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Development of a Problem-Based Interactive E-Module with Social Emotional Learning in Tri Hita Karana to Enhance Mathematical Problem-Solving and Noble Character

Kadek Ayu Kusuma Cahyaningrum[1], I Made Ardana[2], Gede Suweken[3]
Universitas Pendidikan Ganesha, Indonesia
ayuukusuma07@gmail.com

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Abstract

This study explores the development and effectiveness of an interactive e-module based on Problem-Based Learning (PBL) to enhance students' mathematical problem-solving skills and foster noble character traits. The e-module was designed for learning fractions and aimed to address the gap in traditional learning methods that lack student engagement and motivation. The research was conducted in two primary schools, SD Negeri 6 Panji and SD Negeri 1 Baktiseraga, involving 28 students. The results demonstrated significant improvements in students' mathematical abilities, with average post-test scores increasing from 25.04 to 86.05 at SD Negeri 6 Panji and from 19.23 to 85.81 at SD Negeri 1 Baktiseraga. Moreover, the students showed positive behavioral changes, such as consistently greeting others and helping peers, reflecting the development of moral character. This study highlights the potential of interactive e-modules in enhancing both academic skills and character development.

Keywords: Interactive e-module, Problem-Based Learning, Mathematical problem-solving, Character development, Noble character traits, Fractions

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INTRODUCTION

Education in the 21st century demands a holistic approach to developing students' potential, not only in cognitive aspects but also in emotional and social domains (Prasad & O'Malley, 2022). One of the greatest challenges in education is how to integrate the development of academic competencies, such as mathematical problem-solving skills, with the development of students' noble character (Yenti & Sarifah, 2023). In this context, Social Emotional Learning (SEL) plays a crucial role in shaping individuals who are not only academically intelligent but also possess good social and emotional skills (Aprila et al., 2023). Additionally, good character is an essential aspect of school learning, which will have a positive impact on students' lives outside of school (Yuliani et al., 2024).

Mathematics education, particularly in the context of problem-solving, is often considered a major challenge for many students. Although mathematical problem-solving involves high cognitive skills, students often struggle to apply mathematical concepts to solve real-life problems (Primasari & Meiliasari, 2024). On the other hand, while cognitive abilities are crucial, many researchers and educational practitioners agree that emotional and social factors also have a significant impact on students' academic achievement. Therefore, education that solely relies on cognitive approaches often fails to develop students' potential in a comprehensive way (Phungsuk et al., 2017).

To address this, Problem-Based Learning (PBL) has emerged as a suitable approach to enhance students' problem-solving skills. PBL not only develops critical thinking and problem-solving skills but also encourages students to engage in more active and collaborative learning (Jaenudin et al., 2017). By solving problems relevant to real-life situations, students can develop independent thinking, creative solutions, and teamwork skills. However, to achieve optimal results, PBL needs to be combined with elements that support students' social and emotional development, such as through the application of SEL (Serevina et al., 2018).

In the context of Indonesian culture, the values embedded in the philosophy of Tri Hita Karana which emphasizes the importance of balance in relationships between humans and God, humans and other humans, and humans and nature can serve as a strong foundation for developing students' noble character (Permatasari et al., 2020). Tri Hita Karana is not only relevant in spiritual and social contexts but is also highly applicable in character education. These values can be translated into daily life and serve as the basis for

fostering students' emotional and social awareness during the learning process (Kusumantoro et al., 2022).

The application of Social Emotional Learning in the context of Tri Hita Karana in mathematics education based on PBL can create a more meaningful and profound learning experience. By integrating SEL and Tri Hita Karana in an interactive problem-based e-module, students are not only trained to solve mathematical problems but also guided to develop strong character, empathy, and an appreciation for healthy relationships with others and the environment (Ismail et al., 2025). For example, the value of mutual respect in Tri Hita Karana can be taught through collaboration in groups to solve mathematical problems, while spiritual and balance elements can be taught through individual and group reflections (Suardika et al., 2025).

