

Validity of a VARK-Based Mathematics E-Module for Differentiated Learning in Elementary Schools

Baiq Yuni Wahyuningsih^{1,*}, Hikmah Ramdhani Putri¹, Vivi Rachmatul Hidayati¹, Mega Puspita Sari¹, Anggi Amalia Fannisa¹, Monica Tiara Dewi¹

¹ Department of Elementary Teacher Education, Faculty of Teacher Training and Education, University of Mataram, Mataram, Indonesia

Email: baiqyuniwahu27@staff.unram.ac.id (B.Y.W.); hikmah.ramadhaniputri@unram.ac.id (H.R.P); vivirachma@unram.ac.id (V.R.H); mega_fkip@unram.ac.id (M.P.S); anggiamaliafannisa@gmail.com (A.A.F); monicatiaradewi416@gmail.com (M.T.D)

*Corresponding author

Abstract—Mathematics learning in elementary schools continues to face challenges due to the limited availability of digital modules that accommodate students' diverse learning styles in differentiated instruction. This study aimed to develop and examine the validity of a VARK (Visual, Auditory, Read/Write, and Kinesthetic)-based digital mathematics learning module to support differentiated learning in elementary schools. The study employed a modified Research and Development (R&D) method up to the stages of product development and expert validation. Data were collected through a literature review, classroom observations, discussions with teachers and students, and expert validation. The research instruments included observation guidelines, interview guidelines, and expert validation sheets covering module structure, content organization, language, visual design, alignment with the VARK learning styles, and digitalization aspects. Data were analyzed qualitatively using descriptive analysis of the validators' feedback and quantitatively using Aiken's *V* validity coefficient. The findings indicated that the VARK-based digital mathematics learning module demonstrated a high level of validity, with Aiken's *V* coefficients ranging from 0.80 to 1.00 across all evaluation aspects. The digitalization aspect obtained the highest validity score (0.97), followed by visual design (0.95), module structure and VARK alignment (0.93), content organization (0.91), and language (0.88). These findings indicate that the developed module meets the feasibility criteria and is suitable for use as a learning resource to support differentiated mathematics instruction in elementary schools.

Keywords— E-Modul, VARK learning styles, mathematics, elementary school.

Manuscript received August 11, 2026; revised September 25, 2026; accepted October 7, 2026

I. Introduction

Technological advancement in the digital era has had a significant impact on various aspects of life, including education. The use of information and communication technology in the learning process has created substantial opportunities to develop more innovative and adaptive learning media and methods. Technological transformation in education has driven innovation in digital learning resources that are more flexible, interactive, and relevant to students' needs, including the development of digital teaching modules as digital-based learning resources (Febriyanti et al., 2024). One relevant innovation is the development of digital learning modules that can be adapted to students' needs. Mayer (2017) argues that technological advancements have facilitated teachers and students in carrying out and achieving learning objectives.

In the context of mathematics learning, one of the challenges frequently encountered is how to engage students more actively and help them understand concepts that are often considered abstract and difficult. This is consistent with the findings of Tambychik and Meerah (2010), which indicate that most elementary school students perceive mathematics as one of the most difficult subjects to understand because of its abstract nature. One contributing factor is the use of unengaging learning approaches. Many students perceive mathematics instruction as boring or monotonous, with excessive emphasis on memorizing formulas and completing exercises without meaningful real-world contexts. In addition, the limited use of interactive learning methods, such as games, experiments, and technology, makes it difficult for students to establish meaningful connections with the learning materials.

This issue becomes more complex when individual differences in learning styles are taken into consideration. According to the VARK learning style theory introduced by Neil Fleming, students tend to learn through one or a combination of four main learning styles: Visual, Auditory, Reading/Writing, and Kinesthetic. Samsiyah (2016) states that teachers are expected to understand students' learning styles and intelligence as a basis for providing appropriate learning experiences. Based on this consideration, the research problem addressed in this study is how to develop a digital mathematics learning module that is adapted to students' learning styles (VARK). Furthermore, the urgency of this research lies in the pressing need for mathematics learning media that are more inclusive and responsive to students' learning styles in the digital era. By developing a VARK-based module, this study is expected to provide digital mathematics learning materials that accommodate the diversity of elementary school students' learning styles and support the implementation of technology-based learning.

The development of VARK-based digital learning modules is also aligned with the demands of 21st-century education, which require students to develop critical thinking, creativity, collaboration, and technological literacy skills. By utilizing technology, the module is expected not only to help students understand mathematical concepts more effectively but also to encourage them to become more independent and proactive learners. Lubis and Dasopang (2020) developed an augmented reality-based picture storybook as a learning medium to accommodate Generation Z students in mathematics learning. Strengthening the use of digital learning media is also considered crucial for addressing the characteristics and needs of students in the digital era, including Generation Alpha in the context of Society 5.0, thereby enabling classroom learning to be better optimized and students' needs to be accommodated (Hafizah, 2023). This research is important because previous findings by Hidayati et al. (2025) indicate that the majority of students have kinesthetic and auditory learning styles, which require active and interactive learning approaches, whereas existing modules have not yet been able to optimally accommodate these needs. Through a VARK-based module, mathematics learning can be designed to accommodate the diversity of students' learning styles, thereby providing more appropriate and engaging learning experiences. In addition, this research contributes to the development of technology-based learning media that are relevant to the demands of the digital era, support the creation of inclusive learning environments, and assist teachers in providing more varied instructional approaches.

In the context of digital learning, digital modules function not only as resources for presenting learning materials but also as instructional tools that support more adaptive learning through the use of digital features, such as interactivity and flexible access (Febriyanti et al., 2024; Rahmawati et al., 2024). For example, a module designed for students with a visual learning style may include animations or infographics, whereas a module for students with an auditory learning style may provide audio explanations or podcasts. For students with a Reading/Writing learning style, the module may include detailed explanations and writing-based conceptual exercises. Meanwhile, students with a kinesthetic learning style may engage in interactive simulations or educational games involving physical activities.

