Effectiveness of E-Modules in Mathematics Learning in Junior High School: A Systematic Literature Review

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Abstract. This study aims to identify and analyze publications on the effectiveness of E-modules in learning mathematics in junior high schools based on research journal articles in the last five years, from 2019 to 2024. The systematic literature review method was used with the guidance of the PRISMA diagram. Data were obtained from 246 articles from ERIC, Scopus, and Sinta databases. After screening, 11 articles were found that met the criteria as samples. The findings of this study indicate that E-modules are effective in learning mathematics in junior high school. The characteristics of E-modules include aspects of self-instruction, self-contained, stand-alone, adaptive, user-friendly, interactive, and self-regulated. Mathematical skills or knowledge that are often researched are learning outcomes. Future research should investigate the effectiveness of E-modules in other mathematics skills or knowledge.

INTRODUCTION

Maths is very important in various aspects of life [1]. The study of mathematics encourages the development of systematic, scientific, logical, and critical thinking skills, which can subsequently enhance creativity [2]. Its usefulness can help students solve various problems in everyday life. [3]. In the global education curriculum, mathematics is given space to be included in the scope of education [4]. However, several challenges are often encountered in learning mathematics, including difficulties in understanding abstract mathematical concepts and the need for students to be more motivated in learning mathematics [5]. Therefore, to achieve optimal mathematics learning objectives, effective and efficient strategies are needed in learning, one of which is using the right learning media [6].

The mathematical characteristics of junior high school students in solving mathematical problems can be observed through visual representations. These characteristics are influenced by the perception of the problem, the actualization of information by analogy according to what people think, and the activity involving body movements (sensory-motor) [7]. Learning mathematics is often still considered difficult by most students. This is due to several factors, such as difficulties in understanding concepts and the methods used by educators are less understandable. In addition, students often feel bored due to a lack of interaction and minimal use of technology.

The use of media in learning has led to a high trend of research and development of learning media, ranging from traditional learning media to media, starting to integrate Information and Communication Technology (ICT) in its development [8]. Learning media is divided into visual, audio, and audio-visual media. [9]. Various types of learning media can help students understand various mathematical concepts better and more effectively through visual, interactive, and multimedia representations [10]. In addition, learning media can also increase students' motivation to learn mathematics by providing a more interactive and enjoyable learning experience, by using this learning media can improve students' mathematics learning achievement both individually and in groups [11]. Learning media can also develop mathematical cognitive abilities, including mathematical problem-solving, mathematical understanding, mathematical communication, mathematical critical thinking, mathematical representation, mathematical reasoning, and spatial ability [5, 12].

The use of digital technology has an effective impact on learners, namely fostering learning achievement [13]. This statement is aligned with Cozad and Riccomini [14] It is a tool that can advance learners' academic performance.

Learning through technology can have a profound impact on learner motivation in the classroom and plays an important role as a facilitator, motivator, and communicator in the search for knowledge [15]. Thus, it is necessary to have technology and information-based learning materials that support students in learning. The availability of teaching materials plays an important role in the learning process [16]. One of the teaching materials is the E-Module (Electronic Module). In terms of presentation, an e-module is a systematically organised transfer from printed to electronic form that serves independent learning in a way that requires learners to practice solving problems independently [17]. E-modules are modules in digital format, which contain text, images, or both, containing digital electronic material with relevant replication to support the learning process [18]. According to Budiarti *et al* [19] Learning by using E-Modules will bring creativity, be productive in thinking, and create an intense, efficient, progressive, and interesting atmosphere. Therefore, the application of E-Modules is essential in supporting the teaching process. This agrees with the explanation by Astalini *et al.* [20] The mathematics E-modules produced can increase students' perseverance in learning mathematics.