This research offers significant novelty in its approach, particularly in the integration of three elements that are rarely combined in the context of mathematics education. First, this study develops an interactive problem-based e-module (PBL) that not only focuses on mastering mathematical content but also integrates Social Emotional Learning (SEL), which is typically applied in non-mathematics subjects. Second, the integration of Tri Hita Karana values into this e-module provides an approach that not only emphasizes academic aspects but also delves into students' character development with a focus on the balance of life in social, spiritual, and ecological contexts. This approach is unique because it combines local cultural values relevant to the educational context in Indonesia, enriching both mathematics learning and character education in a holistic manner. Another novelty is the use of technology in the form of an interactive e-module, which supports more flexible learning that can be accessed anytime and anywhere, allowing students to learn independently with emotional and social elements effectively integrated.

Thus, this research aims to create an innovation in mathematics education that not only prioritizes academic achievement but also takes into account character formation and students' social-emotional intelligence through the application of holistic educational theories that are relevant to Indonesian cultural values.

METHODS

This study follows a design research methodology, an advanced stage of development research, focused on creating innovative theories or products to address practical problems

in the educational context (Andriani et al., 2023). The primary goal is to produce a Problem-Based Learning (PBL) e-module with a Social Emotional Learning (SEL) approach, integrating Tri Hita Karana values, which is valid, practical, and effective for enhancing students' problem-solving skills and character development. Design research involves iterative processes of analysis, design, evaluation, and revision, with collaboration between researchers and practitioners (Maqfiroh & Munahefi, 2022). The research includes three main phases: Preliminary Research, Prototyping, and Assessment. The e-module is developed through these phases, ensuring it meets the criteria of validity (alignment with curriculum and accurate content), practicality (ease of use for teachers and students), and effectiveness (supporting character development through learning experiences) (Zhang et al., 2022).

The research will take place in SD Negeri 1 Baktisegara and SD Negeri 6 Panji during the first semester of the 2024/2025 academic year (Juni – Desember 2024). The subjects of this study include experts in the field, as well as students and teachers, specifically 4th-grade students from the two schools. Data will be collected using various instruments, such as validity sheets, practicality questionnaires for both students and teachers, and a mathematical problem-solving test to assess the effectiveness of the e-module (Sugiyono, 2024). The study's procedure involves conducting a preliminary research phase, where information is gathered about current educational challenges and analyzing the curriculum and classroom practices (Sajidan et al., 2022). Afterward, the prototyping phase includes expert validation and limited field trials to refine the e-module (Lee et al., 2016). Finally, in the assessment phase, semi-summative evaluations will determine the final version of the e-module, ready for practical implementation in the classroom.

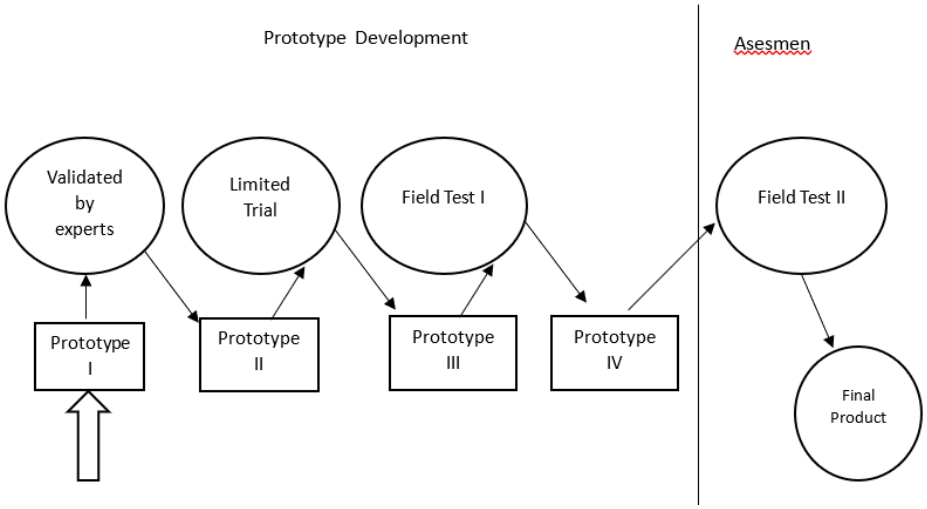


Figure 1: Development Model

RESULTS

Initial investigation stage

The needs and learning analyses were conducted at SD Negeri 1 Baktiseraga and SD Negeri 6 Panji during ongoing mathematics lessons. The purpose was to gather the necessary data to improve the quality of mathematics education in the classroom. Through interviews with the mathematics teachers of grade IV at both schools about fractions and student characteristics, several challenges faced by the students were identified. Most students struggled with math problems, particularly essay-type questions, relying solely on school textbooks. Additionally, many students lacked parental support when studying at home, as parents felt they couldn't explain math concepts effectively using only the school textbooks.