Previous studies on mathematics learning difficulties among elementary school students and difficulties in conceptual understanding in relation to students' learning styles have shown that a large proportion of students have a kinesthetic learning style, indicating that they tend to understand learning materials more effectively through physical activities and hands-on practice. Meanwhile, students with combined Visual, Auditory, and Reading/Writing learning styles have also demonstrated varying abilities in solving mathematical problems. Although some students are able to perform calculations correctly and relate their results to the information provided, others continue to experience difficulties with arithmetic. Some students have also not fully understood how to establish relationships among the given data, resulting in errors when drawing conclusions.

Research on the development of digital learning modules has been widely conducted, particularly with a focus on utilizing technology to improve student learning outcomes. Through technology, teachers can incorporate animations or simulations to facilitate students' understanding of abstract, dynamic, and complex concepts (Karima, 2024). Mathematics learning enriched with technology, such as hypermedia and simulations, can facilitate students' inquiry processes and analysis of new information. However, previous studies have often not specifically addressed differences in students' learning styles. Research integrating the VARK learning style framework into the design of learning modules remains limited, particularly in mathematics learning.

In mathematics education, digital modules have been developed using various design and development approaches. A web-based digital mathematics module developed through a research and development (R&D) approach using the ADDIE model represents a progressive effort to support mathematics learning in the digital era, as ADDIE provides a systematic sequence of analysis, design, development, implementation, and evaluation (Rahmawati et al., 2024). In addition, digital module design can be directed toward promoting independent learning because the use of digital modules is not restricted to classroom settings and can support self-directed learning (Setiyani et al., 2020). Therefore, the need for digital mathematics learning modules is not limited to the digitization of content but also involves the quality of instructional design and the capacity of

the module to accommodate differences in how students learn (Febriyanti et al., 2024; Nugraha & Budiyo, 2022).

This study differs from previous research because it explicitly adopts VARK learning style theory in the design of a mathematics learning module. The novelty of this study lies in two main aspects: (1) a personalized approach, in which the module is designed to accommodate individual students' needs based on their dominant learning styles; and (2) the integration of interactive multimedia, in which the module incorporates various elements, such as animations, audio, and simulations, to accommodate the VARK learning styles. Watson and Watson (as cited in Rahayu, 2017) explain that technology has several positive impacts, including providing interactive content, delivering immediate feedback, diagnosing students' learning needs, assessing learning processes and outcomes, and storing students' work that can subsequently support the learning process.

Several studies have investigated mathematics learning difficulties in terms of conceptual understanding as well as the relationship between students' learning styles and their learning outcomes or conceptual understanding. Wahyuningsih and Hidayati (2024), in their study of students' learning difficulties, reported that students experienced difficulties in understanding concepts, relating information, and performing basic arithmetic calculations. In addition, Jampel (2016) investigated elementary school students' motivation and learning styles. The findings showed that the visual learning style was the dominant learning style among the students and that both internal and external factors influenced their learning styles. This is consistent with the purpose of differentiated learning, which is to address individual students' learning needs by providing learning experiences adapted to their potential, learning styles, interests, and levels of ability. Therefore, learning materials that can accommodate diverse learning needs are required. In this study, these needs are addressed through the development of a VARK-based mathematics e-module designed to support differentiated learning. This study represents the initial stage of the development process and focuses on assessing the validity of the e-module as a basis for subsequent implementation and evaluation.

II. Literature Review

A. E-Modules in Mathematics Learning

An e-module is an electronic teaching material systematically designed to help students achieve learning objectives through the structured presentation of materials, activities, and assessments. Unlike printed modules, e-modules allow the integration of various digital elements, including text, images, audio, video, animation, hyperlinks, and interactive activities. In mathematics learning, these characteristics provide opportunities to present concepts through multiple forms of representation, allowing abstract mathematical concepts to be explored through more concrete and visual learning experiences. Research on digital mathematics textbooks indicates that digital learning resources possess dynamic characteristics that are not available in printed textbooks, thereby offering greater opportunities to enrich the ways in which mathematical content is presented and used in learning. Wijaya et al. (2022) also demonstrated that the use of digital mathematics textbooks is associated with changes in the characteristics of learning resources, including the potential use of dynamic and interactive elements.

The development of mathematics e-modules has been widely undertaken as an effort to provide more flexible and interactive learning resources. For example, a study on the development of a mathematics e-module for geometry demonstrated that electronic modules can be designed by integrating mathematical software and can undergo validity and practicality assessments before being implemented in learning. Another study involving elementary school students developed an illustrated electronic module and showed that an e-module can serve as a systematically designed learning product developed through research and development procedures. Therefore, the e-module developed in this study is not merely intended to transform printed teaching materials into a digital format but also to integrate various forms of representation and interactive activities that are appropriate for the characteristics of elementary mathematics learning. The product was developed using Canva, Microsoft PowerPoint, and iSpring Suite 10 to produce an HTML5/SCORM-based module that can be accessed across various devices.

B. Mathematics Learning in Elementary Schools

Mathematics learning in elementary schools has characteristics that require the use of representations and learning experiences appropriate to students' developmental levels. Mathematical concepts such as numbers, measurement, geometry, and data and probability require not only procedural skills but also the ability to understand relationships, interpret representations, analyze information, and communicate mathematical thinking. Therefore, the presentation of mathematical content should provide students with opportunities to interact with various forms of representation. In the context of data analysis, for example, students need to understand information presented through tables, pictograms, and charts and use such information to derive and

communicate conclusions. Research on digital mathematics learning resources also indicates that technological developments provide opportunities to present more dynamic mathematical representations than those available through conventional learning resources.

