

# Perspective on the Use of Mathematics Modules

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**Abstract:** There have been many studies on the use of mathematics modules. Where, the use of mathematics modules is also suggested in the revised curriculum. This indicates that we need a combination of several studies that are analyzed systematically and detail in a study. This study used a meta-analysis method to make a systematic and integrated research review on the use of published mathematics modules. Scientific publications written between 2017 and 2021 were detected based on titles, abstracts and keywords using database 'advanced search' tools. The key word used is 'math module'; 'math e-module'; 'math textbook'; and 'math e-book'. 101 scientific publications were selected after an extensive literature review. However, 25 studies that match the research objectives had been identified. Based on the results of the content analysis, it showed some weaknesses of the mathematics module that had been developed. For this reason, an improvement is needed to develop a mathematics module that can be used more optimally.

**Keywords:** Mathematics, Modules, E-modules, Textbook, E-book.

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## I. INTRODUCTION

Educational institutions will not be able to meet various forms of individual needs of each student optimally. This is because each student is a unique individual. They have divergent personalities and qualifications [1]. In this context, a media that can be used as a way out for meeting the needs of individual students is needed [2]. The media can be in the form of modules. A module is a learning activity guide that has clear and detailed objectives. The module is an integral part of the learning process that can be used as a guide to get learning outcomes. Modules can be a medium for students to learn independently to meet individual needs. Important information about the subject matter that must be studied by students can be obtained from a module. Modules are teaching materials arranged systematically and attractively which include material content, methods and evaluation that can be used independently [3]. The learning module is a teaching and learning program that is learned by the students themselves individually [4]. The use of learning modules can make students more interested in teaching and learning activities and students are also able to think creatively and mathematically [5].

Learning using modules can also maximize students to solve problems creatively and mathematically in daily life. As for the research of Counsel & Cribbie with the results of research showing that student independent, student learning effectiveness, and student learning achievement can relatively increase after implementing learning by utilizing teaching modules [6]. Research by Yulastri et al. with the results of his research which showed that student responses can be classified as very positive towards the development of teaching modules [7]. Learning using the teaching module makes students feel happy and motivated. Furthermore, research conducted by Hoch et al. showed that a review of didactic; construct; and technical aspects of the *constructivism*-based fraction module with caricature insertions for grade 6 students were in the valid category [8]. With this the resulting module can be developed as a medium for learning mathematics.

In addition to the use of modules, the use of effective teaching materials such as digital teaching materials is considered an important aspect of the newly developed mathematics curriculum in the face of the *Covid-19 pandemic* situation. The study of the use of digital teaching materials in mathematics reveals various benefits for students. Somakim et al. revealed in their research that the use of *PISA*-based mathematics teaching materials has a potential effect on students in scientific activities [9]. Moraova in her research revealed that the use of cultural content in electric mathematics teaching materials can foster students' mathematical thinking [10]. The results of research by Mutmainah et al. showed that the use of experiential learning based teaching materials in mathematics was effective in improving the cognitive abilities of mathematics in fifth grade elementary school students [11]. Baist et al.'s research showed that the use of computational mathematics teaching materials had an effect on improving students' independent learning [12]. *NCTM* published a report suggesting that students should be provided with easy access to teaching materials to improve their

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mathematical understanding. A student-centered approach has been adopted and teaching materials have been integrated into the learning environment [13]. The form of digital teaching materials related to modules is the e-module and e-book.

Based on the aspect of its effectiveness, E-module is a medium that can build competence and assess the need for learning [14]. E-modules are teaching materials that are used by researchers based on technology and are developed, so that they become products in electronic form [15]. E-module is a teaching material that contains a unit of material concept that can be displayed with an electronic device in the form of a computer [16]. E-modules can be used as learning media because of their characteristics that can be accessed asynchronously and the content is integrated by video, audio, and images to help students understand learning material [17]–[19]. E-modules have various advantages to balance the demands of 21st century learning. Various forms of renewable applications have also been developed and can be used as a medium for designing an e-module in blended learning [20].

Based on this, a systematic review of existing studies on the use of mathematics modules is required. There have been many studies on the use of mathematics modules. Where, the use of these mathematics modules has also been suggested in the revised *curriculum*. There are also several other studies related to mathematics modules. This indicates that we need a combination of several studies that are analyzed systematically and in detail in a study. Where this research can certainly provide a unique and exclusive role related to the use of modules in learning mathematics. So that the main purpose of this research was to describe the perspective of using modules in mathematics learning.