Beyond academic challenges, there were also concerns with students' character development, particularly in terms of moral values, as shown by their low participation in class discussions. After returning to offline learning, many students still needed guidance to build good character. One of the main issues identified was the lack of learning media that integrates mathematics with character education, compounded by students' disinterest in learning math through school books and the limited involvement of parents, who were unsure how to help their children with math at home.

The curriculum in place at both schools follows the Merdeka Curriculum, with learning goals aligned to the established Learning Outcomes. For example, the goal for fractions is for students to identify, read, count, and write fraction symbols for objects divided by different divisors. Before introducing the e-module, it is important to consider the students' learning styles, motivation, academic abilities, and character. Based on observations and interviews, students engage better with learning styles that include appealing visuals and interactive exercises, allowing them to check their answers independently.

In terms of character development, students showed a decline due to learning activities at home without parental guidance. This was mainly due to parents' lack of knowledge on how to assist their children in learning math and their misunderstanding of how to integrate math with character education. To address this, an interactive e-module based on Problem-Based Learning (PBL) and oriented toward Social Emotional Learning (SEL) in the context of Tri Hita Karana was developed. This e-module not only focuses on fractions but also helps students develop their character, with guidance from their parents, offering a more comprehensive learning experience.

Development Stage

a. Designing the Product

The design of the product begins by adjusting the information gathered during the initial investigation stage. This information serves as a guideline in creating the interactive e-module and aligning the characteristics of the fraction material with a problem-based learning approach, focused on social-emotional learning in Tri Hita Karana. This process is further adjusted to comply with the Merdeka Curriculum policy. Several software tools are utilized in the creation of the interactive e-module, such as Canva, GeoGebra, and Google Forms. Canva is used to design the e-module layout, Google Forms is used to create quizzes within the e-module, and GeoGebra is used to design visually engaging material for the content. The interactive e-module created with these software tools is accessible online through a link. The e-module includes three main topics: basic concepts of fractions, equivalent fractions, and fraction operations. A detailed presentation of the interactive e-module's interface will be provided.

b. Validation Stage

The first prototype, Prototype I, was then validated by experts, including one lecturer from the Master's in Mathematics Education Program and one teacher from an elementary school. This expert review was conducted to prepare the initial prototype for limited trials. The e-module was validated using a validation sheet with a scoring system of 1 to 5, and an average score was calculated and converted into a validity criterion. The content validator gave an average score of 4.6, indicating that the e-module met the criteria for excellent validity. Based on these results, the e-module was deemed highly suitable for implementation. The expert validation also provided corrections, suggestions, and feedback, which served as essential guidance for improving the product before field trials. After incorporating the experts' feedback, the revised prototype, Prototype II, was ready for testing at the school where the research was conducted. The product testing was carried out in three stages: limited trials, field test I, and field test II.

c. Limited Trial

Prototype II was then tested in a limited trial with 14 students from grade IV A at SD Negeri 1 Baktiseraga. The goal of this trial was to assess the practicality of the e-module by distributing questionnaires to the 14 students and one mathematics teacher. The practicality of the e-module was evaluated based on the responses collected from the teacher

and students. The results from the student questionnaire, shown in the table, revealed a practicality score of 74.08%, categorized as practical. For the teacher's feedback, the practicality score was 75.00%, categorized as very practical. Based on this feedback, the e-module was refined, and Prototype III was created for further testing in field test I.

d. Field Test

After improvements based on the limited trial results, Prototype III was subjected to field test I. The aim of field test I was to evaluate the quality of the product, specifically its practicality and effectiveness. This test involved 14 students from grade IV at SD Negeri 6 Panji. The process was divided into three main phases: implementation, observation, and reflection/evaluation. Prior to implementation, an observation sheet was used to assess the students' initial characteristics. The observation revealed that only 3 out of 14 students had displayed well-developed character traits, suggesting that most students at SD Negeri 6 Panji required more attention in terms of character development.

