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Development of web-based digital Mathematics Module for class VII of SMPN 1 Watansoppeng

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ABSTRACT

The type of research conducted is research and development aimed at identifying the needs of digital mathematics modules, designing digital mathematics modules, and measuring the levels of validity, practicality, and effectiveness of these modules. The development process of the digital modules follows the ADDIE model, comprising five stages: analysis, design, development, implementation, and evaluation. The test subjects are 29 seventh-grade students from SMP Negeri 1 Watansopppneg, designated as class VII.1. The results indicate that both content experts and media experts rated the modules as valid. The practicality of the digital modules was assessed through analysis of student responses to questionnaires, individual and small group testing, all of which were categorized as practical. Furthermore, analysis of learning test results showed an increase in average posttest scores, indicating effectiveness. The effectiveness of the digital modules was tested through N-gain values, which fell within a moderate category, signifying a significant difference in student learning outcomes and thus effectiveness. Based on the analysis, it can be concluded that the digital mathematics modules can be utilized in the learning process.

Keywords: *Development, Digital modules, Mathematics, Web*

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ABSTRAK

Jenis Penelitian ini adalah research and development yang bertujuan untuk mengidentifikasi kebutuhan modul digital matematika, mendesain modul digital matematika dan mengukur tingkat kevalidan, kepraktisan, dan keefektifan modul digital matematika. Proses pengembangan modul digital mengacu pada model ADDIE yang mencakup 5 tahapan yaitu analisis (analysis), desain (design), pengembangan (development), implementasi (implementation), dan evalusi (evaluate). Responden uji coba produk adalah peserta didik kelas VII.1 SMP Negeri 1 Watansopppneg yang berjumlah 29 orang. Hasil penelitian menunjukkan bahwa penilaian validator ahli materi dan ahli media masing-masing dalam kategori valid. Tingkat kepraktisan modul digital diperoleh dari hasil analisis pada angket respon peserta didik, hasil uji coba individu dan kelompok kecil melalui angket respon peserta didik masing-masing berada dalam kategoti praktis. Selanjutnya hasil analisis tes hasil belajar, rata-rata nilai posttest mengalami peningkatan. Sehingga diperoleh nilai dengan kategori efektif yang teruji tingkat efektifitas modul digital dari nilai N-gain termasuk dalam kategori sedang, artinya terdapat perbedaan yang cukup signifikan hasil belajar siswa, sehingga dinyatakan dalam efektif. Mengacu pada perolehan hasil analisis maka dapat disimpulkan bahwa modul digital matematika dapat digunakan dalam kegiatan pembelajaran

Kata Kunci: *Pengembangan; Modul digital; Matematika; web*

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INTRODUCTION

Education involves a deliberate and systematic endeavor to cultivate a conducive learning environment and process, enabling students to actively develop their potential in religious, spiritual, self-control, personality, intelligence, noble morals, and essential skills required by themselves, society, and the nation. Attaining learning objectives is facilitated through meticulously designed learning strategies aimed at providing a high-quality educational experience. One effective approach teachers employ to devise such strategies is by integrating information and communication technology tools into the teaching process (Minister of Education, Culture, Research, and Technology of the Republic of Indonesia, 2022). Enhancing the overall quality of education and students' learning experiences, in line with process standards, necessitates innovative measures. These may encompass elevating the competence of teachers and educational staff, refining the curriculum, fostering learning innovation, and ensuring the adequacy of facilities and infrastructure (Nurhikmah et al., 2021). Teachers serve as leaders in the learning process, entrusted with the responsibility to optimize classroom activities in accordance with the contemporary needs and characteristics of students. Hence, teachers are expected to demonstrate regularity, creativity, and consistency in their pedagogical practices (Hutahaen et al., 2022).