## II. METHODE

This research can be classified into a *meta-analysis* study which includes empirical research on the use of mathematics modules. This study addresses gaps in the literature by conducting content analysis on the learning efficiency in relative from several forms of mathematics modules. In addition, this study discusses the extent of the use of modules in mathematics learning and discusses in detail some of the things that affect the use of mathematics modules. The main objective of this research was to describe the perspective of using modules in mathematics learning, by analyzing related research published between 2017 and 2021. This study used a *meta-analysis* method to make a systematic and integrated review of research on the use of mathematics modules which have been published. *Meta-analysis* is a research method that utilizes the results of previous research for a specific purpose [21]. Literature reviews were conducted systematically to select studies to be included in the *meta-analysis*.

A method was used to access all published research and focus on modules in mathematics learning. In line with the research objectives, searches were carried out on search engines such as *Google Scholar*, *ERIC*, *Directory of Open Access Journal (DOAJ)*, *Researchgate*, and *Freefullpdf* in January 2021. Using this database's 'advanced search' tool, scientific publications written between 2017 and 2021 were detected by title, abstract and keyword. The key words were as follows; 'math module'; 'math e-module'; 'math textbook'; and 'math e-book'. 101 scientific publications were selected after an extensive literature review. However, 25 studies that match the research objectives had been identified. After the selected articles were obtained, the next step was the *coding* process. The *coding* process is an activity to sort several selected studies according to their specifications [22]. At this stage the research included in the *meta-analysis* was coded through a coding form prepared by the researcher. 25 of the 101 studies that were found in the literature search and that met the criteria on the coding form were entered in the *meta-analysis*.

## III. RESULTS AND DISCUSSIONS

This research was conducted to determine the content analysis of modules utilization in mathematics learning. The 25 of content analysis in each selected article was described as follows. Research with code M01 was research conducted by Wiburg et al. in 2017. Where Wiburg et al. developing a module containing Math Snacks material [23]. The *Constructivist* Instructional Design Model which was applied to the design and development of its digital math game modules was utilized to facilitate *constructivist* learning that supports students as they try various solutions to problems. However, module development focuses on math games and has not provided opportunities for students to maximize the use of their senses in carrying out *constructivist* learning. Research with the M02 code was research conducted by Smith in 2017. Smith developed a module with statistical material verification [24]. *Collaborative peer feedback* implemented in the mathematics module can provide significant benefits for students in their learning experience. However, the module used was too focused on feedback. So that it has not provided opportunities for students to carry out learning by utilizing the senses which they have in finding useful new experiences. Research with code M03 was the research of Chao et al. in 2017. Mathematics in *Atayal's craft* was the choice of material used in the development of e-books in their research [25]. The effectiveness of presenting the problem in this developed e-book was used as a starting point for learning to evaluate the results of problem solving. However, the e-book developed by Chao et al. have not

provided opportunities for students to treat the senses and integrate them into the deepest understanding until that understanding is embedded in students. Research with the M04 code was research conducted by Hwang & Lai in 2017. Traditional mathematics was the material they chose to include in the developed e-book (Hwang & Lai, 2017). There was an increase in student learning outcomes after being taught by using a Mathematical E-book based on the *Flipped-Blended Learning* model. The E-book developed focuses on the video content contained therein. It has not provided opportunities for students to carry out sensory learning. The research given the M05 code was research conducted by Ekowati & Nenohai in 2017. They chose the subject matter on *thematic* material as the material included in the book they developed [26]. In the books they developed, students get more opportunities to study on their own, read the descriptions and instructions in the activity sheet, and answer questions and carry out tasks that must be completed in each assignment. However, the book they had developed has not provided opportunities for students to collaborate exploration of material carefully. Where, this activity should be done together with classmates and friends outside the class.