During the implementation phase, the researcher, the teacher, and the students engaged in learning using Prototype III, following the planned schedule. In the reflection phase, the practicality of the e-module was evaluated based on the student and teacher response questionnaires. The results of the student questionnaire indicated a practicality score of 78.98%, categorized as very practical. The teachers' response indicated a score of 81.67%, also categorized as very practical, suggesting that the material was effectively delivered and well received by both students and teachers. Observations of student character development were also carried out using the observation sheet, along with interviews with parents and assessments of the students.

Assessment Stage

The assessment stage was conducted through field test II, using Prototype IV. This stage involved 34 students from grade IV at SD Negeri 1 Baktiseraga. The main goal of field test II was to produce a final product that met the criteria of being valid, practical, and effective. As with field test I, the activities in field test II were carried out in three phases: implementation, observation, and reflection/evaluation. During the implementation phase, the researcher, the teacher, and the students participated in learning using Prototype IV according to the scheduled plan. Student character development was once again observed using the observation sheet.

Based on the results from the student response questionnaires, the practicality score for field test II was 85.13%, categorized as very practical. The teacher response questionnaire showed a practicality score of 90.00%, also categorized as very practical, reflecting that the e-module was seen as highly practical by both students and teachers. The feedback from both the students and teachers showed that the learning method and material were very practical and effective.

Subsequently, the researcher continued to observe and assess the students' character development in field test II, using observations, parent interviews, and student evaluations. The initial observations conducted before the use of the interactive e-module were compared with the post-test observations to evaluate any changes in the students' character.

The module design can be accessed at the following link: https://heyzine.com/flip-book/99ba7888c3.html

DISCUSSION

Characteristics of Interactive E-Modules Based on Problem Based Learning Oriented Social Emotional Learning in Tri Hita Karana

The interactive e-module based on Problem-Based Learning (PBL) with a focus on Social Emotional Learning (SEL) in Tri Hita Karana was developed using the Plomp development model, starting with a needs analysis and learning analysis. After identifying the actual needs and learning conditions in the field, the development of the e-module followed the outlined steps. Several software tools were used in the creation process: Canva for designing the e-module, and Google Forms to add quizzes, allowing educators to assess students' understanding of the material.

The e-module's opening page showcases the cover, designed with attention-grabbing images and visuals to engage students. After the cover, students are presented with several menus, including instructions and learning materials. The instructions contain guidelines for students, teachers, and parents, ensuring that everyone is involved in the learning process. The materials section covers three subtopics on fractions.

The first section introduces the concept of fractions, exploring the parts of a fraction, comparing fractions, and understanding fractions as numbers. In this section, students will learn how to identify the number of parts in a shape and determine which shapes have

equally-sized sections. They will also explore the numerator and denominator through illustrations, helping them understand the value of a fraction. The second section focuses on comparing fractions, including comparisons of fractions with the same numerator, denominator, and different values. The third section covers equivalent fractions, where students will work with an illustration of eight balls to be distributed into different containers. Using a slider tool, they will divide the balls into parts and move them to the respective containers. In the conclusion section, students will identify equivalent fractions based on their earlier work.

In summary, the e-module offers several key characteristics that contribute to student character development, particularly in fostering noble values. First, it includes instructions for both parents and students, where parents are given guidelines to assist their children in solving problems, an essential step in addressing the challenges parents face when supporting their child's learning at home. This aligns with Yew and Goh (2016) , who emphasized that parental involvement in home learning enhances cognitive development, social interaction skills, and academic achievement.

Secondly, the module incorporates Social Emotional Learning (SEL) content, using contextual approaches such as illustrations and everyday scenarios to emphasize the importance of positive thinking and building good relationships with others. According to Siregar et al. (2018), SEL positively impacts character development.