With the various benefits and trends of E-Module research that have been described, it is necessary to review the literature and discuss the effectiveness of E-Modules in mathematics education in learning mathematics more deeply. SLR research into the E-Module approach in specific mathematics education has been conducted by Hidayatulloh [21] On Problem-Based Learning media and research by Aulia & Prahmana (2022). However, we have not found any SLR research that addresses the effectiveness of E-Modules in mathematics education in junior secondary schools. Therefore, this article aims to provide a comprehensive review of the role of E-Modules' effectiveness in mathematics education in junior secondary schools. Through this systematic review, the aim is to analyse the effectiveness of E-Modules in mathematics learning in junior secondary schools and provide literature based on the answers to the research questions (RQ) defined below. However, we have not found any SLR research that addresses the effectiveness of E-Modules in mathematics education in junior secondary schools. Therefore, this article aims to provide a comprehensive review of the role of E-Modules' effectiveness in mathematics education in junior secondary schools. Through this systematic review, the aim is to analyze the effectiveness of E-Modules in mathematics learning in junior secondary schools and provide literature based on the answers to the research questions (RQ) defined below.
RQ1: Is E-Module in learning mathematics in junior high school effective?
RQ2: What are the characteristics of E-modules related to learning mathematics in junior high school?
RQ3: What are the mathematical skills or knowledge enhanced through the E-Module?

METHOD

The methodology employed in this study was that of a systematic literature review. This approach was undertaken to address the research questions. [22]. The research was carried out using (1) a literature search and selection procedure, (2) analysis and synthesis, and (3) quality evaluation, all of which will be detailed in turn below. The databases used were ERIC, Scopus, and Sinta. The keywords used in a literature search on ERIC and SCOPUS used the keywords "e-modules in learning mathematics, digital modules in learning mathematics, electronic modules in learning mathematics. E-modules for teaching mathematics. Digital modules for teaching mathematics, electronic modules for teaching mathematics". Whereas in SINTA, using the keywords "E-Modules of Mathematics," "Digital Modules of Mathematics," and "Electronic Modules of Mathematics," the search resulted in a total of 252 articles. Additionally, use filters to refine the search: (1) The review procedure; and (2) The type of document: a journal article (written or published). The study also removed duplicates, resulting in 246 articles. The data collection was further refined using four inclusion and exclusion criteria, as indicated in Table 1.

Applying 19 of the 246 full-text articles that met the inclusion criteria were kept. Eleven items were available; however, eight of them could not be accessed. A flowchart of the PRISMA-recommended literature search and selection procedure is displayed in Figure 1[23]. This research A narrative approach was employed for the analysis of the data. The initial stage is to undertake a case analysis, with the article itself serving as the unit of analysis. [24]. The following components of a schematic analysis that was performed on the articles were included: (1) Overview data (nation, subject matter expertise in mathematics, research design, number of subjects, conditions sampled, activities in intervention and control conditions, dependent and independent variables, tools, and outcomes); (2) E-module efficacy (RQ1); (3) E-module features and implementation (RQ2); and (4) Features of the junior secondary school students being studied (RQ3), according to Sterne et al. [25] Focus only on categories relevant to educational research. This research assesses actual quasi-experiments and controlled quasi-experiments in terms of (1) the randomization process, (2) missing data results, (3) outcome measurement, and (4) the selection of reported results.

TABLE 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
E-module usage	This article focuses on the use of e-modules to support the learning process.	This article does not focus on the use of e-modules, e.g. using e-modules in the pre and post-test periods, but not as part of an intervention; not to support or stimulate the learning process of students.
Mathematics domain	This article focuses on stimulating the development of students' mathematical competencies through the use of e-modules.	This article does not focus on the mathematics domain. Instead, it examines the impact of mathematics intervention on the development of other content domains in the control condition.
Education in junior high school	The article discusses education in junior high school.	This article discusses education at other levels, such as higher education preschool education (e.g., teacher training), or adult education.
Design of true experimental studies or quasi-controlled experiments	Articles report actual experimental studies or quasi-experimental controlled studies.	Reviews, meta-analyses, theoretical papers, case study, multiple baselines or multiple investigations, correlation, and descriptive

