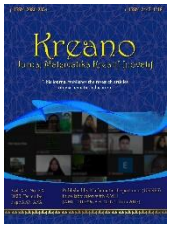
UNNES JOURNALS

Kreano, Jurnal Matematika Kreatif-Inovatif
Volume 16, number 2, 2025, pp. 382-296



Heyzine Flipbook as a Learning Media: Development of a Digital Realistic Mathematics Education Module

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Abstract

The high level of difficulty students face in mastering the concept of congruence, coupled with teachers' pedagogical constraints in presenting the material contextually, underlies the main objective of this research. This development research aims to produce and test an interactive digital module based on Realistic Mathematics Education (RME) as an effort to improve students' conceptual understanding of congruence material. The research method adopted the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) with data collection using expert validation, student response questionnaires, and analysis of pretest-posttest results. The findings show that the developed module achieves high validity, practicality, and effectiveness criteria for use in mathematics learning. These results confirm that the integration of an interactive digital module based on RME is a significant solution in bridging the abstraction of mathematical concepts, while simultaneously advancing innovative and effective digital learning practices.

Keywords: Digital Module; Flipbook; Heyzine; Mathematics Learning Media; Realistic Mathematics Education

Information of Article

Subject classification	*97U80 Audiovisual media and their use in instruction*
Submitted	*28 March 2025*
Review Start	*11 September 2025*
Round 1 Finish	*2 October 2025*
Round 2 Finish	*19 November 2025*
Accepted	*24 December 2025*
Scheduled online	*31 December 2025*
Similarity Check	*16%*

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Abstrak

Tingginya kesulitan siswa dalam menguasai konsep kekongruenan, yang diiringi oleh kendala pedagogis guru dalam menyajikan materi secara kontekstual, melatarbelakangi tujuan utama penelitian ini. Penelitian pengembangan ini bertujuan menghasilkan dan menguji modul digital interaktif berbasis Realistic Mathematics Education (RME) sebagai Upaya untuk meningkatkan pemahaman konseptual siswa pada materi kekongruenan. Metode penelitian mengadopsi model ADDIE (Analisis, Desain, Pengembangan, Implementasi, dan Evaluasi) dengan pengumpulan data menggunakan validasi ahli, kuesioner respon siswa, dan analisis hasil pretest-posttest. Temuan menunjukkan bahwa modul yang dikembangkan mencapai kriteria validitas, kepraktisan, dan efektivitas yang tinggi untuk digunakan dalam pembelajaran matematika. Hasil ini menegaskan bahwa integrasi modul digital interaktif berbasis RME merupakan solusi yang signifikan dalam menjembatani abstraksi konsep matematika, sekaligus memajukan praktik pembelajaran digital yang inovatif dan efektif.

INTRODUCTION

Mathematics plays a crucial role across various disciplines, from physics and engineering to economics and biology. A strong understanding of mathematical concepts enables individuals to develop critical thinking, abstract reasoning, and creative problem-solving skills, which are essential for addressing real-life challenges. The vision of mathematics is to orient the learning process toward a deep understanding of mathematical concepts and ideas, ensuring their effective application in problem-solving and interdisciplinary contexts (Hendriana & Soemarmo, 2014). In line with this vision, innovative learning approaches are needed to bridge abstract concepts with real-life experiences, making it easier for students to understand and apply mathematics in everyday situations.

Although mathematical problem-solving skills are crucial for developing critical and logical thinking, Indonesia's proficiency in this area remains low. This is evident from various studies, including the 2018 Program for International Student Assessment (PISA), which ranked Indonesia 74th out of 79 countries in mathematical literacy, with an average score of 379—well below the OECD average of 489 (OECD, 2019). Additionally, local studies indicate that many students struggle with applying mathematical concepts to real-world problems (Gumanti et al., 2022). This low performance highlights the need for innovative teaching methods and the development of more contextual and interactive learning materials to enhance students' mathematical problem-solving skills.