Compared to previous studies, such as Anggraini et al. (2019), which developed an interactive e-module to enhance problem-solving skills and foster a love for the country, the e-module here offers a unique feature by incorporating both parental and student instructions. This collaboration between teachers, parents, and students in supporting the learning process at home makes it more holistic. Other studies, like Suyantiningsih et al. (2016) and Sasmita et al. (2019), developed e-modules that focused mainly on scientific approaches and character education without facilitating the collaboration between educators, parents, and students or including SEL aspects.

The developed e-module stands out due to its advantages, such as (1) being operable on both PCs/laptops and smartphones, catering to digital-native students, (2) supporting student-centered learning, where students construct their own understanding, (3) facilitating collaborative learning environments, and (4) offering parental guidance for students facing difficulties. However, some limitations include (1) difficulties in navigating the module on

smartphones due to smaller screens and (2) the inability to control the material selection, as students can freely choose which topics they want to explore.

The Level of Validity of Interactive E-Module Based on Problem Based Learning Oriented Social Emotional Learning in Tri Hita Karana

The interactive e-module that adopts a problem-based learning approach is considered valid based on the assessment conducted by media experts and material experts through questionnaires. The evaluation results obtained show an average score of 4.6, which is in the very good category, so this e-module is considered valid with good quality. This finding is in line with Shabrina et al. (2021), which states that interactive e-modules that integrate character education are suitable for use as learning media. Nevertheless, both experts provided some suggestions and input for further improvement to make this e-module more effective as a problem-based learning media.

Practicality Level of Interactive E-Module Based on Problem Based Learning Oriented Social Emotional Learning in Tri Hita Karana

The practicality of interactive e-modules based on problem-based learning is measured by analyzing the responses given by students and teachers through questionnaires that have been distributed. The trial was conducted in several stages, namely limited trial, field test I, and field test II, involving 14 students from SD Negeri 6 Panji with 1 grade IV mathematics teacher, and 34 students from SD Negeri 1 Baktiseraga with 1 grade IV mathematics teacher. From the analysis of questionnaires filled out by teachers, an average score of 75.00% was obtained in the limited trial, which was included in the very practical category, 81.67% in field test I, and 90.00% in field test II, all of which showed very high practicality. On the other hand, students' responses showed that in the limited trial, the average score obtained was 74.08%, which fell into the practical category, then increased to 79.62% in field test I and 84.61% in field test II, both of which fell into the very practical category. When viewed as a whole, the results of the analysis of teacher and learner response questionnaires show a percentage of 97.20%, which is included in the very practical category, confirming that this e-module has an extraordinary level of practicality in supporting the learning process.

Level of Effectiveness of Interactive E-Module Based on Problem Based Learning Oriented Social Emotional Learning in Tri Hita Karana

The effectiveness of the interactive e-module based on Problem-Based Learning (PBL) is measured through an analysis of the results from observations and character assessments recorded in the observation sheets. To assess the effectiveness of the developed product, an analysis was conducted on the ratings obtained through observations, both before and after students used the e-module, based on the available observation sheets. The results of the analysis regarding the character assessment related to noble character traits will be explained as follows.

In the first indicator of noble character, which is greeting others, a change was observed at SD Negeri 6 Panji. Before using the developed interactive e-module, 45.71% of the 14 students greeted others, but not consistently. This inconsistency was due to the fact that prior to the introduction of the e-module, students only used textbooks, which led to a lack of motivation in classroom learning. After using the developed media, this indicator showed a significant improvement, with 100% of students consistently greeting others, meeting the cultural norm criteria.

In the second indicator of noble character, which is helping others, a similar change occurred at SD Negeri 1 Baktiseraga. Before the e-module was introduced, only 45.71% of the 14 students helped others, but again, this was not consistent. Before the implementation of the e-module, students relied solely on textbooks, resulting in a lack of motivation. After using the developed media, 100% of the students consistently helped others, meeting the cultural norm criteria.