Furthermore, research with the M06 code was research conducted by Saracoglu & Kol in 2018. In the e-book development research carried out, they chose the subject of vector as material in the e-book [27]. The mathematics e-book they developed received a good response from both educators and students. The mathematics e-book they had developed also had a positive effect on student learning outcomes. And able to help students think more actively during learning. Especially in proving a concept based on their observations and analysis. However, the e-book they had developed has not provided the opportunity for students to observe and analyze directly and thoroughly by treating their senses. Research with code M07 was research conducted by Urhan & Dost in 2018. The topic of book development carried out by Urhan & Dost was Trigonometry [28]. The mathematics book developed by Urhan & Dost provides new knowledge insights to students, both in terms of mathematics material and the relationship between *trigonometric* material and daily life. This mathematics book developed by Urhan & Dost also contains *Trigonometry* material which is prepared using the Problem Based Learning model step which requires students to arrive at the C6 (Evaluation) stage. The module developed by Urhan & Dost is still focused on cognitive aspects, it has not provided opportunities for students to improve their abilities other than *cognitive* aspects, namely on *affective* and *psychomotor* aspects as well. Research with code M08 was research conducted by Pawley and Hughes in 2018. *Algebra; functions and graphs; trigonometry and complex numbers; vectors and matrices; derivatives; and integrals* were materials listed in the modules used in Pawley and Hughes' research [29]. The revision and refresher program on the module in its research was complemented by a boot camp series led by a tutor. The tutor ensured that all required material was covered and provides the opportunity in real time to ask questions about the material. However, the modules used by Pawley and Hughes have not provided opportunities for students to collaborate in problem solving in the form of collaborate discussions. Even though, the new knowledge that students have can be formed with this collaboration. Then research with code M09, namely research Bartholomew et al. in 2018. In developing their mathematics module, they chose *Science, Technology, Engineering, and Math (STEM)* material. The mathematics e-module they had developed met the criteria of being valid, practical and effective [30]. The *Open Ended* based mathematics e-module that they developed directs students to be active in expressing their ideas; exploring problems and looking for various problems; developing learning knowledge and describing everything that students learn. However, the e-modules they have developed have not provided opportunities for students to carry out collaborative understandings. Therefore it can be reduce students' feelings of confusion and doubt in submitting opinions. The research which given the M10 code namely, the research of Hendrix et al. in 2019. Home mathematics was the material chosen by Hendrix et al. to be included in the book being developed [31]. The book that Hendrix et al. developed can lead students to build their knowledge so that they really understand the material. However, the book which was developed has not provided opportunities for children to implement empirical mathematics learning. Whereas with this the teacher can make the *cognitive, affective and psychomotor* domains of students develop simultaneously.

Research coded M11 was a study conducted by Munakata et al. in 2019. The discussion of *geometry* was the material listed in the module used in the research of Munakata et al. [32]. The deliberate focus on creativity in this math module challenges students' conceptions of mathematics; enabling them to reconsider their familiar mathematics in new ways; and it engage them in meaningful collaborations. The modules they had developed were too focused on play activities. It is not yet giving students the opportunity to draw serious learning through various sensory learning activities. Even though with sensory learning activities, the teacher will be able to ensure that students remain on the task of thinking about mathematics without limiting the students' space. Research with code M12 was Mursalin's research in 2019. The algebraic form material was chosen by him to be included in the e-book being developed [33]. The mathematics e-book product with *algebraic* form material which is equipped with a discussion of *elementary algebra* for students majoring in Mathematics Education with the *scientific approach* that they had developed was suitable for use in the learning process. However, the e-book developed focuses on discussing *elementary algebra*. It has not shown to provide opportunities for students to build their own knowledge in a problem solving. Research given the M13 code

namely the research of Supiyati et al. in 2019. The topic of material discussed in the *ethno-mathematics* module they developed was *basic algebra* [34]. In terms of the *ethno-mathematical approach* implementation, it was able to motivate students to be actively involved in finding local cultures related to mathematics. The developed module focuses on the *cognitive realm*. It has not provided opportunities for students to carry out activities that are able to develop students' abilities in the *affective and psychomotor* domains. Research with code M14 was Angelone's research in 2020. The e-module developed by Angelone was related to *Geometry* material [35]. The *Realistic Mathematical approach* applied to the development of the E-module is feasible and can be used in elementary mathematics learning, especially in learning geometry. However, the E-module developed has not shown to provide opportunities for students to use their senses empirically in imagining, exploring, experimenting, testing, manipulating, interacting, collaborating, and speculating in solving mathematical problems. Research with code M15 was research by Li et al. in 2020. Li et al. develop e-book related to *number pattern* material [36]. The developed interactive mathematics e-book gives students the opportunity to be able to do direct evaluations in the e-book and the opportunity to choose a number that is easy to work on first. The score in the evaluation process can be seen directly by students. The e-book developed focuses on the evaluation of learning, not yet providing opportunities for students to use their senses empirically in carrying out all activities related to the learning process.