Realistic Mathematics Education (RME) is a mathematics learning approach that emphasizes the use of realistic situations as a source for developing mathematical concepts, tools, and procedures, allowing students to apply their mathematical knowledge in various contexts (Van den Heuvel-Panhuizen & Drijvers, 2020). According to Gravemeijer (1994), there are three main principles underlying Realistic Mathematics Education: Guided Re-invention & Progressive Mathematization, Didactical Phenomenology, and Self-Developed Models.

Furthermore, Soedjadi (2014) explains in detail that Guided Re-invention & Progressive Mathematization emphasizes how students reconstruct mathematical concepts through contextual problems with minimal guidance, progressing from situational understanding to formal concepts. Didactical Phenomenology highlights the importance of selecting appropriate contextual problems so that students can actively and meaningfully discover concepts. Meanwhile, Self-Developed Models underline the role of student-developed models as a bridge from real-world contexts to formal mathematics,

beginning with informal models and progressing to more abstract ones. By implementing RME, students not only gain stronger conceptual understanding but also develop critical and systematic thinking skills essential for mathematical problem-solving (Supiarmo et al., 2022).

The traditional implementation of the Realistic Mathematics Education (RME) approach is often carried out through print media (such as worksheets or paper modules), which are effective in presenting initial contextual problems. However, print media possesses significant limitations in optimally facilitating the full RME cycle, especially concerning interactivity and immediate feedback; students must wait for teacher assessment to know the correctness of their answers (Babushko et al., 2024).

Technology, such as mathematical software (e.g., GeoGebra or computational tools), serves as an effective tool for engaging students in exploration and problem-solving. Furthermore, in the context of digital learning, integrating such software into interactive modules allows students to move beyond passive information reception. By offering visual and contextual simulations, digital platforms enable students to construct their own knowledge, making the learning experience more self-directed and aligned with modern pedagogical demands (Yadav, 2024).

In the digital era, interactive digital modules enhance students' understanding of mathematical concepts through visual and contextual learning (Mahfudhah et al., 2022; Prasetyo & Wantoro, 2024). One innovative digital learning method is the flipbook, which presents materials dynamically and engagingly.

A flipbook is defined as a virtual or electronic book-based learning medium that presents interactive simulations, in which document files such as PDFs are transformed into a book-like display with digital page-turning effects (Hadiapurwa et al., 2021). Empirical studies indicate that digital flipbooks enhance student learning outcomes through their integration of interactive elements such as images, videos, and animations, which contribute to improved comprehension and engagement (Amalia et al., 2023). Furthermore, flipbooks have been shown to increase learner motivation and active participation while supporting differentiated learning by providing varied instructional experiences aligned with students' interests (Amalia et al., 2023; Tifani et al., 2024)

When integrated with RME, flipbooks promote interactivity through illustrations, simulations, and contextual examples, helping students bridge abstract concepts with real-world experiences. Additionally, their flexibility allows students to learn independently at their own pace, effectively improving conceptual understanding and problem-solving skills (Handayani et al., 2023).

Digital modules in flipbook format offer high accessibility and an interactive visual experience. Flipbooks enhance student motivation through dynamic and engaging presentations, as studies have shown that interactive digital learning media can boost interest, conceptual understanding, and student engagement (Fitriyah & Sahda, 2023; Haryanti & Saputro, 2016; Qomah & Khosiyono, 2022). One platform supporting flipbook development is Heyzine, chosen for its easy access without requiring downloads, making it a more practical and flexible tool for innovative learning (Erawati et al., 2022).

Heyzine's main strength is its ability to create attractive visual content that can be accessed on any device without

downloading extra apps, making it very practical for digital learning (Tifani et al., 2024). In addition to easy accessibility, Heyzine also offers features that allow users to add interactive multimedia elements such as videos, audio, and external links, which can significantly enhance students' motivation and engagement in understanding the learning material (Yuni et al., 2025).

A digital module based on the Heyzine flipbook serves as an ideal platform for integrating RME principles (such as the use of context, models, and interaction), as its multimedia features allow realistic problems to be presented through videos, animations, or simulations that are difficult to include in printed modules (Farokhah et al., 2024). The development of an RME-based digital module has been shown to be valid and practical because it provides students with opportunities to independently and interactively rediscover mathematical concepts (re-invention), thereby enhancing their conceptual understanding of mathematical topics (Aspriyani & Suzana, 2020).