Based on the initial data collected at SMP Negeri 1 Watansoppeng during the odd semester of 2023, it was observed that teachers had developed teaching modules aligned with the independent curriculum guidelines. These modules typically include learning objectives, activity sequences, and assessments necessary for a specific unit or topic, following the flow of learning objectives or a predefined timeframe. However, despite the availability of these teaching modules, students have not fully utilized them as learning references in class. This is attributed to the limited scope of material covered in the modules. Through interviews with mathematics teachers at SMPN 1 Watansoppeng, it was revealed that there is a need for teaching modules structured according to the flow of learning objectives, accompanied by diverse reading materials. Particularly in mathematics, which often involves abstract concepts, it is crucial to present the material in various formats, not solely relying on textual explanations. Mathematics is perceived as a subject that not only needs to be comprehended but also serves as a conceptual tool for constructing and reconstructing knowledge, refining thinking skills necessary for problem-solving in real-life situations (Kemendikbud, 2022). Exclusively relying on verbal and written explanations for learning mathematics can pose difficulties, as some concepts might necessitate visual aids to enhance comprehension. Therefore, the utilization of audio-visual application media is deemed beneficial, allowing learners to not only imagine but also visually experience the concepts being taught (Puspita Sari, 2022).

Utilizing web-based digital mathematics modules offers students the convenience of accessing the module without being restricted by the storage device used. An advantage of digital modules is their ability to incorporate audio or video elements tailored to the learning styles of students at SMP Negeri 1 Watansoppeng. Digital or electronic instructional modules are electronic educational tools that can be divided into tangible learning components and utilized consistently in a self-directed and structured fashion. The benefit of utilizing digital teaching modules is the ability to provide learning materials and exercises that are not only text-based but also include images and videos to support the learning process (Fitri et al., 2023).

The novelty introduced by the researchers in this study, setting it apart from earlier research, lies in creating a web-based digital mathematics module that corresponds with the self-directed curriculum.. This module incorporates learning videos and interactive formative assessments. Both the learning modules and videos are crafted using the Canva application, enhancing their visual appeal. Additionally, formative assessments via Google Forms are anticipated to enhance learning competencies in an engaging and collaborative manner, aligning with student-centered learning principles.

The research inquiry in this study revolves around three fundamental queries: (1) Why are Web-Based Digital Mathematics Modules necessary for Grade VII students at SMP Negeri 1 Watansoppeng? (2) How can a Web-Based Digital Mathematics Module for Grade VII at SMP Negeri 1 Watansoppeng be devised? (3) What are the levels of validity, practicality, and effectiveness of the Web-Based Digital Mathematics Module for Grade VII at SMP Negeri 1 Watansoppeng? This study aims to recognize the need for web-based digital mathematics modules for Grade VII students at SMPN 1 Watansoppeng, formulate such a module, and assess its validity, practicality, and effectiveness.

LITERATURE REVIEW

Developments in educational technology

Educational technology, both in theory and practice, encompasses the study and ethical application of facilitating learning and enhancing performance through the effective creation, utilization, and management of technological processes and resources (Januszewski & Molenda, 2008). Within the realm of educational technology, the term "development" refers to the process of designing, constructing, and implementing educational technology tools or solutions aimed at fostering learning and teaching (Januszewski & Molenda, 2008). The developmental process in educational technology comprises several sequential stages or levels, beginning with the review or analysis stage to identify needs, learning environments, and expected objectives. Subsequently, the design phase involves prototyping, followed by the realization or creation of technological products (commonly referred to as "development"). These educational technology products then progress to the utilization or implementation stage, succeeded by the evaluation stage to gauge effectiveness and identify areas for enhancement (Nurhikmah et al., 2021). The integration of all these stages forms a cohesive learning design model or instructional design model (Januszewski & Molenda, 2008). The development of educational technology draws upon various disciplines such as instructional design for pedagogical aspects, software engineering for technological aspects, and user experience design for content aspects (Kewalramani et al., 2020). Therefore, the development of educational technology necessitates collaboration among educators, technology developers, media experts, and other policy stakeholders. Furthermore, educational technology involves the integration of several components, including pedagogical models, technology platforms, and content development (Maharani et al., 2023). These research findings underscore the importance of considering pedagogical aspects in educational technology development and emphasize the effective integration of technology into the learning and teaching process.

To sum up, within the realm of educational technology, "development" pertains to the comprehensive process of creating technological solutions aimed at enhancing learning and teaching performance. This process entails iterative stages and necessitates collaboration among various policy stakeholders. Emphasizing pedagogical aspects throughout the development process is crucial, alongside assessing its effectiveness in enhancing learning outcomes.