Research with code M16 was research conducted by Seibert et al. by 2020. The material listed in the development of mathematics books conducted by Seibert et al. was the tenth grade mathematics material [37]. The advantages of mathematics books with *Multitouch* learning books in tenth grade mathematics material developed by Seibert et al. namely: (1) as a learning guide for students independently; (2) books compiled with *Multitouch* learning books, equipped with *mini math labs* that can make it easier for students to find a concept in the subject matter. So that students know how the concept is obtained. In addition, there were project activities that can increase the knowledge of students to apply the knowledge they have in real life; (3) this book has many illustrations that can make it easier for student to understand the material. However, the book developed still focuses on illustrations in the mini math lab. It is not yet showing that books provide opportunities for students to explore optimally using their senses. Therefore, students will be able to link the conditions that exist around them with mathematics learning. Research given the code M17 was research by Radovic et al. 2020. The system of two-variable linear equations was the material listed in the textbook they had developed [38]. The textbook they had developed consists of an introduction, textbook instructions, table of contents, competencies, learning activities, competency tests, *bibliography*, and answer keys. The learning activity consists of two units. Each unit refers to the principle of a *contextual approach*. There are seven principal components of the *contextual approach*, namely *constructivism*, finding, asking, learning society, modeling, reflection, and actual assessment. This textbook has not been developed to guide students in developing other abilities apart from their *cognitive* abilities. Furthermore, the research given the M18 code was the research conducted by Lim et al. in 2020. *Statistical* material was the material they chose to include in the e-book they develop [39]. The content of the *statistical* material in this e-book is suitable for use in statistics learning. Because it has a relationship between the material used and the basic competencies learned by middle-level students and is in accordance with the 2013 Curriculum applied in Indonesia. However, the e-book that was developed focuses on *formative* questions. It has not been shown that e-books provide opportunities for students to use all abilities that students have, both physically and psychologically. This ability will be used to build new knowledge in mathematics learning. Research with code M19 was Lapawi and Husnin's research in 2020. In the development of the module they chose 'matter' as the topic of discussion [40]. The effectiveness of this developed module was an effective step to increase achievement in science and therefore it must be applied in learning Science, Technology, Engineering, and Mathematics to solve complex problems. The modules they used focus on *Computational Thinking (CT)* and have not provided opportunities for students to relate learning to the realities that exist in the students' social environment. Furthermore, the research given the M20 code was carried out by Lagos in 2020. Lagos chose *exponential and logarithmic functions* as the subject in the module development it was doing [41]. This developed module has a high involvement index; the communication index is outside the acceptable range; and the module level is college. This developed module has not provided the opportunity for students to take full advantage of students' physical and psychological abilities in the implementation of learning.

Research with code M21 was the research of Setiyani et al. in 2020. In the module development carried out by Setiyani et al., *relations and functions* are selected as the material included in the module [42]. The digital module that Setiyani et al. developed in research according to student needs and act as an alternative source of learning that is not *monotonous*. Validity was based on the evaluation of four validators. And after implementation using digital modules, students respond positively with the developed mathematical knowledge. Some of the obstacles that students experience in using this developed digital module include a lack of focus on what the teacher explains. This is because the modules developed have not provided opportunities for students to build their own knowledge by utilizing the abilities they have. Research with the M22 code was a study conducted by Conradty et al. in 2020. 4-dimensional mathematics was a discussion topic listed in the modules

used in the research of Conradt et al. [43]. This module provides a *social environment* that fosters creativity in which students imagine, explores, experiment, test, manipulate, and speculate. The module used has not provided opportunities for students to interact with each other as well as conducting discussions both *face-to-face and online*. The research given the M23 code was research conducted by Dinh and Nguyen in 2020. *Science, Technology, Engineering and Mathematics (STEM)* was the material chosen to be included in the module they were developing [44]. Vietnam's new *K12 textbook series* shows that *STEM-related* subject content had been given more attention and was designed with more *STEM* activities. However, the module used only focuses on *STEM* activities and does not pay attention to the social environment that affects student learning styles. Research with code M24 was Lee and Lim's research in 2020. *Algebra* was the topic they chose to include in the module used in their research [45]. A learning module implemented in basic mathematics which was intended to lead students to a better understanding. It was about the nature and use of *constructive formative feedback*. And it gave them the opportunity to use this understanding in revising their initial feedback on students' *hypothetical* work. The implemented module only focuses on feedback. So this requires a longer allocation of time in its implementation. And not all mathematics concepts or materials can be applied to learning. The last was research given the M25 code, namely research by Biccard in 2020. *A mandatory mathematics* was a topic discussed in the module used in Biccard research [46]. The results of Biccard's research found that students' knowledge and development of mathematical *pedagogy* can be improved through problem-solving learning which was summarized in a module. However, the modules used in problem solving learning have not provided opportunities for students to carry out activities that are able to characterize their affective domains. Based on the content analysis from some of the research results mentioned above, it appears that this study has contributed to the development of modules that can be more optimally utilized in mathematics learning.

#### IV. CONCLUSION

After conducting a *meta-analysis*, it was found that: The features contained in the mathematics “modules, e-modules, text books, and e-books” used and developed in several studies have some similarities. It's just that the content listed in it has several differences. Based on the results of the content analysis, it showed some weaknesses of the mathematics “modules, e-modules, text books, and e-books” that had been developed. So, an improvement is needed to develop a mathematics module that can be used more optimally. The development of the latest mathematics module can consider activities that really involve most of the senses that students have empirically. Therefore, the learning given will be easy to stick inside students selves.

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