Previous studies have extensively explored the development of digital learning media based on Realistic Mathematics Education (RME) and its effectiveness in enhancing students' mathematical understanding. However, most research still relies on conventional formats such as PDFs or desktop-based applications, which are static, less interactive, and often require specific devices or installations, limiting accessibility and flexibility in learning (Suyanti et al., 2021). Furthermore, existing digital learning media have yet to fully optimize web-based technology, which enables real-time access, more intuitive navigation, and a more engaging and interactive learning experience.

Research on using Heyzine Flipbook as a platform for RME-based digital modules is still limited. Heyzine Flipbook can turn static content into interactive learning materials with animations, hyperlinks, and multimedia, making it more engaging. Its no-download access also makes it flexible for remote and hybrid learning. However, it is unclear how effective the module is in improving students' understanding, engagement, and problem-solving skills in mathematics. The research problem of this study is how to develop a digital mathematics module based on Realistic Mathematics Education for the topic of congruence. Therefore, this study aims to evaluate the feasibility and effectivity of the developed RME-based digital mathematics module.

METHOD

This study employs the Research and Development (R&D) method, which aims to create and evaluate the effectiveness of an educational product (Sugiyono, 2013). To ensure a systematic development process, the study adopts the ADDIE model, consisting of five key stages: Analysis, Design, Development, Implementation, and Evaluation.

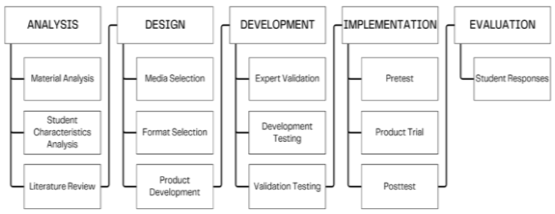

Figure 1. Research Flow Diagram

The first phases, Analysis, involves conducting a material analysis to identify the relevant mathematical content, a needs analysis to determine the learning media requirements of teachers and students, an analysis of student characteristics to ensure the suitability of the module for the target learners, and a

literature review to establish a strong theoretical foundation related to RME and digital learning media. The Design stage comprises selecting Heyzine Flipbook as the primary digital platform, determining the structural and visual format of the module, and developing an initial product prototype aligned with RME principles.

In the Development phase, the digital module is refined through a series of systematic steps to ensure the quality and effectiveness of the final product. The first step is expert validation, during which the designed module is reviewed by experts to assess the quality of its content, the appropriateness of the material, and its alignment with the intended learning objectives. The next step is developmental testing, conducted to ensure that the design and interactive features of the module function properly. In this study, the developmental test involved three eighth-grade students who were given the opportunity to use the module and subsequently participated in one-on-one interviews to provide direct feedback regarding their learning experience and ease of use. After revisions were made based on these findings, the module proceeded to the validation test stage, which evaluated its practicality by involving eight students from the acceleration program at MTs Negeri Pacitan. At this stage, the researcher conducted direct observations of student interactions with the module during learning activities to assess how easily the module could be used and understood, as well as its effectiveness in supporting the learning process.

The implementation phase of the digital module based on Realistic Mathematics Education (RME) involved several key procedures. The process began with administering a pretest to identify students' initial abilities prior to using the module. The module was then applied in classroom learning to observe its effectiveness and smooth integration in a real instructional setting. After the learning activities were completed, a posttest was administered to evaluate the improvement in students' understanding following the use of the module. This implementation trial was conducted with 27 eighth-grade students one of the Islamic junior high schools (MTs) in Pacitan.

At the evaluation stage, the process begins with collecting the score data from the pretest and posttest that have been administered. Statistical analysis is then carried out to calculate the mean scores of both tests and compare them to identify any improvements, both in the small-scale and large-scale trials. The results of this analysis provide insights into the effectiveness of the digital module in enhancing learning outcomes and serve as a basis for formulating recommendations for further improvements in the learning process.