The need for appropriate learning resources becomes increasingly important because mathematics learning takes place in classrooms characterized by diverse student needs. Research on the implementation of differentiated learning in elementary mathematics indicates that variations in students' abilities and learning needs constitute one of the challenges in mathematics instruction, requiring teachers to employ strategies and learning resources that can provide alternative learning experiences. In this study, this need serves as the basis for developing an e-module on data analysis. The needs analysis conducted by the researchers indicated that teachers still predominantly use textbooks and student worksheets, which tend to be informative and lack interactivity, whereas students require learning resources that are more concrete, engaging, and capable of providing learning experiences through various activities. Therefore, the e-module is designed to enrich mathematics learning resources through the integration of multimedia and interactive activities

C. VARK as a Framework for Learning Preferences

VARK is a framework introduced by Neil D. Fleming to describe individuals' preferences for receiving and interacting with information through four modalities: Visual, Aural/Auditory, Read/Write, and Kinesthetic. The Visual modality involves representations such as images, diagrams, graphs, and symbols; the Aural modality involves information received through verbal explanations or oral communication; the Read/Write modality involves the use of text and reading or writing activities; while the Kinesthetic modality involves concrete experiences, practice, simulations, and hands-on activities. Fleming describes VARK as a strategy that can help educators consider variations in how information is presented during the learning process. The primary source for this framework is *Teaching and Learning Styles: VARK Strategies* by Fleming (2006).

Nevertheless, the use of VARK needs to be positioned carefully within educational research. Literature on learning styles indicates that empirical evidence supporting the claim that learning becomes more effective when instructional methods are directly matched to specific learning styles remains insufficient. Pashler et al. (2008) emphasized that claims concerning the matching or meshing hypothesis require experimental evidence demonstrating an interaction between learner characteristics and instructional methods, whereas evidence meeting these criteria remains insufficient. Therefore, this study does not position VARK as a basis for rigidly categorizing students into a single learning type or claiming that students can learn optimally through only one modality. Instead, VARK is used as a multimodal design framework to provide varied representations and activities within the e-module. This is implemented through the use of infographics and animations for the visual modality, audio for the auditory modality, text and writing activities for the read/write modality, and simulations and interactive activities for the kinesthetic modality.

D. Differentiated Learning

Differentiated learning is an instructional approach designed to take into account the diversity of students' characteristics throughout the learning process. Tomlinson (2017) explains that differentiation enables teachers to adapt instruction according to students' needs, including their readiness, interests, and learning profiles, and can be implemented through differentiation of content, process, product, and learning environment. This approach views student diversity as a condition that needs to be addressed through flexible instructional planning rather than as an obstacle that must be eliminated. Therefore, differentiated learning is particularly relevant in elementary school contexts because students within the same classroom may have different levels of readiness, experiences, interests, and learning needs.

In elementary mathematics learning, differentiation is important because differences in students' abilities and learning needs may influence how they understand mathematical concepts. Recent research on differentiated learning in elementary mathematics indicates that its implementation can be used to respond to variations in students' abilities; however, teachers still face challenges related to the limited availability of learning resources and strategies that can be applied flexibly. Therefore, providing digital learning resources with varied representations and activities can serve as an alternative means of supporting differentiated learning. In this study, the VARK-based e-module is designed to provide various forms of learning experiences within a single product, enabling teachers to use a learning resource that offers variations in content and learning processes according to students' needs. Thus, VARK in this study functions as one of the design frameworks for supporting the provision of varied learning experiences rather than as a system for labeling students according to a single learning style

III. Methods

A. Research Design

This study employed a Research and Development (R&D) approach based on a modified version of the development model proposed by Borg and Gall (1983). The R&D approach was selected because the study aimed to develop a VARK-based mathematics e-module and assess its validity before subsequent implementation. In this study, the development procedure was limited to the initial stages of product development and expert validation. The research procedure consisted of four main stages: (1) needs analysis, (2) development planning, (3) product development, and (4) expert validation, as illustrated in Figure 1. The needs analysis stage involved a literature review, classroom observations, and discussions with elementary school teachers and students to identify the need for a digital mathematics learning module capable of accommodating differences in students' learning styles. The findings from this stage were used to determine the product specifications.

The development planning stage involved designing the module, determining the content structure, developing learning activities based on the VARK framework (Visual, Auditory, Read/Write, and Kinesthetic), and designing the digital module interface. The product development stage involved the development of a digital mathematics learning module using Canva for visual design, Microsoft PowerPoint for animation and interactive navigation, and iSpring Suite 10 to convert the developed module into an HTML5/SCORM format. The resulting e-module can be accessed through various devices, including laptops, tablets, and smartphones. The final stage was expert validation, which was conducted to assess the validity and feasibility of the developed e-module before its subsequent implementation in a field trial. The overall research procedure is presented in Figure 1.