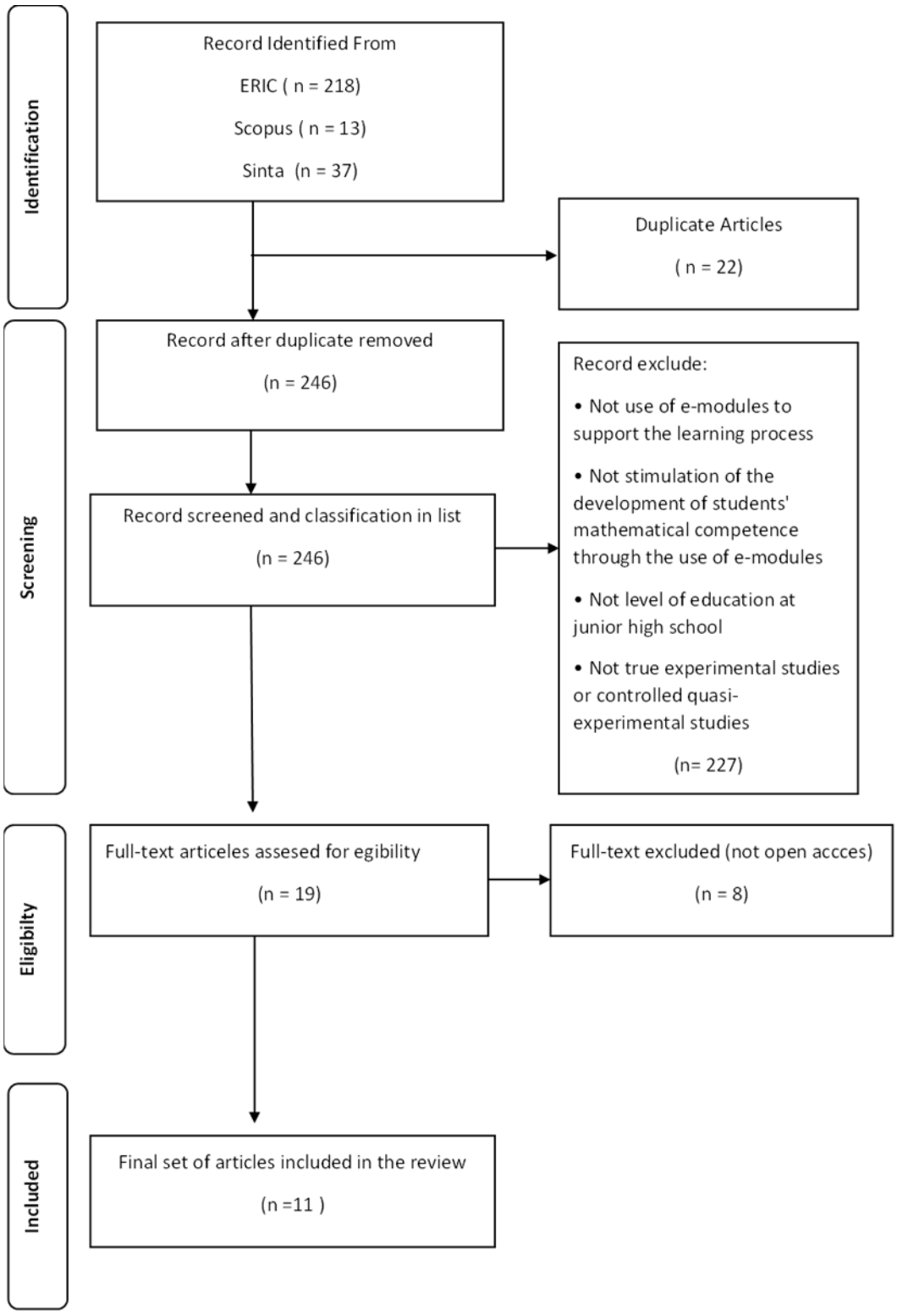

FIGURE 1. Prisma diagram of the article selection process

RESULTS

RQ1: Are E-Modules in learning mathematics in junior secondary school effective?