Digital Module

Teaching materials refer to systematically organized resources utilized by teachers to facilitate classroom learning activities. These materials can encompass written or unwritten content (Misrawati & Suryana, 2021). They play a significant role in shaping students' listening skills during learning sessions. Engaging and well-crafted teaching materials significantly impact students' learning processes and outcomes. It is essential for teaching materials to align with students' cognitive levels, and the language utilized should adhere to proper linguistic conventions, ensuring clarity and ease of comprehension for students (Suryaningsih et al., 2021).

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Digital modules are self-paced instructional materials designed systematically and electronically for independent study. They offer interactive features, allowing navigation through linked content, enhancing the learning experience. Digital modules can incorporate multimedia formats, such as videos, audio, and animations, enriching students' learning experiences (Kurniawan & Kuswandi, 2021). The characteristics of digital modules are akin to those of printed modules and can be adapted accordingly. Some shared characteristics include self-instructional, self-contained, stand-alone, adaptive, and user-friendly features.

Web based learning

Web-based learning, commonly known as e-learning, refers to the educational process conducted via the internet network (Fauziah, 2020). The internet, comprising myriad interconnected computers and local networks, facilitates global connectivity. It offers various tools and platforms for educational purposes, such as email, Internet Relay Chat, mailing lists, file transfer protocol, and the World Wide Web. Accessing information sources online is a fundamental requirement for web-based learning. Users need to locate the desired information sources, which may include freely accessible data repositories or authorized databases. Internet technology enables convenient and rapid access to information from diverse sources worldwide. This accessibility is one of the key advantages of web-based learning.

However, implementing web-based learning entails more than simply uploading learning materials online for access via computers. The web serves not just as a digital storage medium but also as a platform that offers unique advantages over traditional media like paper. Leveraging these advantages requires a strategic approach to web-based learning, aiming to capitalize on the web's interactive capabilities and accessibility (STAIN Parepare Tarbiyah and Adab & Urusan Department, 2017). Web-based learning relies on various principles that significantly influence the success of the learning process during its implementation. The effectiveness of web-based learning largely hinges on the perspectives of stakeholders. As a result, pinpointing the essential principles necessary for web-based learning can be challenging. Azizah et al. (2019) outlined several principles in web-based learning, including interaction, dependency, and relevance. From the aforementioned description, the key principles for implementing web-based learning entail fostering interaction between students and instructors within the learning environment utilizing web-based learning. Additionally, there needs to be a sense of dependency, outlining how learning is developed based on the web, fostering a consistent and straightforward learning atmosphere to alleviate students' learning challenges. Moreover, web-based learning must exhibit relevance in delivering specific information to enhance students' comprehension.

Flip pdf professional

Flip PDF Professional is a software tool designed to transform PDF files into dynamic digital publications, enhancing their visual appeal akin to flipping through a traditional book (Seruni et al., 2019). It offers several advantages, particularly in terms of user-friendliness, as it can be utilized by novices unfamiliar with HTML programming. This multipurpose flipbook creator allows for page editing and enables the integration of multimedia elements such as images, YouTube videos, MP4 files, audio clips, hyperlinks, quizzes, flash animations, and interactive buttons, resulting in visually appealing and interactive digital products (Seruni et al., 2019).

The output generated by Flip PDF Professional can be in various formats, including HTML5, EXE, ZIP, Mac app, FBR, mobile versions, or burned to CD (Rahman et al., 2021). The HTML5 format ensures online interoperability across smartphones and computers, while other formats are suitable for offline manual operation on computers (Febriati et al., 2019).

METHODS

The relevant research methodology for achieving the stated objectives is Research and Development (R&D). R&D is a research approach utilized to create specific products and evaluate their effectiveness. It is commonly employed in the field of educational technology, particularly in the design and development of systems and educational materials (Reeves et al., 2004). The aim of R&D research is to generate

meaningful interventions and practices, addressing real educational challenges (Armstrong et al., 2020). Prior to engaging in development endeavors, thorough research is essential. This research follows the ADDIE development model, comprising five stages: Analysis, Design, Development, Implementation, and Evaluation. The chosen research location for this developmental study was SMPN 1 Watansoppeng, involving 29 seventh-grade students from class VII.1 as participants. Data collection tools comprised validation sheets, questionnaires, and assessments of learning achievements. The validation sheets were distributed to two lecturers with expertise in material and media, along with a mathematics teacher from SMPN 1 Watansoppeng, acknowledged as an expert in the field. Data gathered from questionnaires were analyzed utilizing descriptive percentages. The formula utilized to compute the percentage for each subject was:

$$Persentase = \frac{\sum(Jawaban \times Bobot\ Pilihan)}{N \times Bobot\ Tertinggi} \times 100\ \%$$

N represents the total count of questionnaire items.