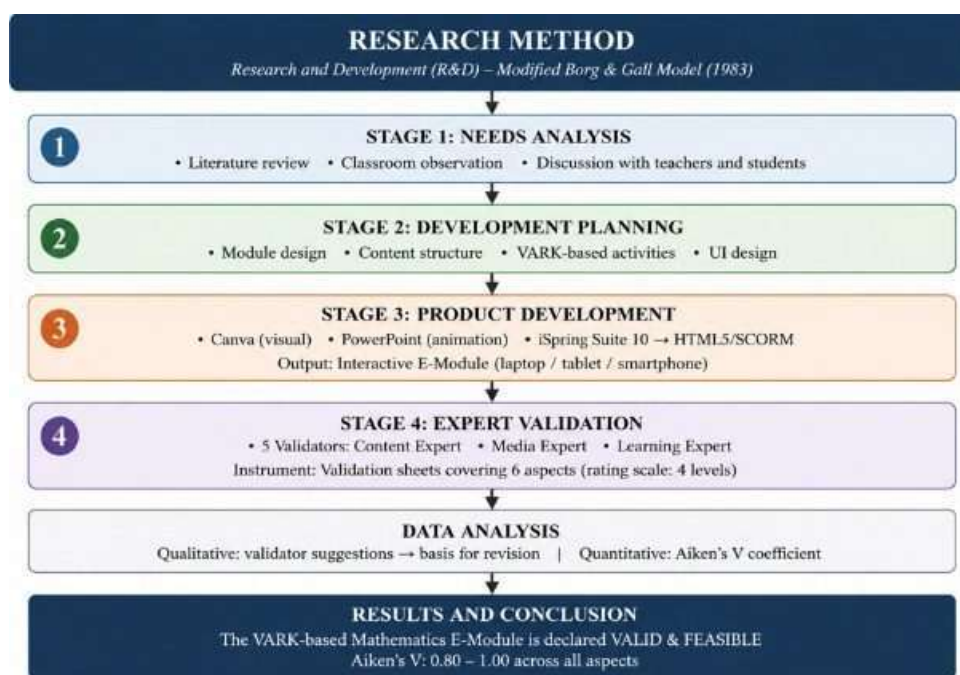


Figure 1. Research Procedure

B. Population and Sample

The participants in the expert validation stage consisted of five validators, comprising subject matter experts, media experts, and learning experts with relevant expertise in their respective fields. The validators were selected based on their competence and expertise relevant to the aspects assessed in the VARK-based mathematics e-module. At the needs analysis stage, elementary school teachers and students were involved through classroom observations and discussions to identify learning needs and the characteristics of existing mathematics learning resources. However, the present study focused on the expert validation of the developed e-module, and therefore the primary validation participants were the five experts.

C. Data Collection Instrument

Data were collected through a literature review, classroom observations, discussions with teachers and students, and expert validation. The instruments consisted of an observation guide, a discussion guide for unstructured interviews, and an expert validation sheet. The expert validation sheet was developed using a four-point rating scale and covered six assessment aspects: (1) module structure, (2) content organization, (3)

language, (4) presentation, (5) alignment with VARK learning style characteristics, and (6) digitalization. Before being administered to the validators, the validation instrument was conceptually reviewed based on indicators derived from the theoretical framework of digital module development and the characteristics of VARK-based learning. The instrument was designed to obtain expert judgments regarding the quality and validity of the developed e-module.

D. Data Analysis

The data obtained from the validation process were analyzed using both qualitative and quantitative approaches. Qualitative data in the form of comments, suggestions, and recommendations provided by the validators were analyzed descriptively and used as a basis for revising the developed e-module. Quantitative data obtained from the four-point validation ratings were analyzed using Aiken's V coefficient to determine the validity of the e-module based on the six assessed aspects. In this study, the validation instrument used a four-point rating scale, with five validators involved in the assessment. Therefore, the Aiken's V coefficient was calculated based on the agreement of the validators regarding each assessed aspect. The resulting Aiken's V coefficients were interpreted to determine the validity of the developed VARK-based mathematics e-module. An Aiken's V coefficient ranging from 0.80 to 1.00 was considered to indicate that the e-module met the established validity criteria. Coefficient values below 0.80 were considered to indicate that further revision was required before the product could proceed to subsequent development stages.

IV. Results and Discussion

A. Research Results

The study was conducted based on the stages planned in the research proposal and guided by a modified Research and Development (R&D) model. Of the seven development stages, the present study focused on four main stages: needs analysis, development planning, product development, and expert validation to assess the validity of the developed product. The presentation of the research findings focuses on the achievements corresponding to the planned stages, particularly the needs analysis from the perspectives of teachers and students as the direct users of the module, as well as the product development planning stage, which emphasized the specifications of the digital module and the strategies for presenting the learning materials.

1. Needs Analysis

The needs analysis stage was conducted through a literature review, observations, and preliminary discussions with elementary school teachers and students. The analysis focused on the data analysis and probability elements, particularly data analysis, with the following learning objectives: (a) students are able to accurately present observational data in the form of pictograms, frequency tables, and bar charts; and (b) students are able to analyze data presented in the form of pictograms, frequency tables, or bar charts to draw conclusions or obtain information, such as identifying the largest and smallest values and determining the order of the data: (a) Teachers still rely primarily on textbooks and student worksheets, which tend to be informative and lack interactive features. Teachers still rely on textbooks and worksheets which tend to be informative and not yet interactive; (b) Teachers experience difficulties in contextualizing data analysis content within students' everyday lives. Teachers need ready-to-use digital media that makes it easy for differentiated learning according to VARK learning styles; (c) Teachers require ready-to-use digital learning media that can facilitate differentiated learning based on VARK learning preferences; (d) The curriculum (Merdeka Curriculum) requires the implementation of differentiated learning; however, teachers still have limited access to appropriate learning resources; (e) Students experience difficulties in understanding abstract concepts, particularly in representing data using tables, pictograms, and bar charts; (f) Students require interactive and concrete learning media that are engaging and aligned with their learning preferences, namely Visual, Auditory, Read/Write, and Kinesthetic; (g) Students' learning motivation increases when learning materials are presented in an interactive digital format resembling educational applications or games; (h) Students require practice-based learning experiences, such as collecting real-world data and afterward processing and interpreting the results. Based on these findings, a gap was identified between the existing learning conditions and the expected learning needs. Both teachers and students require an interactive digital module that is contextual, engaging, applicable, and capable of accommodating students' learning preferences based on the VARK learning model.

2. Development Planning

Based on the results of the needs analysis, the development planning stage focused on designing an interactive digital module that innovatively integrates VARK learning preferences as a basis for implementing differentiated learning in elementary mathematics education. The module was developed using Canva for visual

design, layout arrangement, and illustrations; PowerPoint for incorporating animations, hyperlinks, and interactive navigation buttons; and iSpring Suite 10 for converting the module into HTML5/SCORM format, allowing flexible access both online and offline through laptops and mobile devices.

The module was systematically structured, beginning with an introductory page containing the title, author information, and an engaging visual design, followed by usage instructions, competencies and learning objectives aligned with the curriculum, and a concept map of the data analysis content. The core materials covered data collection, data representation, and data analysis, which were presented through VARK-based interactive activities as a form of content and process differentiation. The visual component was represented through infographics, animations, and interactive diagrams; the auditory component through audio narration and oral explanations; the read/write component through explanatory texts and activities requiring students to write conclusions; and the kinesthetic component through drag-and-drop simulations and simple data-collection activities. The integration of the four learning preferences within a single digital module enables students to select and interact with learning resources according to their preferences. Thus, the module functions not only as a digital learning medium but also as a differentiated learning resource that responds to the diversity of students' learning characteristics. The module is also equipped with a glossary and references to strengthen students' conceptual understanding and establish connections between the learning materials and relevant sources

3. Product Development

The product developed in this study was a digital mathematics learning module based on VARK learning preferences (Visual, Auditory, Reading/Writing, and Kinesthetic). The module was designed as an innovative learning medium that accommodates differences in students' learning characteristics, enabling them to understand mathematical concepts in a more personalized and meaningful manner. The development of the module was grounded in the principles of differentiated learning, in which students' activities following the presentation of the learning materials were aligned with their respective learning preferences. Thus, the product functions not only as a learning resource but also as a means of reflection that enables students to recognize and optimize their learning preferences.

