematics to real-world applications [7, 9-11]. Similarly, RME fosters conceptual understanding and engagement through meaningful contexts [12, 13]. While e-modules enhance self-paced and interactive learning, few studies integrate STEM and RME to develop e-modules specifically targeting numeracy skills in high school students. This study developed a STEM-RME-based mathematics e-module to enhance numeracy skills using Analyse, Design, Develop, Implement, and Evaluate (ADDIE) model. Its novelty includes (i) unique integration of STEM and RME in a digital format, (ii) personalized and adaptive learning pathways for customized learning, and (iii) enhanced interactivity through an interactive application that provides instant feedback, guides problem-solving, and reinforces conceptual understanding.

2. Literature Review

Figure 1 illustrates the integration of STEM and RME in digital learning, which has gained significant attention. STEM education promotes interdisciplinary learning, problem-solving, and real-world applications [14-16], while RME emphasizes contextualized learning, enabling students to build mathematical understanding through realistic situations [17]. Combining these approaches in an e-module enhances numeracy skills, especially in secondary education. E-modules improve student engagement by offering interactive, multimedia-rich content that enhances conceptual understanding and motivation [18]. Research shows that STEM-integrated e-modules foster critical thinking and problem-solving [19], while RME-based teaching presents mathematics in meaningful contexts, improving real-life application skills [20-22]. The contextual approach of RME, combined with STEM's practical applications, helps students connect mathematical concepts to real-world problems, deepening their numeracy skills.

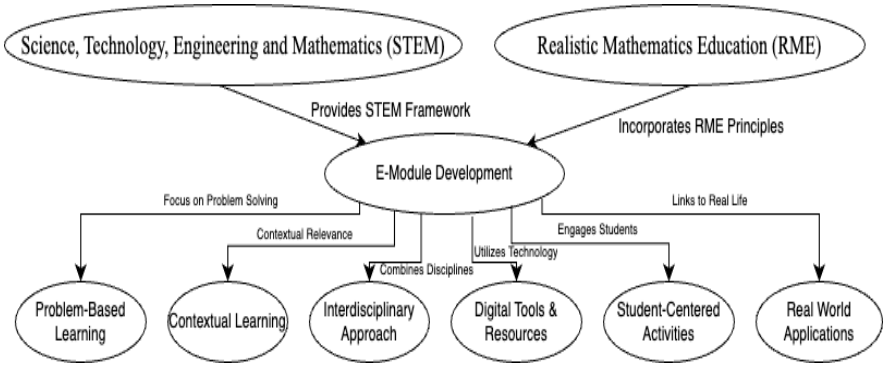


Fig. 1. The integration of STEM and RME in e-module development.

3. Method

This study employed the ADDIE model, beginning with an analysis of teacher and student needs regarding the e-module. A literature review on STEM and RME principles was conducted, along with an evaluation of available technological resources. The findings from this stage informed the design of learning activities, ensuring alignment with the STEM-RME approach for effective numeracy skill development. Detailed information regarding concept of ADDIE is explained elsewhere [23].

4. Results and Discussion

The STEM-RME-based mathematics e-module is designed based on teacher and student needs, ensuring that learning content aligns with objectives, contextualization, and interactivity for engaging independent learning. Teachers emphasize clear explanations, interactive features, and ease of implementation, while students require accessible, visually appealing content with relatable examples [24, 25].

Figure 2 outlines the e-module development flowchart, incorporating facts, concepts, principles, and assessment instruments adapted to STEM-RME learning activities. It presents materials using images, animations, videos, and quizzes, integrating interactive competency assessments for students, evaluated by teachers. E-modules function as self-learning materials, enhanced with video tutorials, animations, and interactive links for enriched learning [26, 27]. Features such as clickable buttons, linked resources, and input fields allow users to engage dynamically with the content [28, 29].