The data collection techniques in this study were aligned with the ADDIE framework to ensure a systematic evaluation of the RME-based digital module. In the Analysis stage, observations and interviews were conducted to identify the needs of students and teachers, using instruments that had first undergone expert validation. The Design and Development stages involved documenting the module development process and conducting expert validation, with all instruments used in these stages also validated to ensure their clarity, relevance, and feasibility. In the Implementation stage, questionnaires and tests were administered to assess the effectiveness of the module in improving students' conceptual understanding and skills, following prior expert validation of these instruments. In the Evaluation stage, a

combination of interviews and questionnaires was used to gather feedback and assess the module's sustainability in the learning process, with all instruments having been validated to ensure the quality and reliability of the data collected.

The data analysis techniques in this study included reduction, presentation, and conclusion drawing for data obtained through observations, interviews, and documentation. Meanwhile, module validation data were analyzed using the Content Validity Index (CVI) by experts, and module practicality data were collected through student questionnaires. The validity criteria for the digital module were determined based on the following index (Guilford & Fruchter, 1978):

Table 1. Validity Criteria

CVI Score	Description
CVI < 0.0	Not valid
0.0 ≤ CVI < 0.2	Very low validity
0.2 ≤ CVI < 0.4	Low validity
0.4 ≤ CVI < 0.6	Moderate validity
0.6 ≤ CVI < 0.8	High validity
0.8 ≤ CVI < 1	Very high validity

Based on these criteria, the module is considered valid and ready for use if it falls at least within the moderate category, with a score of 0.4 ≤ CVI < 0.6.

Furthermore, the practicality of the digital module is determined based on student responses collected through a Likert scale (1-5) questionnaire. The total score is then calculated from student response ratings using the following formula (Sudjana, 1995):

$$\text{Average score} = \frac{\text{Total Questionnaire Score}}{\text{Number of Respondents}}$$

The practicality criteria for the digital module based on percentage categories are as follows (Sudjana, 1995):

Table 2. Practically Criteria

Average Score	Category
1,00 – 1,80	Highly Impractical
1,81 – 2,60	Impractical
2,61 – 3,40	Moderate
3,41 – 4,20	Practical
4,21 – 5,00	Highly Practical

The effectiveness of the digital module is measured based on the improvement in students' ability to solve mathematics problems on the congruence material. This improvement in students' problem-solving ability can be observed from the results of the pretest and posttest, which are calculated using the average N-gain score. The formula and categories for the N-gain score (Sukarelawan et al., 2024) are as follows:

$$N_{Gain} = \frac{Skor\ Posttest - Skor\ Pretest}{Skor\ Ideal - Skor\ Pretest}$$

Table 3. N-Gain Criteria

N-Gain Score	Category
$0{,}70 \leq g \leq 100$	High
$0{,}30 \leq g < 0{,}70$	Medium
$0{,}00 < g < 0{,}30$	Low
$g = 0{,}000$	No Increase
$-1{,}00 \leq g < 0{,}00$	Decrease

RESULT AND DISCUSSION

Results

Analysis

The first stage of this research is analysis, which involves several sub-stages to ensure that the development of the digital module based on Realistic Mathematics Education (RME) aligns with students' needs and characteristics. First, a material analysis was conducted through interviews with mathematics teachers at one of the Islamic junior high schools (MTs) in Pacitan to identify mathematical concepts that students find difficult to understand, particularly in the topic of congruence. The results of these

interviews served as a foundation for designing a module that addresses these learning challenges.

Additionally, a questionnaire distributed to 22 mathematics teachers from various MTs in Pacitan Regency revealed that many teachers struggle to teach the concept of congruence in a concrete and relevant manner. Based on the needs analysis, it was found that 72.7% of teachers faced difficulties in motivating students to grasp this material, highlighting the importance of developing an interactive module that connects mathematical concepts to real-life contexts. The data of the analysis results are presented in the following Table 4.