The results of the research data included in this literature review are analyses and summaries of documented articles related to the effectiveness of E-Modules in learning mathematics in junior secondary schools, presented in Table 2. The results of the research data included in this literature review are analyses and summaries of documented articles related to the effectiveness of E-Modules in learning mathematics in junior secondary schools, presented in Table 2.

TABLE 2. Effectiveness of E-Modules

Code	Author	Article Title	Journal	Sample	Statistical Method	Effectiveness Measures
A1	[26]	Pengembangan E-Modul Matematika pada Materi Perbandingan Berbasis Android	Jurnal Cendekia: Jurnal Pendidikan Matematika	20 students	Percentage of Completion	Effective
A2	[27]	Pengembangan Modul Digital Matematika Dengan Menggunakan Flip Pdf Corporate Edition	EMTEKA: Jurnal Pendidikan Matematika	32 students	Percentage of Completion	Effective
A3	[28]	Self-regulated learning-based digital module development to improve students' critical thinking skills	Al-Jabar: Jurnal Pendidikan Matematika	40 students (control class) and 36 students (experimental class).	t-test	Effective
A4	[29]	Modul Berbasis Realistic Mathematics Education Berbantuan Qr Code Untuk Memfasilitasi Kemampuan Berpikir Kritis Siswa Smp	AKSIOMA: Jurnal Program Studi Pendidikan Matematika	Three students (Small-scale trial) and 12 students (Large-scale trial)	Percentage of Completion	Effective
A5	[30]	Pengembangan e-modul matematika berbasis Open Ended pada materi sistem persamaan linear dua variabel kelas VIII	AKSIOMA: Jurnal Program Studi Pendidikan Matematika	25 students	Percentage of Completion	Effective
A6	[31]	Pengembangan E-Modul Berbasis Problem Based Learning Untuk Memacu Kemampuan	AKSIOMA: Jurnal Program Studi Pendidikan Matematika	30 students	Uji paired sample t- test	Effective

		Berfikir Kritis Abad-21				
A7	[32]	Pengembangan Modul Digital Berbasis STEM untuk Mengembangkan Kemampuan Pemecahan Masalah	Edumatica: Jurnal Pendidikan Matematika	NA	average score	Effective
A8	[33]	Efektivitas E-Modul dengan Flip Pdf Professional Berbasis Gamifikasi Terhadap Siswa SMP	Jurnal Pendidikan Matematika Raflesia	10 students (Small-scale trial) and 20 students (Large-scale trial)	Effect size	Effective
A9	[34]	Efektivitas E-Modul Berbasis Flip PDF Professional Terhadap Pemahaman Konsep Peserta Didik SMP	Jurnal Review Pendidikan dan Pengajaran (JRPP)	22 students (control class) and 21 students (experimental class).	Independent Sampel T- test dan uji effect size	Effective
A10	[35]	Efektivitas E-Modul Model Pembelajaran Problem Solving pada Pelajaran Matematika	Jurnal Cendekia: Jurnal Pendidikan Matematika	NA	Uji paired t - test	Effective
A11	[36]	The Effectiveness of Mathematics E-Modules with a Contextual Approach on Geometry Matters to Improving Students' Learning Outcomes	JPI: Jurnal Pendidikan Indonesia	Five students (Small-scale trial) and 20-30 students (Large-scale trial)	Inferential statistics	Effective

RQ2: What are the characteristics of E-modules related to learning mathematics in junior high school?

Module characteristics according to Depdiknas [37] Includes self-instructional, self-contained, stand-alone, adaptive, and user-friendly.

TABLE 3. Characteristics of E-Modules

Number	Characteristics	Code Paper
1	Self-instructional	A1A2A4A6A7A9A10
2	Self-contained	A1A2A4A5A11
3	Stand alone	A2
4	Adaptif	A2A11
5	User Friendly	A1A2A5A7A8

RQ3: What are the mathematical skills or knowledge enhanced through the E-Module?