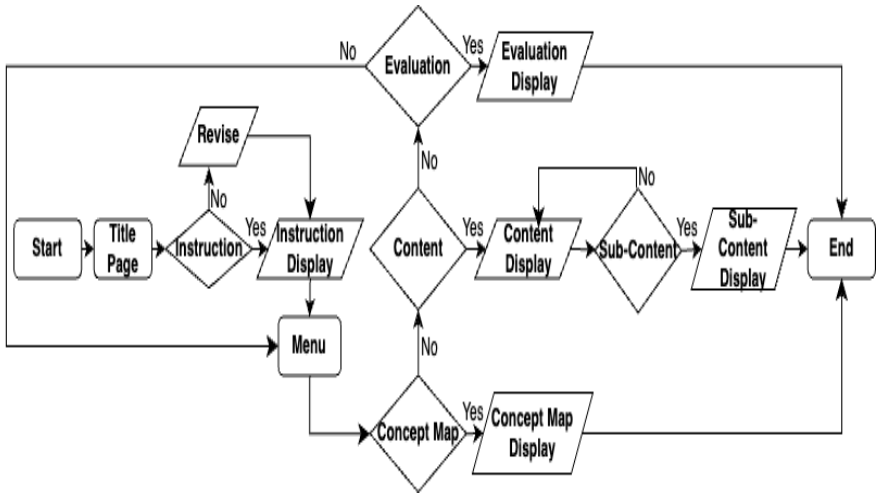


Fig. 2. The flowchart of e-module development.

Table 1 shows validation results from five experts, with media experts rating it 93.18%, pedagogy experts 90.54%, and material experts 89.58%. Teachers and students rated it 88.51% and 83.07%, respectively, placing it in the "Very Good" category with an overall validity of 88.98%, confirming its feasibility for implementation [30, 31].

Table 2 illustrates the integration of STEM and RME principles into the e-module, ensuring context, interaction, and feedback to support deep mathematical understanding [32-34]. This e-module transforms traditional learning by: (1) connecting real-world applications of numbers and mathematical symbols, (2) integrating STEM disciplines to improve data analysis and interpretation skills, and (3) promoting problem-solving through realistic, data-driven decision-making tasks [35, 36]. The RME approach ensures that problems are relevant, realistic, and applicable to STEM fields, bridging mathematics with real-world contexts [17, 37, 38]. This study advances numeracy education, enriching previous research and contributing to innovative, multidisciplinary learning strategies. This study adds new information regarding mathematics education [39-43].

Table 1. Results of the e-module validation.

No.	Validator	Percentage	Criteria
1	**Material Expert**	89.58%	Very Good
2	**Pedagogy Expert**	90.54%	Very Good
3	**Media Expert**	93.18%	Very Good
4	**Teacher**	88.51%	Very Good
5	**Student**	83.07%	Very Good

Table 2. Application of STEM-RME in e-module.

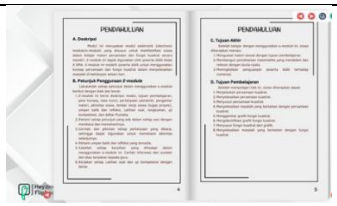
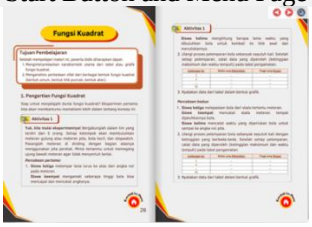
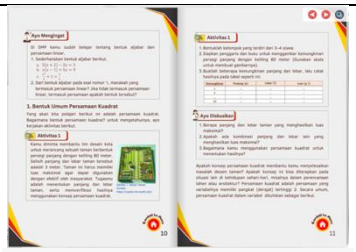
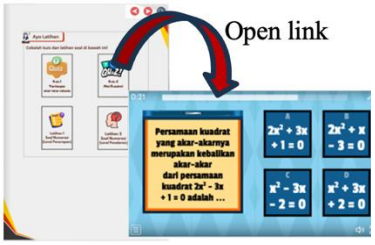
No.	E-Module View	
1	 E-module front page view	 Instruction Display
2	 Start Button and Menu Page	 Concept Map Display
3	 Discovery of the concept of quadratic equation through real contexts or scientific experiments.	 Use of technology to visualise and deepen understanding of quadratic function concepts

Table 2(Continue). Application of STEM-RME in e-module.