Technically, the module was developed in an interactive digital format that can be accessed through various devices, including laptops, tablets, and smartphones. The module consists of several main sections, including an introduction, an overview of VARK learning preferences, presentation of mathematics content according to the four learning preferences, exercises and assessments, and guidelines for educators. Each learning preference is represented through specific content and activities, including infographics and animations for the visual preference, audio narration and oral explanations for the auditory preference, explanatory texts and writing activities for the reading/writing preference, and simulation activities and educational games for the kinesthetic preference. Interactive features, such as learning-preference quizzes and automated feedback, were also incorporated to enhance students' engagement and learning motivation.

In addition, the module features a simple and engaging user interface (UI) with easy-to-use navigation. The visual design incorporates bright colors to attract students' attention while maintaining user comfort. To support educators, the module is also equipped with guidelines for implementing differentiated learning based on the results of students' learning-preference identification. Based on the needs analysis and development planning, an initial version of the interactive digital module was produced according to the predetermined design. The product was subsequently prepared for validation by five validators. The validation focused on several aspects, including module structure, organization of learning materials, language, visual presentation, alignment with VARK learning preferences, and digitalization

4. Expert Validation results

The developed product was validated by five validators consisting of media experts, content experts, and learning experts. The validation aimed to assess the validity of the developed VARK-based digital mathematics learning module for elementary school students. The results showed that all assessed aspects achieved a high validity category, with Aiken's V coefficients ranging from 0.80 to 1.00. These results indicated that the module met the validity criteria and was considered suitable for proceeding to the subsequent stage of development. The validation results obtained from the experts are presented in Table 1. The table shows the average Aiken's V coefficient for each assessed aspect of the digital mathematics learning module

Table 1. E-Module Validation Results

Aspect	Number of Indicators	Aiken's V Value	Validity Criterion
Module Structure	5	0,93	High
Material Organization	8	0,91	High

Language	5	0,88	High
Visual Pretentation	5	0,95	High
Alignment with VARK	10	0,93	High
Digitalization	4	0,97	High

As presented in Table 1, the assessments provided by the five validators showed consistently high scores across nearly all validation aspects. The Aiken's V coefficients ranged from 0.80 to 1.00, indicating that the module met the validity criteria and was suitable for use in the subsequent stage of development. Overall, the validation results demonstrate that the module met the established quality standards across the assessed aspects. The high Aiken's V coefficients across nearly all components indicate that the developed product was considered consistent and relevant for supporting differentiated learning.

- (a) The module structure aspect obtained an average Aiken's V coefficient of 0.93, which was categorized as high validity. This result indicates that the module was systematically and consistently organized and was easy to follow

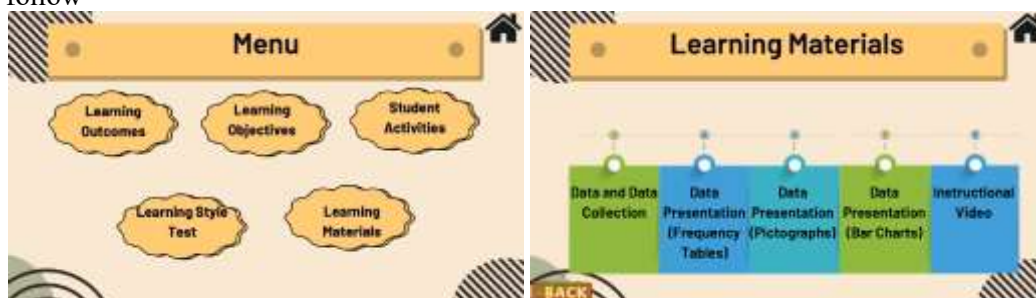


Figure 2. Module Writing Structure

- (b) The material organization aspect obtained an average Aiken's V coefficient of 0.91, which was categorized as high validity. This result indicates that the module content was organized in accordance with the learning outcomes of the Merdeka Curriculum, with the presentation following a progression from simple to more complex concepts. However, several validators suggested that the explanation and example presentation should be more clearly separated between the introductory and concluding sections, particularly in the topic of bar charts.