Table 4. Questionnaire Congruence Content Needs Analysis

No	Statement	Agree	Disagree
1	Difficulty in explaining the concept of congruence concretely and relevantly for students.	45,5%	54,5%
2	Students often experience difficulty in understanding the relationship between the concept of congruence and real-life situations.	77,3%	22,7%
3	Teachers often find it difficult to find effective ways to motivate students in understanding congruence.	72,7%	27,3%
4	There is need for the development of a realistic-based mathematics module that contain mathematics problems, specifically on the topic of congruence, within a reality context that is relevant to daily life.	100%	0%
5	There is need for the development of a realistic-based mathematics module that integrates technology, such as mathematics software or interactive applications, to enhance students' learning experience and provide a technology-based experience	100%	0%

Next, an analysis of student characteristics was conducted through observations and questionnaires to identify the challenges students face, particularly in understanding more abstract mathematical concepts such as congruence. The findings revealed that students tend to feel bored with monotonous material, highlighting the need for a visually engaging and contextually relevant module to enhance their understanding. Lastly, a literature review analysis indicated that while several studies have developed digital modules to support mathematical problem-solving, the integration of RME principles in these modules remains very limited. This underscores the importance of this research in developing a digital module based on RME that effectively helps students understand mathematical concepts in a more applicable and real-life-relevant manner.

Design

The next step in the design phase involved establishing learning objectives aligned with the national curriculum and developing module content relevant to the concept of congruence in mathematics. The Realistic Mathematics Education (RME) approach was applied to ensure that students could understand mathematical concepts through real-life contexts. The module consists of several learning activities that progressively build an understanding of congruence, starting from observing congruent objects in the students' surroundings to applying congruence rules in solving geometric problems. In designing the user interface (UI), the researcher utilized Canva templates to select an engaging color palette and create a visually appealing, easy-to-read module layout. This ensures that students can easily follow and effectively engage with the learning materials.

Figure 2. Module Content Display

Figure 2 presents the module's introductory section, which engages students in observing everyday objects based on the principles of Realistic Mathematics Education (RME). This approach connects the concept of congruence with real-life situations, making it easier for students to understand the material contextually and applicatively.

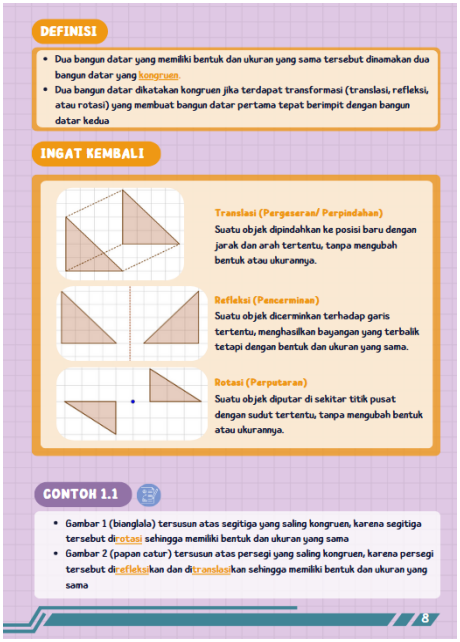

Figure 3. Definition Section Display

Figure 3 presents the concept of congruence with an engaging design. The "DEFINISI" section features a bright orange background to highlight the conditions for congruence, while the "INGAT KEMBALI" section illustrates geometric transformations with visuals. "CONTOH 1.1" incorporates a Ferris wheel and a chessboard to connect the concept to real-world applications, making learning more visual and enjoyable.

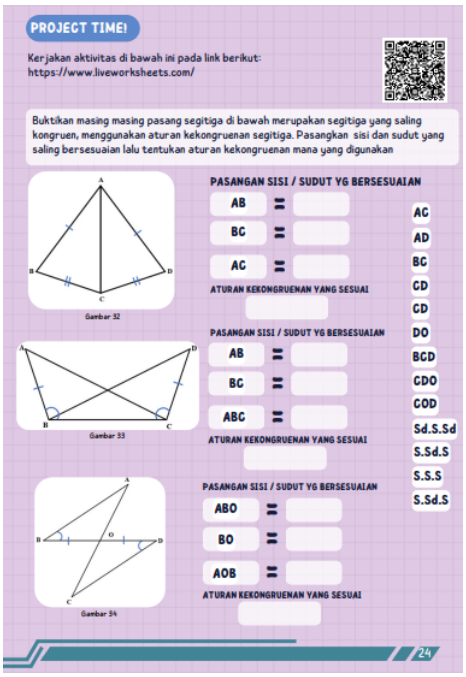

Figure 4. Project Section Display

Figure 4 presents the project section of the module, designed to provide an interactive learning experience. Developed using Canva and accessible via Heyzine Flipbook, the module is integrated with Liveworksheet, enabling students to complete exercises with real-time automated feedback. This integration enhances engagement, facilitates deeper conceptual understanding, and fosters active student participation.