No.	E-Module View	
4		
	Use of engineering phenomena as a context to understand the concept of equations and quadratic functions.	Develop mathematical models to solve problems independently
5		
	Evaluation	Competency Assessment for Numeracy

5. Conclusion

This study confirms the effectiveness of a STEM-RME-based mathematics e-module in improving numeracy skills among high school students. By integrating STEM for real-world applications and RME for contextual learning, the e-module enhances critical thinking and problem-solving. Validation results from experts, teachers, and students confirm its high quality and feasibility. The interactive features, such as videos, animations, and quizzes, support independent learning and engagement. By linking mathematics with real-life contexts, the e-module strengthens data analysis, interpretation, and decision-making. These findings highlight the importance of STEM-RME integration, recommending broader implementation to enhance mathematical literacy in digital learning environments.

Acknowledgments

We received scholarships from the Higher Education Financing Center (BPPT), the Indonesian Education Scholarship (BPI), and the Indonesian Endowment Fund for Education Agency (LPDP).

References

1. Hidayah, I.R.; Kusmayadi, T.A.; and Fitriana, L. (2021). Minimum competency assessment (AKM): An effort to photograph numeracy. *Journal of Mathematics and Mathematics Education*, 11(1), 14.
2. Megawati, L.A.; and Sutarto, H. (2021). Analysis numeracy literacy skills in terms of standardized math problem on a minimum competency assessment.

Unnes Journal of Mathematics Education, 10(2), 155-165.

3. Miralda, D.; Marhaeni, N.H.; and Dwikarini, M. (2022). Needs analysis of student's worksheets to improve numerical literacy skills for students of SMP Negeri 4 Yogyakarta, Indonesia. *Indonesian Journal Education*, 1(1), 25-29.
4. Aishalya, A.S.; Nandiyanto, A.B.D.; Kurniawan, T.; and Bilad, M.R. (2022). Implementation of numeracy literacy through economics learning in elementary school. *Indonesian Journal of Multidiciplinary Research*, 2(1), 63-68.
5. Saefurohman, S.; Maryanti, R.; Azizah, N.N.; Al Husaeni, D.F.; Wulandary, V.; and Irawan, A.R. (2021). Efforts to increasing numeracy literacy of elementary school students through Quiziz learning media. *ASEAN Journal of Science and Engineering Education*, 3(1), 11-18.
6. Arciosa, R.M.; Perfecio, J.; and Cerado, E.C. (2022). Community extension: Literacy and numeracy enhancement program for alternative learning system and out-of-school youth learners. *ASEAN Journal for Science Education*, 1(2), 75-80.
7. Khotimah, R.P.; Adnan, M.; Ahmad, C.N.C.; and Murtiyasa, B. (2021). Science, mathematics, engineering, and mathematics (STEM) education in Indonesia: A literature review. *Journal of Physics*: *Conference Series*, 1776(1), 1-9.
8. Kurt, M.; and Benzer, S. (2020). An investigation on the effect of STEM practices on sixth grade students' academic achievement, problem solving skills, and attitudes towards STEM. *Journal of Science Learning*, 3(2), 79-88.
9. Apriyani, R.; Ramalis, T.R.; and Suwarma, I.R. (2019). Analyzing students' problem solving abilities of direct current electricity in STEM-based learning. *Journal of Science Learning*, 2(3), 85-91.
10. Arivina, A.N. and Jailani. (2020). Development of trigonometry learning kit with a STEM approach to improve problem-solving skills and learning achievement. *Jurnal Riset Pendidikan Matematika*, 7(2), 178-194.
11. Firdaus, A.R.; and Rahayu, G.D.S. (2019). Effect of STEM-based learning on the cognitive skills improvement. *Mimbar Sekolah Dasar*, 6(2), 198.
12. Fauzan, A.; Harisman, Y.; Tasman, F.; Nisa, S.; and Syaputra, H. (2024). Realistic mathematics education (RME) to improve literacy and numeracy skills of elementary school students based on teachers' experience. *Infinity Journal*, 13(2), 301-316.
13. Saraseila, F.; Karjiyati, V.; and Agusdianita, N. (2020). Pengaruh model realistic mathematics education terhadap kemampuan literasi matematika siswa kelas V sekolah dasar gugus XIV kota Bengkulu. *Jurnal Math-UMB.EDU*, 7(2), 1-9.
14. Ali, R. (2024). Enhancing 21st-century skills through integrated STEM education using project-oriented problem-based learning. *Geo Journal of Tourism and Geosites*, 53(2), 421-430.
15. Eugenijus, L. (2023). Integrating blended learning and STEM education: Innovative approaches to promote interdisciplinary learning. *Research and Advances in Education*, 2(9), 20-36.
16. Shidiq, A.S.; Permanasari, A.; and Hernani, S.H. (2021). The use of simple spectrophotometer in STEM education: A bibliometric analysis. *Moroccan Journal of Chemistry*, 9(2), 290-300.
17. Gravemeijer, K.; and Terwel, J. (2000). Hans Freudenthal: A mathematician on