Moreover, to compute the percentage for all subjects, the following formula was employed::

$Percentage = F : N$

F = The total percentage of the subject

N = Many subjects

The collected data is subsequently categorized into groups based on their effectiveness levels, which include highly effective, effective, moderately effective, and minimally effective, as outlined below:

Table 1 . Indicators of success of the learning process

No	Score	Category
1	<20%	minimally effective
2	21% - 40%	Less Effective
3	41% - 60%	moderately effective
4	61%-80%	Effective
5	81%-100%	highly effective

Source: Arikunto (2010)

The distribution of importance and decision-making is utilized in the following provisions.

Table 2. Convert the Level of Achievement with a Scale of 5

Achievement Level	Qualification	Information
90%-100%	Very good	No Need Revised
75%-89%	Well	No Need Revised
65%-74%	Enough	Revised
55%-64%	Not enough	Revised
0%-54%	Very less	Revised

Source: Arikunto (2010)

If the validity test results fall within the range of 75% - 100% or within the categories of good to very good, it will be deemed valid. Similarly, if the practicality test results range between 75% - 100% or fall within the categories of good to very good, it will be considered practical. Qualitative research data, such as comments and suggestions, will be utilized as a basis for refining the web-based digital mathematics module.

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During the product trial phase, students undergo testing, including a pretest prior to engaging with the digital module and a posttest after completion. Data gathered from both the pretest and posttest results are calculated using the following formula:

$$Nilai = \frac{Jumlah\ benar}{jumlah\ soal} x\ 100$$

y analyzing the computed values from the pretest and posttest of each respondent, we utilize the normalized N-gain, as introduced by Hake (2002). According to Fadaei (2019), Hake's gain serves as a tool to gauge the comparative effectiveness of different teaching methodologies, and for digital module-based learning, the N-gain can be determined using the subsequent formula:

$$N_{gain} = \frac{\bar{x}posttest - \bar{x}pretest}{100 - \bar{x}pretest}$$

(Fadaei, 2019)

Information:
$\bar{x}pretest$: the average score of the initial test
$\bar{x}posttest$: final test average score

To assess the efficacy of the digital module, the outcomes of N-gain are interpreted according to the following table:

Table 3. Criteria for obtaining Ngain Score

Critical *N-gain* Value	Criteria
If $\boldsymbol{N_{gain} \geq 0,7}$	Tall
If $\boldsymbol{0,7 > N_{gain} \geq 0,3}$	Currently
If $\boldsymbol{N_{gain} < 0,3}$	Low

RESULTS AND DISCUSSION

The research findings delineate the progression involved in crafting web-based digital mathematics modules, encompassing the prerequisites for digital modules, the design of digital modules, as well as the validation, practicality, and efficacy of digital mathematics modules. This comprehensive explanation is elucidated as follows:

Needs Analysis

Analysis includes examining facilities and infrastructure, as well as assessing student characteristics. Following a needs analysis conducted through teacher interviews, various findings emerged.: 1) The achievement of mathematics learning in phase D has been analyzed together with mathematics teachers at the school at each grade level. In addition, mathematics teachers at SMPN 1 Watansoppeng have already formulated learning objectives and the flow of mathematics learning objectives in phase D. 2) Teachers have compiled teaching modules based on ATP, but the reading materials in the modules are still very limited. As a result, the teaching modules have not been maximally utilized by students as a learning resource. The parts of the teaching modules accessed by students are only the assessments and worksheets. 3) The common media used are electronic books in PDF format, PowerPoint, and instructional videos from YouTube. However, the videos taken from YouTube are not entirely aligned with the learning objectives formulated by the teachers. 4) Teachers' ability to create instructional media such as instructional videos is still limited. Moreover, creating instructional videos requires a lot of time, and since teachers have a heavy teaching workload at school, they do not have enough time to create instructional videos.