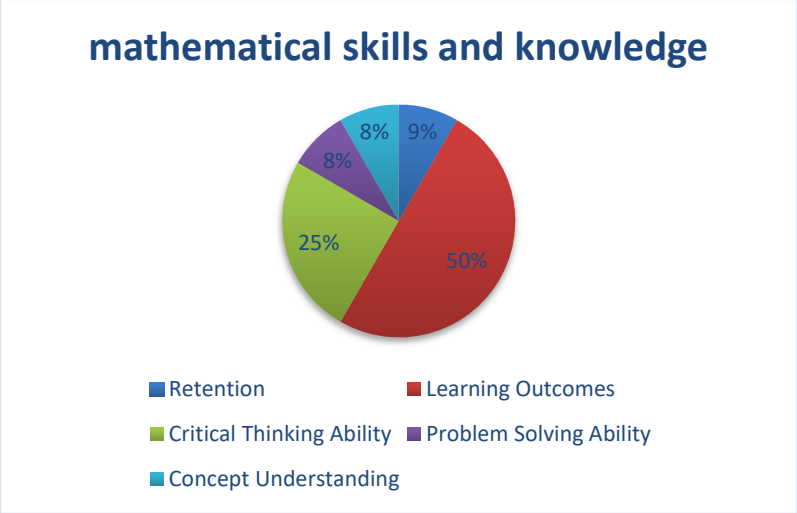

FIGURE 2. Pie chart of mathematical skills and knowledge

DISCUSSION

The initial cohort of media comparison studies (n=6) sought to ascertain the efficacy of e-modules utilizing disparate media. All six of these studies compared the effectiveness of e-modules with non-e-module media (e.g., e-modules with conventional) #A3#A4#A8#A9#A10#A11. The first subgroup showed that the e-module intervention was more beneficial for improving students' mathematical knowledge or skills than instruction using non-e-module media. The second subgroup of the e-module implementation study (n=5) explained the use of e-modules by comparing using pretest and posttest #A1#A2#A5#A6#A7. The subgroups showed an increase in students' mathematical knowledge or skills after the implementation of e-modules in learning.

Based on Table 3, the characteristics of E-modules obtained and related to learning mathematics in junior high school are E-modules that contain several aspects such as *self-instruction, self-contained, stand-alone, adaptive,* dan user-friendly *in* line with the opinion of Khoiriyah et al. [27] Aspects of e-module development include self-instructional, self-contained, stand-alone, adaptive, and user-friendly. Meanwhile, according to Kusmaharti & Yustitia [28], The following traits are displayed by the digital module, which was created using the principles of self-regulated learning: (1) Self-regulated learning-based digital modules include fundamental competencies, core competencies, and unambiguous signs of competence attainment. (2) The Independent Curriculum's requirements are met by creating digital modules based on self-regulated learning. (3) Has an internal Four: allowing students to build their knowledge through self-regulated learning using digital modules; (5) starting the content presentation with real-world occurrences and challenges (7) encouraging students to think critically-modules are a useful tool for learning since they are not limited to writing; they can also be combined with audio, video, and motion animation to create engaging interactive learning materials that prevent learning from becoming boring [30].

Based on Figure 2, the mathematical skills or knowledge improved through E-Modules are retention, critical thinking ability, problem-solving ability, concept understanding, and learning outcomes. The mathematical skills or knowledge that are improved through E-Modules that are most widely used in research are learning outcomes of 50%, critical thinking skills of 25%, retention of 9%, and problem-solving skills and understanding of concepts of 8%.

CONCLUSION

This study concludes that E-modules are effective in learning mathematics in junior high school. The defining characteristics of E-modules are as follows: self-instruction, self-contained, stand-alone, adaptive, and user-friendly. Mathematical skills or knowledge that are often researched are learning outcomes. Future research should investigate the effectiveness of E-modules in other mathematics skills or knowledge. The limitations of this study only discusses

research with experimental methods and junior high school level. As the findings of the article are limited, to deepen the findings of the importance of e-modules in mathematics skills can be continued by using quantitative research references.

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