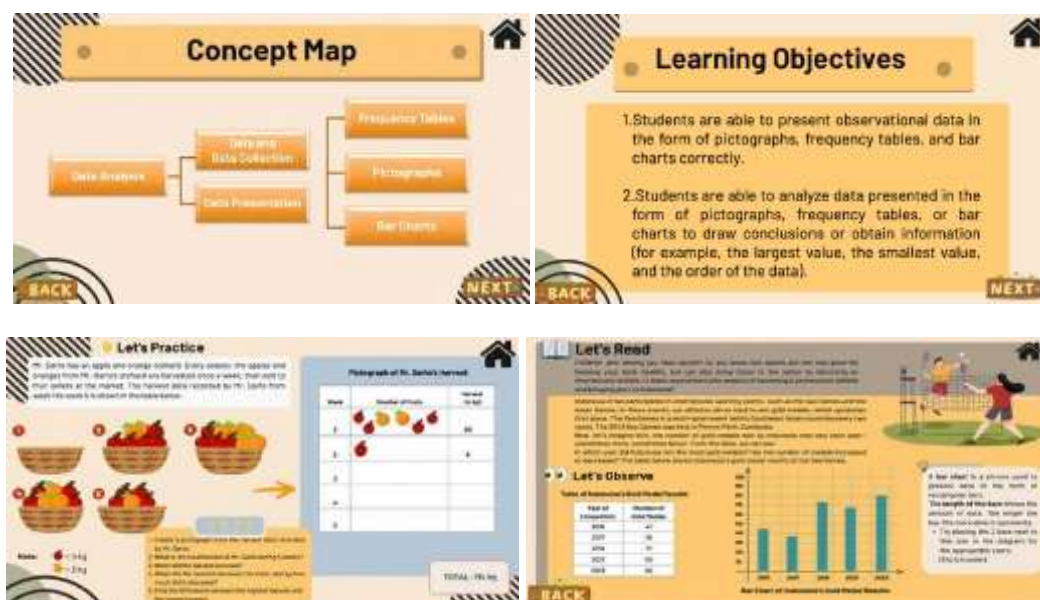


Figure 3. Material Presentation Structure

- (c) The language aspect obtained an average Aiken's V coefficient of 0.88, which was categorized as high validity. The language used in the module was considered communicative and consistent with standard Indonesian language conventions. However, the validators recommended further adjustment of the readability level to better suit the characteristics of elementary school students. Several terms used in the learning-style diagnostic instrument were considered too abstract. Therefore, the validators suggested simplifying the context and response options to make them easier for students to understand.



Figure 4. Language Use in the Learning-Style Test

- (d) The visual presentation aspect obtained an Aiken's V coefficient of 0.95, indicating a very high level of visual quality. The images and icons were used in appropriate proportions, the typeface and font sizes were consistent, and the color scheme supported readability. Nevertheless, several validators provided suggestions for improvement. These included incorporating visual elements relevant to the data presentation topic into the page backgrounds, such as graphs or charts with low transparency, to strengthen the contextualization of the learning materials. In addition, greater consistency in the use of icons was recommended to ensure that visual characters, such as teachers, students, and children, appeared uniform throughout the module. The validators also suggested adding exclamation marks (!) to interactive instructions such as Ayo Membaca! and Ayo Mengamati ! to enhance the interactive feel of the learning activities



Figure 5. Material Presentation

- (e) The alignment with VARK learning preferences obtained an average Aiken's V coefficient of 0.93, indicating that the module adequately accommodates differences in students' learning preferences. Visual activities were presented through images, infographics, and diagrams; auditory activities through audio and narration; read/write activities through texts and written exercises; and kinesthetic activities through simulations, drag-and-drop activities, and simple hands-on practice

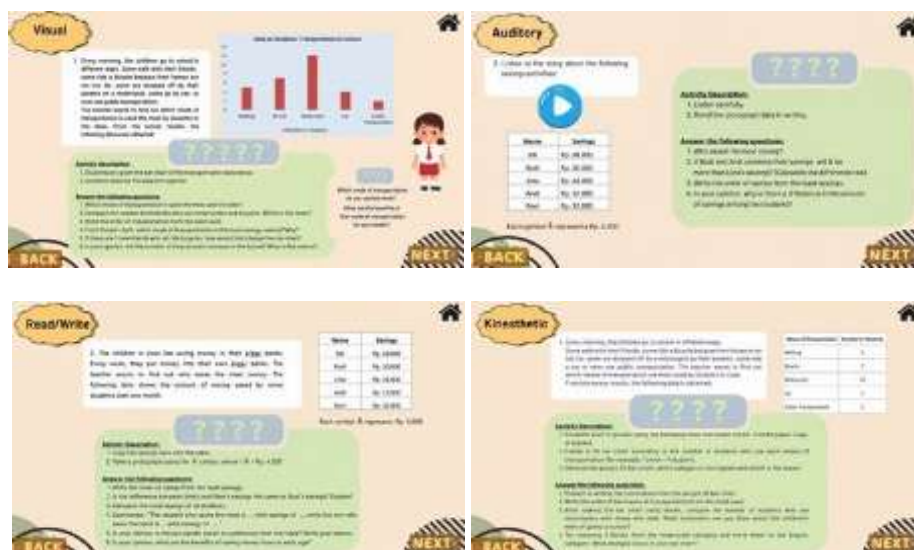


Figure 6. Student Activities Based on Learning Preferences

- (f) The digitalization aspect obtained the highest Aiken's V coefficient, with an average value of 0.97, indicating that the module effectively utilized digital features, including interactive navigation, multimedia integration (images, audio, video, and animations), and an engaging and accessible user interface.



Figure 7. E-Module Digitalization

Overall, the validation results indicate that the VARK-Based Digital Mathematics Learning Module demonstrated a very high level of validity. The Aiken's V coefficients, ranging consistently from 0.88 to 0.97, indicate that the module adequately fulfilled the assessed aspects of content, presentation, language, visual design, and pedagogical alignment. The suggestions provided by the validators served as valuable input for further product refinement, particularly regarding visual aesthetics, icon consistency, language simplification, and strengthening the contextualization of the learning-style diagnostic instrument.

B. Discussion

The needs analysis revealed a gap between the existing learning conditions and the needs of teachers and students. Teachers still relied heavily on informative and non-interactive learning materials, while students required more concrete, engaging, and contextual learning experiences, particularly for understanding data representation and analysis. This condition provided an important basis for designing a digital module that not only presents learning materials but also offers interactive activities and diverse learning experiences. This need is also related to the implementation of differentiated learning under the Merdeka Curriculum. Integrating VARK learning preferences into the module provides an alternative approach to presenting learning materials through various forms of representation and activities. Thus, the development of the module was not merely oriented toward digitizing learning materials but also toward providing more diverse learning experiences that respond to students' individual characteristics.

The expert validation results showed that the VARK-Based Digital Mathematics Learning Module demonstrated high validity across all assessed aspects. The Aiken's V coefficients ranged from 0.88 to 0.97, indicating a high level of consistency and relevance in terms of content delivery, module structure, visual presentation, and pedagogical alignment (Alwi et al., 2024; Hendriani, 2021). These findings indicate that the module was developed by integrating pedagogical, technical, and visual considerations into a comprehensive digital mathematics learning resource.