Mathematics digital module design

The design phase commences with an examination of learning outcomes, the assembly of learning objectives and their sequence, the creation of scenarios or instructional activities, gathering reference materials, installing necessary applications such as Flip PDF Professional, and specifying the elements to be incorporated like color schemes, text formatting, images, audio, and video. These elements will be integrated to form the foundational visual layout of the digital mathematics module.

Compiling material for the digital mathematics module, the material chosen is class VII material which contains material on integers, rational numbers, ratios and algebraic forms. The reference sources for the material used are mathematics concepts and applications books published by the National Ministry of Education, and mathematics books published by the Ministry of Education and Culture, Research and Technology. After the material has been collected. Next, digital modules are created using the application flip *pdf professional*. The initial stage of creating a digital module is designed background and module components using canva. After all the material has been designed properly, the next step is to import the Canva results into a form pdf, the result of the Back import into flip *pdf professional.* We include the learning videos that have been made previously flip *pdf professional* by adding hyperlink go to the previously created video location shortcut. Use Flip *pdf professional* in making this digital module is in line with research conducted by Yulia Aftiani (2021) *flip pdf professional* is an application that can be used to convert *Pdf* page publication flipping *digital* which allows us to create interactive learning content with several supporting features.*Flip Pdf Professional* this is different from pdf which is usually used. In terms of appearance,flip pdf professional it's like a look-book which can be flipped back and forth while reading it.

Comparing the findings from the design phase with Aftiani's research, which highlights the utility of Flip PDF Professional for crafting interactive learning materials, aligns with the conclusions drawn by previous researchers. They advocate for the use of Flip PDF Professional in digital module design due to its capability to enhance the visual appeal of PDFs, rendering them akin to flip-over modules, thereby offering a more engaging reading experience.

Mathematics Digital Module Design

In the ADDIE model, the design phase involves creating a digital module product to be developed. The initial step is media selection, which aims to choose media that aligns with the material's characteristics to facilitate achieving learning goals. In this case, the chosen media is a web-based digital module designed using the Flip PDF Professional application. The next step is to prepare the material according to the teaching module. This involves developing eight module units covering topics on number and algebra elements. Additionally, developers prepare student worksheets and assessments to be integrated into the digital mathematics module. The third step is the initial planning phase, which includes outlining the media plan for the development process. This initial plan results in the creation of a prototype digital module to be further developed in subsequent stages. The designed digital module at this stage is web-based and tailored to students' preferences for materials supplemented with learning videos.

The design/prototype of the digital mathematics module is described as follows:

Table 4. 4 Prototypes of Mathematics-Based Digital Modules *Web*

No.	Component	Description
1	Specification	This digital module uses software application *flip pdf professional.*
2	Design/template	Before the material is extracted into the professional Flip PDF application, a template is first created using canva.

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3	Content/material design	The material is created first in canva which then exposed to pdf. Next, the file or material is entered into the software flip *pdf professional* and published in the form html5. Then the module in html form is uploaded to the web use *netlify*.
4	Visual design	Visual design using canva to create an attractive design for digital module users.
5	Body frame	Consists of a cover, foreword, table of contents, instructions for using the module, general information, core components, attachments, and bibliography.
6	Content	Consists of 8 digital module units listed inside*web* digital modules, namely: understanding integers, integer operations, integer factors, understanding rational numbers, rational number operations, ratios, getting to know algebraic forms, and algebraic form operations.

The fourth step is compiling a research instrument. The instrument is used as a tool for collecting data in order to solve a research problem

Analyze the validity, practicality and effectiveness of digital modules

The evaluation of the digital mathematics module's validity in this study followed the development phase as per the ADDIE model. Researchers conducted the development stage to ensure the resulting product was validated. Before assessing the validity of the interactive learning multimedia, the development of learning tools and materials was undertaken to generate digital module products. The process unfolded in the following manner:

Table 5. Validation of Interactive Learning Multimedia from Material Experts and Media Design Experts

No	Instrument	Percentage	Criteria
1	Material	94,29%	Valid
2	Design and media	99,13%	Valid
3	Teacher response questionnaire	95,33%	Valid
4	Student response questionnaire	97,67%	Valid
5	Learning result test	91,33%	Valid

After conducting validation tests, revisions were implemented based on feedback and suggestions provided by experts. One of the revisions made to the digital module involved adjusting the color of the tools in the Flip Digital Module template to ensure readability when displayed on the web or Google Slide. Additionally, material experts provided input, suggestions, and comments related to the digital mathematics module, particularly regarding the assessment table. Specifically, they suggested placing the criteria points for achieving the goals after the learning objectives. This feedback was addressed by reviewing the display of the digital modules in each unit and ensuring alignment of learning activities, student worksheets, and all materials and videos with the learning objectives.