Development

Subsequently, in the Development phase, the digital module underwent

validation by three experts from the Mathematics Education Study Program at Universitas Muhammadiyah Surakarta to ensure its quality and suitability. Content validation was conducted to assess the accuracy, clarity, and alignment of the material with the principles of Realistic Mathematics Education (RME), while media validation focused on evaluating the module's design, usability, and graphical consistency. The validation results are summarized in the following table 5:

Table 5. Expert Validation Result

No	Aspect	Validator 1	Validator 2	Validator 3
1	Content Feasibility	4,4	4,1	3,4
2	Language Clarity	5	4	3
3	Presentation	4,25	4,25	3,25
4	Module Design Layout	4	4,6	3,4
5	Ease of Use	4	4	4
6	Consistency	4	5	3,3
7	Graphic Quality	4,75	4	3,75

Based on Table 5, the expert scores were analyzed using the Content Validity Index (CVI) to quantitatively assess the module's validity. The first step involved converting the Likert scale scores (1-5) into binary data, where scores of 1-3 were categorized as "not relevant" (0), and scores of 4-5 as "relevant" (1). Next, the Item-Level Content Validity Index (I-CVI) was calculated for each item by dividing the number of experts who rated the item as relevant (1) by the total number of experts. Once I-CVI was determined for all items, the Scale-Level Content Validity Index (S-CVI) was computed. S-CVI includes two types: S-CVI/Ave, which represents the average of all I-CVI values, and S-CVI/UA, which is obtained by dividing the number of items with Universal Agreement (UA = 1) by the total number of items. These S-CVI values provide an overall measure of the instrument's validity.

The results of the validation test indicate that the module obtained an S-CVI score of 0.8, which falls within the high validity category. This score demonstrates that both the content and media within the module are deemed appropriate and meet the necessary quality criteria to effectively support the learning process.

The next step is module development test to ensure that the design and interactive features functioned optimally. A small-scale trial was conducted with three eighth-grade students to identify technical errors, usability challenges, and the overall effectiveness of the interface and navigation. The trial revealed several areas for improvement, including the font size on page 6, which was too small, the background color on page 17, which was too bright, and the color-text combination on page 8, which lacked contrast and reduced readability.

Next, a validation test was conducted in an eighth-grade class at MTs Negeri Pacitan through direct observation and questionnaires as an evaluation of the developed digital module. The observation assessed students' interactions with the module, while the questionnaire evaluated user experience, material effectiveness, and accessibility. The results of the student response questionnaire are presented in the following table.

Table 6. Result of the Practically Questionnaire

No	Aspect	Average Score	Category
1	Presentation	4,48	Highly Practical
2	Engagement	4,59	Highly Practical
3	Ease of Use	4,54	Highly Practical

Based on Table 6, the overall score exceeds 4.2, indicating that the module falls into the highly practical category.

The high validity scores from experts contribute to the module's practicality, as the refined design and content facilitate students' understanding of the material.

Implementation

After the researcher completed the revisions based on the findings from the previous stage, the refined module was subsequently tested on 27 eighth-grade students at one of the Islamic junior high schools (MTs) in Pacitan to evaluate its effectiveness, applicability, and student responses within an authentic classroom learning context. This stage begins with a pretest, which serves to identify students' initial abilities before they interact with the digital module.

Next, a live product trial is conducted in the classroom, where the module is implemented in the learning process to observe how the material, interactive features, and learning flow operate in a real-world context. At this stage, researchers also observe student engagement, the module's ease of use, and their responses throughout the learning process.