In addition to improving character, an analysis was also conducted on students' problem-solving abilities in mathematics. Based on the pre-test and post-test results, the interactive e-module proved effective in improving students' problem-solving abilities in the topic of fractions. At SD Negeri 6 Panji, the average pre-test score was 25.04, while the average post-test score was 86.05. At SD Negeri 1 Baktiseraga, the average pre-test score was 19.23, and the average post-test score was 85.81. These results indicate that the interactive e-module significantly improved students' mathematical problem-solving abilities. This improvement is attributed to the effectiveness of the interactive e-module in teaching and the alignment of the material with students' needs.

Moreover, during the learning process with the interactive e-module, particularly in the exercise section of basic fraction concepts, some students provided different answers for questions 2 and 4, which shows a variance in understanding and highlights areas that may need further attention in the learning process.

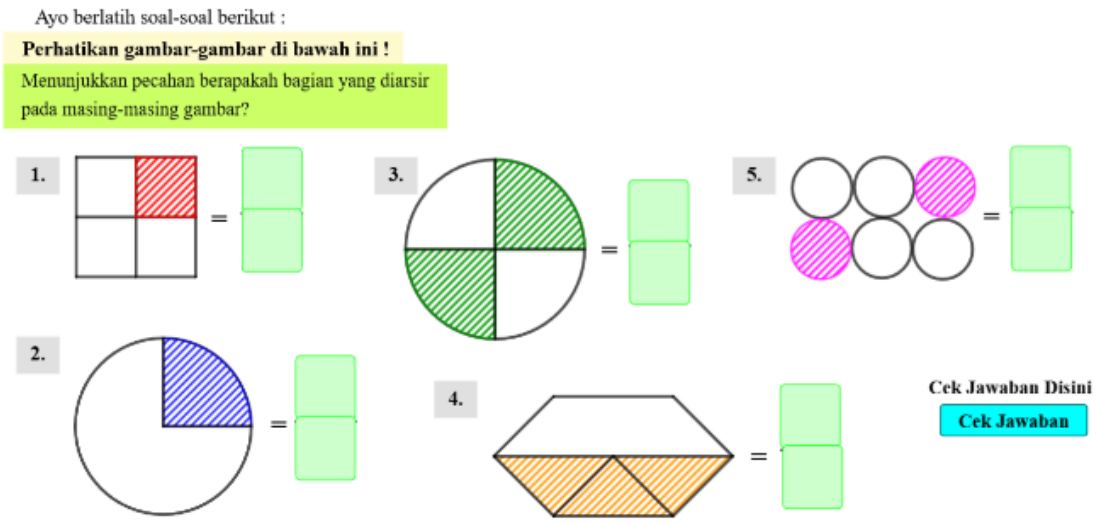


Figure 2: Practice Questions on the Basic Concepts of Fractions

Learning Trajectory of Interactive E-Module in Learning Fraction Matter

After the interactive e-module developed has been proven valid, practical, and effective, the next step is to design the learning experience trajectory for students when using the e-module in their lessons. A learning trajectory is the path or process through which students are provided with experiences to achieve a certain change through the interaction of stimulus and response. This trajectory includes the starting point (which reflects the students' prior experiences and conditions), the path (comprising a sequence of activities), and the endpoint (learning objectives). The learning trajectory created by the teacher should guide students step by step to achieve the learning goals.

The development of the Hypothetical Learning Trajectory (HLT) for each learning activity is a key element in designing meaningful learning experiences for students. This design is inseparable from the learning trajectory, which outlines the lesson plan for the material to be taught. In this context, the learning trajectory acts as a conceptual map that students will follow throughout the learning process. In this study, the learning trajectory begins with an introduction to the basic concept of fractions using the interactive e-module.

Next, the understanding of fractions will be reinforced through visual representations using flat geometric shapes. Once students grasp this foundational concept, they are expected to explore further aspects of fractions and apply them to solve various problems related to this concept.

CONCLUSION

This research demonstrates that the development of an interactive e-module based on Problem-Based Learning (PBL) is valid, practical, and effective in enhancing both students' mathematical problem-solving skills and their character development. The implementation of the e-module significantly improved students' ability to solve fraction-related problems, as evidenced by the notable increase in post-test scores compared to pre-test scores. Furthermore, the e-module contributed to the development of noble character traits, such as helping others and greeting others consistently, which were reflected in the positive changes observed in students' behavior during the learning process.