After completing the development stage, the digital mathematics module was implemented in the subsequent phase. The practicality of the product was evaluated during implementation through teacher response questionnaires, aiming to collect feedback on program performance and user experiences with the digital mathematics modules. These assessments encompassed various aspects, including the learning process, presentation quality, usefulness of module components, and alignment with the

curriculum. According to the responses gathered from the mathematics teacher questionnaire, the product attained a score of 91.7%, indicating a high level of practicality. Subsequently, the practicality test involved 9 students from class VII.1, divided into 3 groups, with each group comprising 3 students. The average percentage of the digital mathematics module products from these 9 students was 84.9%, indicating overall good qualifications. Therefore, there was no need for revisions to be made to the products in this digital mathematics module.

The effectiveness of the digital mathematics module was assessed through a pretest conducted with 29 students from class VII.1 at SMPN 1 Watansoppeng to measure their initial knowledge level on algebraic operations before using the digital mathematics modules. Following their participation in learning activities with the digital modules, students completed a posttest to evaluate their knowledge levels. The results of the pretest revealed an average score of 46.03% among the 29 students at SMPN 1 Watansoppeng, indicating their initial understanding of the subject matter.

Table 6. Recapitulation of Pretest Results

No	Score	Category	Number of Respondent
1	< 20%	Very Less Effective	2 participants
2	21% - 40%	Less Effective	11 participants
3	41% - 60%	Enough Effective	11 participants
4	61% - 80%	Effective	5 participants
5	81% - 100%	Very Effective	0 participants

Based on the data presented, it is apparent that a considerable number of students encounter difficulties in understanding algebraic operations concepts. Consequently, there arises a need for interventions aimed at enhancing comprehension and thereby improving proficiency in this subject area. As a result, students are engaged in the learning process utilizing digital mathematics modules.

After participating in learning activities with digital mathematics modules focused on algebraic operations, students undergo a posttest assessment. This posttest comprises 20 multiple-choice questions designed to align with the cognitive difficulty level of the material. The average score achieved by students in the posttest is 78.28. Further details of the posttest outcomes are outlined in Table 7 below.

Table 7. Recapitulation of Pretest Results

No	Score	Category	Amount Respondent
1	< 20%	Very Less Effective	participants
2	21% - 40%	Less Effective	11 participants
3	41% - 60%	Enough Effective	11 participants
4	61% - 80%	Effective	5 participants
5	81% - 100%	Very Effective	0 participants

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These findings indicate a notable improvement in students' posttest scores following their engagement with web-based digital mathematics modules. The evaluation of effectiveness is gauged through the "Tune" metric, derived from the disparity between pretest and posttest average scores.

Through calculations, a "Tune" value of 0.59 falls within the moderate category, signifying a reasonably positive impact of web-based digital mathematics modules on student learning outcomes. The progression from pretest to posttest scores suggests that the use of digital modules can enhance student motivation, consequently influencing their academic performance positively. The extent of improvement varies based on individual student interactions with the digital module, yet overall, the development of the digital mathematics module appears beneficial in fostering students' comprehension of the material's concepts.

Discussion

The creation of a web-based digital mathematics module aimed at enhancing the learning comprehension of Grade VII students in Mathematics at SMPN 1 Watansoppeng has completed all procedural phases. This digital module is envisioned to reinforce understanding of mathematical concepts related to numbers and algebra while providing a fresh learning environment for students facing participation constraints. Additionally, it is anticipated that this digital module will optimize the learning experience by leveraging technology.

The impetus for developing a digital mathematics module in this study stemmed from an analysis of students' requirements for such modules. Following this, the developer conducted a thorough examination of material needs, revealing students' struggles with comprehending mathematical concepts. Data sourced from mathematics teachers indicated that a significant portion of Grade VII students encountered difficulties with both numerical and algebraic operations. Concurrently, insights into students' digital module necessities highlighted a demand for learning resources featuring instructional videos offering lucid explanations and playback capabilities.