didactics and curriculum theory. *Journal of Curriculum Studies*, 32(6), 777-796.

18. Cirneanu, A.L.; and Moldoveanu, C.E. (2024). Use of digital technology in integrated mathematics education. *Applied System Innovation*, 7(4), 66.
19. Seruni, R.; Munawaroh, S.; Kurniadewi, F.; and Nurjayadi, M. (2020). Implementation of e-module flip PDF professional to improve students' critical thinking skills through problem based learning. *Journal of Physics*: *Conference Series*, 1521(4), 042085.
20. Sukmaningthias, N.; Hasyanah, Y.; Sari, N.; and Nuraeni, Z. (2023). The influence of RME-based teaching media assisted by pixton application on students' mathematics problem solving ability. *Mosharafa*: *Jurnal Pendidikan Matematika*, 12(2), 363-374.
21. Fauzana, R.; Dahlan, J.A.; and Jupri, A. (2020). The influence of realistic mathematics education (RME) approach in enhancing students' mathematical literacy skills. *Journal of Physics*: *Conference Series*, 1521(3), 032052.
22. Lady, A.; Utomo, B.T.; and Lovi, C. (2018). Improving mathematical ability and student learning outcomes through realistic mathematic education (RME) approach. *International Journal of Engineering and Technology*, 7, 55-57.
23. Susilawati, A.; Al-Obaidi, A.S.M.; Abduh, A.; Irwansyah, F.S.; and Nandiyanto, A.B.D. (2025). How to do research methodology: From literature review, bibliometric, step-by-step research stages, to practical examples in science and engineering education. *Indonesian Journal of Science and Technology*, 10(1), 1-40
24. Aprinasari, C.; and Suyanta, S. (2024). Need analysis of web-based electronic module development. *AIP Conference Proceedings*, 2622(1), 050004.
25. Prabasari, J.S.; Muzzazinah, M.; and Wahyuningsih, D. (2023). The need for implementation of problem-based learning electronic modules (e-modules) to improve students' critical thinking ability. *AIP Conference Proceedings*, 2727(1), 020063.
26. Najuah, N.; Sidiq, R.; and Lukitoyo, P.S. (2020). The development electronic module of history using ADDIE model. *International Journal of Educational Research and Social Sciences*, 2(6), 1658-1663.
27. Delita, F.; Berutu, N.; and Nofrion, N. (2022). Online learning: The effects of using e-modules on self-efficacy, motivation and learning outcomes. *Turkish Online Journal of Distance Education*, 23(4), 93-107.
28. Sumarmi, S.; Bachri, S.; Irawan, L.Y.; and Aliman, M. (2021). E-module in blended learning: its impact on students' disaster preparedness and innovation in developing learning media. *International Journal of Instruction*, 14(4), 187-208.
29. Hadiyanti, N.F.D.; Hobri; Prihandoko, A.C.; Susanto; Murtikusuma, R.P.; Khasanah, N.; and Maharani, P. (2021). Development of mathematics e-module with STEM-Collaborative project based learning to improve mathematical literacy ability of vocational high school students. *Journal of Physics: Conference Series*, 1839(1), 012031.
30. Rahmawati, D.; Vahlia, I.; and Yunarti, T. (2022). Validity analysis of development of Socrates-based linear aljebra e-modules. *Education Quarterly Reviews*, 5(2), 357-364.
31. Melisa, M.; Susilowati, E.; and Dewantara, D. (2021). Development of electronic modules based on STEM to train students' creativity: Validity and