The implementation of the RME-based digital module was conducted in two meetings with eighth-grade students at one of the Islamic junior high schools (MTs) in Pacitan. Throughout the lessons, students showed strong enthusiasm in navigating the digital module, responding to prompts, and engaging with its interactive activities on congruence.

Learning began with an introduction and apperception, followed by students exploring the digital module's introductory materials to build initial understanding. During the main activities, the digital module guided students to identify congruent objects, analyze corresponding sides and angles, and complete group project tasks directly within the module's interactive features. They also used the module to explore congruence rules and work through structured problem-solving steps.

The session ended with a reflection supported by prompts provided in the digital module. Overall, the digital module played a central role in supporting active, contextual, and meaningful learning, enabling students to understand congruence concepts while engaging with interactive digital content.

After the entire learning series is completed, a posttest is administered to students to measure their improvement in conceptual understanding and skills after using the module. The pretest and posttest results are then analyzed to obtain a more comprehensive picture of the module's contribution to improving student learning outcomes.

Evaluation

In the evaluation phase, the process begins with collecting score data from the pre-test and post-test. Next, a statistical analysis is performed to calculate the average score for both tests, which is then compared to assess any improvement. The results of this analysis will provide an overview of the digital module's effectiveness in improving student performance and serve as a basis for recommending further improvements in learning. The following table shows the results of the pre-test and post-test after mathematics learning using the RME-based digital mathematics module.

Table 7. Pre-Test and Post-Test Result

Mean Score Pre-Test	Mean Score Post-Test	N-Gain	Category
1,6	2,8	0,58	Medium

Table 7 presents the pre-test and post-test results of 27 students who participated in mathematics learning

using an RME-based digital module. The average pre-test score of 1.6 indicates that students' initial understanding of the material was still relatively low before the learning intervention. After students learned to use the digital module, the average post-test score increased to 2.8, indicating a significant increase in conceptual understanding.

The N-Gain value of 0.58 is in the moderate category, indicating that the use of the RME-based digital module was moderately effective in improving student learning outcomes. This improvement indicates that the digital module was able to help students connect mathematical concepts to contextual situations, in line with the Realistic Mathematics Education approach. Overall, the data demonstrates that the implementation of this digital module positively contributed to the development of students' learning abilities.

Discussion

This study developed a digital module based on Realistic Mathematics Education (RME) through five key stages of the ADDIE model: analysis, design, development, implementation, and evaluation.

In the analysis phase, a thorough examination of teacher needs, student characteristics, learning materials, and relevant literature was conducted to establish the foundation for module development. The findings consistently indicate that teachers often struggle to effectively convey the abstract concept of congruence, highlighting a critical need for more innovative and contextual learning media. This difficulty aligns with findings indicating that teachers need to address students' difficulties in understanding abstract geometric concepts that lack real-life relevance (Laila et al., 2025)

Furthermore, research by St. Goar & Lai (2021) on the importance of a contextual approach in geometry provides strong justification for learning innovation. In the context of needs analysis findings that demonstrated teachers' difficulties in presenting congruence concretely, the study emphasized that providing authentic situations is key to overcoming barriers to student understanding. This implication strongly supports the selection of RME as the primary theoretical foundation, as RME explicitly aims to bridge abstract mathematics with students' real-world experiences.

In the design phase, the module was developed using Canva due to its flexibility in creating visually appealing, engaging, and interactive learning media. Studies by Rahmasari & Yogananti (2021) and Kharissidqi & Firmansyah (2022) indicate that attractive graphic design enhances students' attention and motivation, aligning with multimedia learning theory, which emphasizes the importance of combining text, images, and colors to improve comprehension.To enhance accessibility, the module was packaged in a flipbook format using Heyzine, allowing students to access materials easily without the need to download large files. Research by Fitriyah & Sahda (2023) and Erawati et al. (2022) suggests that digital flipbooks can boost learning motivation due to their dynamic and interactive presentation.