Regarding the module structure, the Aiken's V coefficient of 0.93 indicates that the module was systematically organized and easy to navigate. A clear structure is important for supporting independent learning because it helps students understand the sequence of activities and learning objectives. This finding is consistent with Prastowo (2015), who emphasized the importance of a clear module structure in supporting students' learning independence. It is also in line with Lukman et al. (2022), who reported that well-structured learning modules can support students' independent learning. In the context of a digital module, systematic organization becomes particularly important because students interact with various content elements and learning activities within a digital environment. Therefore, clear organization can help students navigate the learning materials more effectively and maintain their focus on the intended learning objectives.

For material organization, the Aiken's V coefficient of 0.91 indicates that the learning materials were aligned with the intended learning outcomes and presented progressively from simpler to more complex concepts. Nevertheless, the validators' suggestions regarding the separation of introductory sections, examples, and conclusions indicate that the quality of learning materials depends not only on content alignment but also on how information is organized and presented. Structuring the material into clearly differentiated stages may help students develop their understanding progressively and provide opportunities to construct meaning before reaching conclusions. This finding is consistent with Anwar and Ruslan (2019), who highlighted the importance of material organization in the development of learning resources.

The language aspect obtained an Aiken's V coefficient of 0.88, which was the lowest among the assessed aspects, although it remained within the high-validity category. This finding indicates that readability requires particular attention when developing learning materials for elementary school students. Language used in learning materials should not only conform to linguistic standards but also be appropriate for students' cognitive development and reading abilities. Herawati and Muhtadi (2018) emphasized the importance of adapting the language of learning materials to students' developmental characteristics. Similarly, Naila et al. (2021) highlighted the importance of clear instructions in enabling students to use learning materials more

independently. Therefore, the validators' recommendations to simplify terms and response options in the learning-preference diagnostic instrument constituted an important basis for further refinement of the module.

The visual presentation aspect obtained an Aiken's V coefficient of 0.95, indicating a high level of visual quality. The appropriate use of illustrations, icons, typography, and colors can support readability while enhancing the attractiveness of learning materials. The validators' suggestions concerning icon consistency and the relevance of visual elements indicate that aesthetic considerations should be addressed alongside functional aspects. Consistent visual characters and design elements may also contribute to a more coherent and structured user experience for students. This finding is consistent with Febriandi et al. (2019), who emphasized the importance of visual quality in supporting student engagement in learning.

The Aiken's V coefficient of 0.93 for alignment with VARK learning preferences indicates that the module successfully incorporated activities representing the four VARK preferences. This integration enables mathematics content to be presented through multiple forms of representation, including visualizations, audio, text, and interactive activities. A multimodal approach provides greater variety in students' learning experiences and allows the same content to be encountered through different forms of representation. In mathematics learning, such variation is particularly relevant because mathematical concepts can be represented through symbols, images, verbal explanations, and hands-on activities. This finding is consistent with Lubis et al. (2021) regarding the application of multimodal approaches in learning.

Digitalization obtained the highest Aiken's V coefficient, at 0.97. This result indicates that the integration of digital features was one of the major strengths of the developed product. Interactive navigation, multimedia, animations, audio, and other interactive elements enable the module to function not merely as a digital version of printed learning materials but as a learning resource that provides a more dynamic interaction between students and the learning content. Such technological integration is also relevant to the characteristics of learning in the digital era and may support the development of more flexible learning experiences. This finding is consistent with Febriannie and Kurniati (2021), who emphasized the importance of technology integration in supporting the learning process.

Overall, the findings demonstrate that the development of the VARK-Based Digital Mathematics Learning Module resulted in a highly valid product in terms of content, presentation, language, visual design, alignment with VARK learning preferences, and digitalization. A key strength of the product lies in the integration of differentiated learning, multimodal representation, and interactive digital features within a single learning resource. These characteristics suggest that the module has the potential to serve as an alternative digital mathematics learning resource that is more responsive to the diversity of students' learning characteristics. However, because the present study was limited to the expert validation stage, claims regarding the module's effectiveness in improving students' learning outcomes or mathematical abilities require further investigation through product trials and effectiveness testing. The validators' recommendations, particularly those concerning language simplification, visual consistency, and material organization, provide an important basis for refining the product before it is implemented in subsequent stages of the research.

V. Conclusion

This study successfully developed a VARK-based digital mathematics learning module (Visual, Auditory, Read/Write, and Kinesthetic) as a learning resource to support differentiated learning in elementary schools. Based on validation by five experts, the module obtained Aiken's V coefficients ranging from 0.80 to 1.00 across all assessed aspects, including module structure, material organization, language, visual presentation, alignment with VARK learning preferences, and digitalization. These findings indicate that the module has a high level of validity and meets the feasibility criteria for proceeding to the subsequent trial stage. The developed module has the potential to serve as an alternative digital learning resource that accommodates the diversity of students' learning preferences and supports more interactive and differentiated mathematics learning in elementary schools. Further research is recommended to examine the practicality and effectiveness of the module through classroom implementation so that its benefits for students' learning processes and outcomes can be empirically established.

Conflict of Interest

The authors declare no conflict of interest related to this study

Author Contributions

B.Y.W. contributed to the conceptualization, research design, and overall coordination of the study. H.R.P. and V.R.H. contributed to the research implementation, data collection, and development of the VARK-based mathematics e-module. M.P.S. and A.A.F. contributed to data analysis and interpretation of the findings. M.T.D.

contributed to the preparation, review, and editing of the manuscript. All authors contributed to the revision of the manuscript and approved the final version for publication..

Funding

This research was supported by the DIPA BLU through the PNPB Research Scheme, Faculty of Teacher Training and Education, University of Mataram, Fiscal Year 2025. Fund of University of Mataram under contract number 2960/UN18.L1/PP/2025. The funding information is consistent with the manuscript and research report.

Acknowledgment

The authors would like to express their sincere gratitude to Faculty of Teacher Training and Education, University of Mataram, the participating lecturers and the two experts who contributed to the validation of the research instruments.