Despite the promising results, this study has several limitations. First, the sample size was limited to a small number of students from two schools, which may not fully represent the broader student population. Second, the study was conducted within a short period, limiting the opportunity to explore long-term effects of the e-module on students' learning outcomes and character development. Lastly, the research focused primarily on the improvement of mathematical problem-solving skills and character development related to fractions, leaving other mathematical concepts and character traits unexplored.

Future research should involve a larger sample size to enhance the generalizability of the findings and explore the long-term impact of using interactive e-modules in mathematics education. Additionally, further studies could examine the effectiveness of such e-modules in other mathematical topics and evaluate the broader range of character traits. It is also recommended to integrate more diverse teaching strategies, including collaborative learning and peer interactions, to further enhance the effectiveness of e-modules in promoting both academic and personal growth among students.

REFERENCES

Andriani, W., Ananto, R. P., Zahara, & Aprila, D. (2023). The Influence of Financial Literacy and Educational Background on the Financial Governance of Nagari Owned Enterprises. *Ilomata International Journal of Tax & Accounting*, *4*(4), 742–754. https://doi.org/10.52728/ijtc.v4i4.928

Aprila, D., Andriani, W., & Ananto, R. P. (2023). Financial Management of Nagari Owned Enterprises (BUMNAG) and Its Impact on Community Welfare. *Jurnal Akuntansi Bisnis*, *16*(2), 210–225. https://doi.org/10.30813/jab.v16i2.4461

Handayani, T., Mujasam, M., Widyaningsih, S. W., & Yusuf, I. (2017). Snowball Throwing Terhadap Hasil Belajar. *Jurnal Curricula*, *2*(1), 47–58. https://doi.org/10.22216/jcc.2017.v2i1.1543

Ismail, N. S., Mertasari, N. M. S., & Widiartini, N. K. (2025). The Impact of Problem-Based Learning and HOTS Based Formative Tests on Critical Thinking. *International Journal of Humanities, Education, and Social Sciences*, *3*(1), 26–46. https://doi.org/10.58578/IJHESS.v3i1.4296

Jaenudin, A., Baedhowi, P., & Murwaningsih, T. (2017). The Effectiveness of the E-Module of Economics Learning on Problem-Based Learning used to Improve Students' Learning Outcomes. *International Conference on Teacher Training and Education*, *158*(Ictte), 30–36. https://doi.org/10.2991/ictte-17.2017.32

Karunanayaka, S. P., Rajendra, J. C. N., Ratnayake, H. U. W., & Naidu, S. (2016). Peer-facilitated discussions to enhance OER-based e-learning. *Asian Association of Open Universities Journal*, *11*(1), 90–104. https://doi.org/10.1108/AAOUJ-07-2016-0022

Kusumantoro, Jaenudin, A., & Sari Melati, I. (2022). Case-Based Interactive E-Module: an Alternative Supplement to Increase Student Learning Motivation. *Journal of Education Technology*, *6*(4), 674–684. https://doi.org/10.23887/jet.v6i4.47254

Launuru, A., Rumahlatu, D., & Matdoan, M. N. (2021). PjBL-HOTS learning model: Its application and effect on cognitive learning outcomes, critical thinking, and social attitudes. *BIOEDUPAT: Pattimura Journal of Biology and Learning*, *1*(1), 1–10. https://doi.org/10.30598/bioedupat.v1.i1.pp1-10

Lee, Y. C., Lau, K. chi, & Yip, V. W. Y. (2016). Blended learning for building student-teachers' capacity to learn and teach science-related interdisciplinary subjects: The case of Hong Kong. *Asian Association of Open Universities Journal*, *11*(2), 166–181. https://doi.org/10.1108/AAOUJ-09-2016-0029

Maqfiroh, S. L., & Munahefi, D. N. (2022). Development of Teaching Materials of Flat Side Spaces Building Based on Problem Based Learning with Assemblr Assistance to Improve Students' Spatial Ability. *Unnes Journal of Mathematics Education*, *11*(3), 228–238. https://doi.org/10.15294/ujme.v11i3.60568