The results of the research at the development stage, namely the product, have been comprehensively validated by experts in the fields of materials, media, and practicality. This expert validation resulted in the finding that the module is feasible and valid for use in the learning process, reviewed from the suitability of

the RME content, the effectiveness of digital features, and ease of use. This feasibility strengthens the results of previous studies, such as those conducted by Fadhila et al. (2025), which also confirmed that interactive digital modules based on RME are effective for learning innovation. However, Fadhila's research focused on mathematical representations in the Circle material, while this study applies it to the concept of congruence.

The similarity in feasibility findings is also reflected by Safitri et al.(2024), where the RME-based module was proven valid for improving problem-solving skills in the Number material, which is consistent with the objectives of RME. Furthermore, the potential impact of the developed module is in line with the hypothesis proposed by Pramartha et al. (2025), who examined the impact of RME-based E-Module on improving students' conceptual understanding and critical thinking skills on Function material.

The implementation of a digital module based on the Realistic Mathematics Education (RME) approach indicates that the module is significantly effective in facilitating increased student engagement and conceptual understanding of congruence. Observations conducted throughout two learning sessions identified high levels of student enthusiasm and responsiveness to the instructions and content presented. This high level of student participation reflects a strong interest in the material and demonstrates that the digital module successfully stimulates an interactive and student-centered learning environment. In general, mathematics learning facilitated by digital modules has been shown to stimulate learning motivation and simplify the understanding of abstract mathematical concepts (Astuti, A. P., Sondang, M., & Sitompul, 2020; Mahfudhah et al., 2022; Sumliyah et al., 2023; Zaharah & Susilowati, 2020).

In comparison with previous studies, the findings of this research are consistent with studies that emphasize the effectiveness of Realistic Mathematics Education (RME)-based digital modules in improving students' conceptual understanding. For instance, Fadhila et al. (2025) reported that an interactive RME-based digital module significantly enhanced students' mathematical representations on circle material, while Safitri et al.(2024) demonstrated similar effectiveness in improving problem-solving skills on number material. These similarities indicate that the core principles of RME such as contextualization, guided reinvention, and the use of student-developed models are effective across different mathematical topics. However, this study differs from previous research in terms of learning content and technological platform. Unlike earlier studies that predominantly utilized conventional e-modules or PDF-based formats, this research integrates RME within a Heyzine flipbook platform, enabling richer interactivity through multimedia features and seamless web-based access without additional installations. Moreover, while prior studies often focused on general digital modules, this research specifically addresses the abstract concept of congruence, which poses distinct conceptual challenges for students. The moderate N-gain result obtained in this study suggests that the Heyzine-based RME digital module not only aligns with prior findings but also offers a novel contribution by demonstrating how interactive flipbook technology can effectively support contextual and conceptual learning in geometry.

Implication of Research

This study has important implications for educators, researchers, and policymakers. For educators, the interactive digital module based on Realistic Mathematics Education (RME) offers an engaging tool to enhance students' understanding of congruence, supporting self-paced and contextual learning. Researchers can build on this work by exploring its effectiveness in different settings or integrating advanced technologies for adaptive learning. For policymakers, the study highlights the need for digital resources in curricula and teacher training to maximize technology-enhanced instruction. Overall, this research contributes to the advancement of innovative and student-centered mathematics education.

Limitation

This study has several limitations. The small sample size of eight students from an accelerated class limits generalizability. Additionally, the study focuses only on congruence, leaving the module's effectiveness for other topics untested. Lastly, the controlled learning environment may not fully reflect real classroom dynamics. Future research should explore the module's impact on a larger and more diverse student population.

CONCLUSION

The interactive digital module based on Realistic Mathematics Education (RME) was successfully developed to meet the learning needs of teachers and students at one of the Islamic junior high schools (MTs) in Pacitan. This module demonstrates a high level of validity and falls into the "highly practical" category, as evidenced by validation and practicality test results. Its uniqueness lies in the integration of interactive features allowing students to complete exercises directly within the module with automatic feedback, making it more dynamic compared to conventional modules. The successful development and validation of this module contribute significantly to future digital learning practices by providing a concrete model for integrating pedagogical theories (RME) with modern interactive technology This integration sets a precedent for developing effective, validated, and highly engaging digital resources, guiding future researchers and educators toward creating personalized and immediate feedback-driven learning experiences in mathematics and other subjects.

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