practicality analysis. *Berkala Ilmiah Pendidikan Fisika [Physics Education Scientific Periodical]*, 9(3), 335.

32. Adhelacahya, K.; Sukarmin, S.; and Sarwanto, S. (2023). The impact of problem-based learning electronics module integrated with STEM on students' critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, 9(7), 4869-4878.
33. Purnamasari, D.; Ashadi; and Utomo, S.B. (2020). Analysis of STEM-PBL based e-module needs to improve students' critical-thinking skills. *Journal of Physics*: *Conference Series*, 1511(1), 012096.
34. Rasmi, D.P.; Hendri, M.; and Azriyanti, R. (2023). Analysis of the need for development of teaching materials in the form of STEM-based electronic modules. *Jurnal Penelitian Pendidikan IPA*, 9(6), 4135-4141.
35. Goos, M.; Carreira, S.; and Namukasa, I.K. (2023). Mathematics and interdisciplinary STEM education: Recent developments and future directions. *ZDM-Mathematics Education*, 55(7), 1199-1217.
36. Gulen, S. (2018). Determination of the effect of STEM-integrated argumentation based science learning approach in solving daily life problems. *World Journal on Educational Technology: Current Issues*, 10(4), 95-114.
37. Susanti, E. (2025). Enhancing problem-solving skills in elementary students through realistic mathematics education. *Science*: *Jurnal Inovasi Pendidikan Matematika dan IPA*, 5(1), 48-59.
38. Pasaribu, F.T.; and Ramalisa, Y. (2020). Desain media pembelajaran geometri SMP menggunakan 3D Pageflip Professional berbasis RME terintegrasi STEM. *Logaritma*: *Jurnal Ilmu-ilmu Pendidikan dan Sains*, 8(1), 55-66.
39. Hashim, S.; Masek, A.; Mahthir, B.N.S.M.; Rashid, A.H.A.; and Nincarean, D. (2021). Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement. *Indonesian Journal of Science and Technology*, 6(1), 113-122.
40. Solihah, P.A.; Kaniawati, I.; Samsudin, A.; and Riandi, R. (2024). Prototype of greenhouse effect for improving problem-solving skills in science, technology, engineering, and mathematics (STEM)-education for sustainable development (ESD): Literature review, bibliometric, and experiment. *Indonesian Journal of Science and Technology*, 9(1), 163-190.
41. Angraini, L.M.; Susilawati, A.; Noto, M.S.; Wahyuni, R.; and Andrian, D. (2024). Augmented reality for cultivating computational thinking skills in mathematics completed with literature review, bibliometrics, and experiments for students. *Indonesian Journal of Science and Technology*, 9(1), 225-260.
42. Akinoso, S.O. (2023). Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model. *Indonesian Journal of Educational Research and Technology*, 3(1), 79-90.
43. Radiamoda, A.A. (2024). Difficulties encountered by the students in learning mathematics. *Indonesian Journal of Educational Research and Technology*, 4(1), 63-70.