References

- Alwi, N., Kenedi, A., Arwin, A., Anita, Y., Handrianto, C., & Rasool, S. (2024). Socio-cultural approach through digital teaching modules: a solution to improve beginning reading skills in elementary schools. *Journal of Ecohumanism*, 3(7). <https://doi.org/10.62754/joe.v3i7.4552>
- Anwar, Z. and Ruslan, R. (2019). Pengembangan perangkat pembelajaran matematika dengan menggunakan model pembelajaran berbasis masalah. *Qalam Jurnal Ilmu Kependidikan*, 8(2), 92-104. <https://doi.org/10.33506/jq.v8i2.770>
- Febriandi, R., Susanta, A., & Wasidi, W. (2019). Validitas lks matematika dengan pendekatan saintifik berbasis outdoor pada materi bangun datar. *Jurnal Pembelajaran Dan Pengajaran Pendidikan Dasar*, 2(2), 148-158. <https://doi.org/10.33369/dikdas.v2i2.10612>
- Febriannie, V. and Kurniati, A. (2021). Pengembangan perangkat pembelajaran matematika berbasis model student facilitator and explaining (sfae) pada materi matriks untuk siswa sma. *Juring (Journal for Research in Mathematics Learning)*, 4(2), 123. <https://doi.org/10.24014/juring.v4i2.11966>
- Febriyanti, A. I., Nurrahmah, A., Muzayanah, I. N., Hakim, L., & Arif, A. (2024). Modul Ajar Digital : Dokumen Berbasis Digital Pendekatan Baru Untuk Pembelajaran Berbasis Digital. *Jurnal Penelitian Pendidikan Indonesia (JPPI)*, 2(2), 67-73. <https://doi.org/10.62017/jppi.v2i2.2935>
- Fleming, N. D. (2006). *Teaching and Learning Styles: VARK Strategies* (2nd ed.). Christchurch, New Zealand: N.D. Fleming.
- Hafizah, N. (2023). Media Pembelajaran Digital Generasi Alpha Era Society 5.0 Pada Kurikulum Merdeka. *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, 7(4), 1675. <https://doi.org/10.35931/am.v7i4.2699>
- Hendriani, M. (2021). Validitas modul berbasis pbl pada materi pecahan di kelas iv sd. *Jurnal Didika Wahana Ilmiah Pendidikan Dasar*, 7(1), 111-120. <https://doi.org/10.29408/didika.v7i1.3599>
- Herawati, N. and Muhtadi, A. (2018). Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran kimia kelas xi sma. *Jurnal Inovasi Teknologi Pendidikan*, 5(2), 180-191. <https://doi.org/10.21831/jitp.v5i2.15424>
- Hidayati, V. R., Wahyuningsih, B. Y., Nurmawanti, I., & Putri, H. R. (2025). Analysis of Vark Learning Styles in Elementary School Students' Mathematical Concept Understanding. *Griya Journal of Mathematics Education and Application Volume 5 Nomor 2 Juni 2025*, 134-151. DOI: <https://doi.org/10.29303/griya.v5i2.564>
- Lubis, M., Harahap, T., & Nasution, D. (2021). Pembelajaran kooperatif tipe nht dalam membelajarkan kemampuan berpikir kritis siswa: analisis validitas perangkat pembelajaran. *Jurnal Mathedu (Mathematic Education Journal)*, 4(2), 216-223. <https://doi.org/10.37081/mathedu.v4i2.2662>
- Lukman, H., Sutisnawati, A., & Elnawati, E. (2022). Modul ajar matematika sd berdasarkan perspektif tpack-21. *Aksioma Jurnal Program Studi Pendidikan Matematika*, 11(4), 3225. <https://doi.org/10.24127/ajpm.v11i4.6235>
- Naila, I., Ridlwan, M., & Haq, M. (2021). Literasi digital bagi guru dan siswa sekolah dasar: analisis konten dalam pembelajaran. *Jurnal Review Pendidikan Dasar Jurnal Kajian Pendidikan Dan Hasil Penelitian*, 7(2), 166-122. <https://doi.org/10.26740/jrpd.v7n2.p166-122>
- Nugraha, A. A. and Budiyanto, U. (2022). Adaptive E-Learning System Berbasis Vark Learning Style dengan Klasifikasi Materi Pembelajaran Menggunakan K-NN (K-Nearest Neighbor). *Technomedia Journal*, 7(2), 248-261. <https://doi.org/10.33050/tmj.v7i2.1900>

- Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest*, 9(3), 105–119. DOI: <https://doi.org/10.1111/j.1539-6053.2009.01038.x>
- Rahmawati, S., Nurhikmah, H., & Muin, A. (2024). Development of Web-Based Digital Mathematics Modules Grade VII SMPN 1 Watansoppeng. *Inovasi Kurikulum*, 21(2), 647-660. <https://doi.org/10.17509/jik.v21i2.67846>
- Setiyani, S., Putri, D. P., Ferdianto, F., & Fauji, S. H. (2020). Designing a Digital Teaching Module Based on Mathematical Communication in Relation and Function. *Journal on Mathematics Education*, 11(2), 223-236. <https://doi.org/10.22342/jme.11.2.7320.223-236>
- Tomlinson, C. A. (2017). *How to Differentiate Instruction in Academically Diverse Classrooms* (3rd ed.). Alexandria, VA: ASCD.
- Wahyuningsih, B. Y., & Hidayati, V. R. (2024). Studi kasus: Kesulitan belajar matematika dan implikasinya terhadap kemampuan penyelesaian soal pada siswa sekolah dasar. *Jurnal Review Pendidikan dan Pengajaran*, 7(4), 18133-18140. DOI: <https://doi.org/10.31004/jrpp.v7i4.39589>
- Wijaya, T. T., Zhou, Y., Houghton, T., Weinhandl, R., Lavicza, Z., & Yusop, F. D. (2022). Factors Affecting the Use of Digital Mathematics Textbooks in Indonesia. *Mathematics*, 10(11), 1808. DOI: <https://doi.org/10.3390/math10111808>



Copyright © 2026 by the authors. This is an open access article distributed under the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.