Digital mathematics modules are not limited to textual content and images; they also incorporate video presentations discussing the material. Moreover, the design elements such as color schemes, backgrounds, hyperlinks, and animated movements within the digital module effectively capture students' attention. This aligns with Alim's research (2023), which advocates for the integration of multimedia elements like audio, video, animation, and hyperlinks into learning materials, enabling users to control navigation and engage with the material independently. Students can navigate freely, watch, pause, and replay video content embedded in the digital mathematics module. Similarly, as noted by Nurhikmah H (2020), multimedia refers to utilizing computers to combine text, graphics, audio, and moving images, facilitating easier navigation, interaction, creation, and communication for users. Thus, when teachers incorporate multimedia elements into their teaching, including initial, core, and concluding activities, it enhances the learning experience for students. Accordingly, the utilization of text, images, videos, and animations in this digital mathematics module is tailored to meet students' needs, thereby assisting teachers in the teaching and learning process.

Comparing the findings of the needs analysis with the studies by Alim and Nurhikmah, it is evident that incorporating text, images, and videos into digital modules leads to engaging and easily comprehensible information for students. This corresponds with research outcomes, indicating that students prefer digital modules accompanied by instructional videos as it facilitates independent learning, whether in the classroom or at home.

The design phase commences by analyzing learning outcomes, outlining learning objectives and their sequence, creating scenarios or instructional activities, gathering reference materials, and installing necessary applications, such as Flip PDF Professional. Additionally, decisions regarding the elements to be incorporated, including color schemes, text formatting, imagery, audio, and video, are made. These elements are interlinked to establish the foundational layout for the digital mathematics module.

Curating content for the digital mathematics module involves selecting materials relevant to Grade VII curriculum, encompassing topics such as integers, rational numbers, ratios, and algebraic expressions. The chosen resources include mathematics textbooks on fundamental concepts and applications published by the National Department of Education, as well as those released by the Ministry of Education, Culture, Research, and Technology. Once the materials are compiled, the digital modules are developed using Flip PDF Professional application. The initial phase entails designing the module's background and components using Canva. Subsequently, the designed elements from Canva are imported into a PDF format, which is then imported into Flip PDF Professional. Additionally, learning videos are integrated into the module by incorporating hyperlinks to previously created video locations. Utilizing Flip PDF Professional aligns with the findings of Yulia Aftiani's research (2021), which highlights its capability to convert PDF pages into interactive digital publications, facilitating the creation of engaging learning content with various supportive features. Flip PDF Professional distinguishes itself from conventional PDFs by presenting content in a format akin to flipbooks, allowing for easy navigation and interactive reading experiences.

Drawing from the outcomes of the design phase and juxtaposing them with Aftiani's research findings, it is evident that employing Flip PDF Professional for crafting digital books enables the generation of interactive learning materials. This concurs with prior research, affirming the selection of Flip PDF Professional for designing digital modules, as it facilitates transforming PDFs into visually appealing formats resembling flipbooks, enhancing engagement by allowing for interactive navigation during reading.

The assessment of the validity, feasibility, and efficacy of the digital mathematics module products involved validation by two experts—material specialists and media experts—along with individual, small group, and large group testing, incorporating diverse stakeholders to evaluate effectiveness and gauge teachers' responses regarding the module's practicality. The findings indicate that the digital mathematics module products are validated, practical, and effective, as determined by a collaborative effort between material and media experts, along with feedback from Grade VII students at SMPN 1 Watansoppeng.

The evaluation of practicality was conducted by the mathematics subject teacher, assessing aspects such as the utility of digital modules, presentation quality, and the functionality of digital module components. The responses received were highly favorable, indicating the practicality of the modules for educational use. Similarly, practicality was assessed through small group testing involving three groups of Grade VII students. The results, also deemed satisfactory, indicate that the product does not require any revisions.