Paramartha, I. P. G. I., Candiasa, I. M., & Widiartini, N. K. (2025). Development of Character Education Assessment Instruments at Asta Learning Center Training Institution. *International Journal of Education, Culture, and Society*, *3*(1), 55–74. https://doi.org/10.58578/IJECS.v3i1.4344

Permatasari, A. A., Widiana, I. W., & Simamora, A. H. (2020). Tri Hita Karana Oriented Problem Based Learning Improves Natural Science Learning Outcomes. *International Journal of Elementary Education*, *4*(2), 226. https://doi.org/10.23887/ijee.v4i2.25185

Phungsuk, R., Viriyavejakul, C., & Ratanaolarn, T. (2017). Development of a problem-based learning model via a virtual learning environment. *Kasetsart Journal of Social Sciences*, *38*(3), 297–306. https://doi.org/10.1016/j.kjss.2017.01.001

Prasad, S., & O'Malley, C. (2022). An Introductory Framework of Problem-Based Learning (PBL) and Perspectives on Enhancing Facilitation Approaches. *HAPS Educator*, *26*(3), 52–58. https://doi.org/10.21692/haps.2022.016

Primasari, R. S., & Meiliasari, M. (2024). Pengembangan E-learning untuk Meningkatkan Pemecahan Masalah Matematika. *Jurnal Riset Pendidikan Matematika Jakarta*, *6*(1), 45–62. https://doi.org/10.21009/jrpmj.v6i1.29026

Sajidan, Suranto, Atmojo, I. R. W., Saputri, D. Y., & Etviana, R. (2022). Problem-Based Learning-Collaboration (Pbl-C) Model in Elementary School Science Learning in the Industrial Revolution Era 4.0 and Indonesia Society 5.0. *Jurnal Pendidikan IPA Indonesia*, *11*(3), 477–488. https://doi.org/10.15294/jpii.v11i3.30631

Serevina, V., Sunaryo, S., Raihanati, R., Astra, I. M., & Sari, I. J. (2018). Development of E-Module Based on Problem Based Learning (PBL) on Heat and Temperature to Improve Student's Science Process Skill. *TOJET: The Turkish Online Journal of Educational Technology –*, *17*(3), 26–36. https://doi.org/19204/TOJET.18i85.395

Shabrina, F. B., & Amrullah, M. (2021). Application of Bilingual Classroom Learning to English Language Skills at SD Muhammadiyah 1 Gempol Elementary School Students. *Proceedings of The ICECRS*, *10*. https://doi.org/10.21070/icecrs20211151

Suardika, I. M. D., Pujawan, I. G. N., & Divayana, D. H. (2025). Effect of Problem-Based Learning with Interactive Animation Videos on Math Problem-Solving and Critical Thinking Skillstype. *International Journal of Education, Management, and Technology*, *3*(1), 13–29. https://doi.org/10.58578/IJEMT.v3i1.4320

Sugiyono. (2024). *Metode Penelitian Kuantitati, Kualitatif dan R&D*. Bandung: Alfabeta.

Wang, C. C. (2021). The process of implementing problem-based learning in a teacher education programme: an exploratory case study. *Cogent Education*, *8*(1). https://doi.org/10.1080/2331186X.2021.1996870

Yenti, I. N., & Sarifah, A. (2023). *Development of an Interactive E-Module (EMODI) Based Creative Problem-Solving Use Articulate Storyline for Probability Material* (Vol. 1, Issue ICoeSSE). Atlantis Press SARL. https://doi.org/10.2991/978-2-38476-142-5_24

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004

Yuliani, Y., Djarot, P., & Retnowati, R. (2024). Development of problem-based interactive e-modules to improve students ' critical thinking skills and mastery of concepts. *Thabiea: Journal of Natural Science Teaching*, *7*(2), 152–166. 10.3421/Thabiea.12x4.94i89

Zhang, F., Wang, H., Bai, Y., & Zhang, H. (2022). A Bibliometric Analysis of the Landscape of Problem-Based Learning Research (1981–2021). *Frontiers in Psychology*, *13*(March), 1–10. https://doi.org/10.3389/fpsyg.2022.828390