The final phase involves assessing the effectiveness of the developed mathematics module, conducted on a large scale. Pretest and posttest scores are analyzed to evaluate effectiveness, primarily through the N-gain results. The digital mathematics module focusing on algebraic operations has been fairly successful, exhibiting a medium level of effectiveness. Students' responses to the digital mathematics module serve as a gauge for its effectiveness, falling within the medium category. The efficacy of the

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developed digital modules is influenced by visually appealing images, legible text, and instructional videos, which aid students in comprehending the material more easily.

Through the validation, effectiveness, and practicality testing, a digital mathematics module teaching material has been developed, meeting the criteria of validity, effectiveness, and practicality as per various theories. This achievement serves as a valuable tool aiding the learning evaluation process, thereby positively influencing students. These findings resonate with the research conducted by Qamariah (2023) titled "Development of Professional Flip PDF Based E-Modules on Fractional Material." Qamariah's study underscores the creation of electronic modules or digital modules using Flip PDF Professional, which are visually appealing and enhance students' theoretical understanding and interest, particularly in fractional material at the elementary school level.

From the foregoing discussion, it can be inferred that digital mathematics modules offer several benefits, including: 1) Accessibility via gadgets, computers, or laptops without the need for device storage; 2) Customization of text, images, videos, and animations to suit students' needs; 3) Integration of text, images, and videos within the digital module; 4) Demonstrated effectiveness in enhancing student learning outcomes, as evidenced by pretest and posttest results measured by N-gain. However, alongside these advantages, there are certain limitations in the development of digital modules, such as: 1) Inability to access the digital module offline; 2) Inability for students to directly fill in worksheets within the digital module.

CONCLUSION

Based on the findings and discussions surrounding the creation of web-based digital mathematics modules at SMPN 1 Watansoppeng, the following conclusions emerge.

1. The Requirement for Digital Mathematics Modules. The outcomes of the material needs analysis indicate students' struggles with comprehending mathematical concepts. According to the analysis, students require digital mathematics modules featuring instructional videos for clearer explanations of the material, which can be replayed as needed. These modules are essential to support learning both within the school environment and at home. The inclusion of videos discussing the material, along with the visually engaging design elements such as color schemes, backgrounds, hyperlinks, and animated movements, makes digital modules more appealing and captures students' attention effectively.
2. Mathematics digital module design. The process of designing digital modules commences with the analysis of learning outcomes, formulation of learning objectives and their sequence, creation of scenarios or learning activities, gathering material references, and setting up the required applications, such as flip pdf professional. Prior to utilizing flip pdf professional, it's essential to establish the elements to be incorporated, such as background colors, text, images, audio, and video. These components are interconnected and serve as benchmarks for the visual presentation during the development of digital mathematics modules.
3. Validation, Practicality, and Effectiveness of Digital Modules.
   The creation process of digital mathematics modules has resulted in products that are deemed valid, practical, and effective for use in the learning process, following multiple stages of development and revisions. During the validation phase, which involved assessments by media or design experts and content or material experts, the modules were categorized as valid.
   The practicality evaluation was conducted by the mathematics subject teacher, focusing on aspects such as learning with digital modules, presentation quality, and functionality of module components. The responses indicated high qualifications, affirming the practicality of the modules for learning purposes. Similarly, in the practicality assessment, students' responses in both individual and small group trials were rated as good, indicating their practicality for educational use.

The digital mathematics module proves to be effective in enhancing student competency, evident from the comparison of pretest and posttest scores. Pretest scores primarily fell within the poor category, whereas posttest scores predominantly reached the good category, indicating a considerable improvement. This effectiveness is further underscored by the N-gain score, which falls within the medium category at 0.59. The module's attractiveness and the clarity of the material presented through text, images, and videos contribute significantly to its effectiveness.

The recommendations derived from the researchers' study are as follows:

1. Teachers are encouraged to employ the developed digital mathematics modules, particularly in teaching numerical concepts and algebra, to enhance the learning process.
2. Participants are advised to utilize the developed digital modules as supplementary resources in their mathematics learning endeavors to fulfill learning objectives effectively.
3. Future researchers are encouraged to use the development process of digital mathematics modules as a reference for creating other digital modules or improving existing digital mathematics modules.

AUTHOR'S NOTE

Penulis menyatakan bahwa tidak ada konflik kepentingan terkait publikasi artikel ini. Penulis menegaskan bahwa data dan isi artikel bebas dari plagiarisme.

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