THE DEVELOPMENT OF STEM-BASED SCIENCE MODULE: A SYSTEMATIC LITERATURE REVIEW

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Abstract

This research was conducted in order to analyze literature related to STEM-Based Module Development. The purpose of this research is to select articles that are worthy of analysis related to STEM-Based Module Development. The benefit of this research is to facilitate researchers in obtaining proper literature to be analyzed related to the title of the research to be conducted by researchers. The method of this study is using the PRISMA method, which is a method that has steps consisting of identification, screening, eligibility and inclusion. This research was conducted to analyze the literature related to STEM-Based Module Development. The purpose of this research is to select articles that are worthy of analysis related to STEM-Based Module Development. The benefit of this research is that it makes it easier for researchers to obtain the right literature to be analyzed related to the title of the research that will be carried out by researchers. This research method uses the PRISMA method, which is a method that has steps consisting of identification, screening, eligibility and inclusion. Based on the literature review of 3 scientific articles, it can be concluded that the method used in the research was development research (R&D) with 3 articles, with different models, namely 2 rnd articles with 4D mode, 1 article the ADDIE model. most of the previous research carried out module development for classroom learning up to the implementation stage. In previous research also suggested that for further research it is hoped that researchers will increase more research related to STEM-Based Modules.

Keywords: Stem-Based, Systematic Literature Review

Abstrak

This research was conducted in order to analyze literature related to STEM-Based Module Penelitian ini dilakukan untuk menganalisis literatur terkait Pengembangan Modul Berbasis STEM. Tujuan dari penelitian ini adalah untuk memilih artikel yang layak dianalisis terkait Pengembangan Modul Berbasis STEM. Manfaat dari penelitian ini adalah memudahkan peneliti dalam memperoleh literatur yang tepat untuk dianalisis terkait dengan judul penelitian yang akan dilakukan oleh peneliti. Metode penelitian ini menggunakan metode PRISMA, yaitu metode yang memiliki langkah-langkah yang terdiri dari identifikasi, penyaringan, kelayakan dan inklusi. Penelitian ini dilakukan untuk menganalisis literatur terkait Pengembangan Modul Berbasis STEM. Tujuan dari penelitian ini adalah untuk memilih artikel yang layak dianalisis terkait Pengembangan Modul Berbasis STEM. Manfaat dari penelitian ini adalah memudahkan peneliti untuk mendapatkan literatur yang tepat untuk dianalisis terkait dengan judul penelitian yang akan dilakukan oleh peneliti. Metode penelitian ini menggunakan metode PRISMA yaitu suatu metode yang memiliki langkah-langkah yang terdiri dari identifikasi, screening, eligibilitas dan inklusi. Berdasarkan tinjauan pustaka terhadap 3 artikel ilmiah, dapat disimpulkan bahwa metode yang digunakan dalam penelitian ini adalah penelitian pengembangan (R&D) dengan 3 artikel, dengan model yang berbeda yaitu 2 artikel dengan mode 4D, 1 artikel model ADDIE. sebagian besar penelitian sebelumnya melakukan pengembangan modul untuk pembelajaran di kelas sampai dengan tahap implementasi. Pada penelitian sebelumnya juga disarankan untuk penelitian selanjutnya diharapkan peneliti lebih memperbanyak lagi penelitian terkait Modul Berbasis STEM.

Kata kunci: *Pengembangan Modul, Systematic Literature Review*

Introduction

The education system in the 21st century does not only prepare knowledgeable students with a good understanding of concepts, but also various skills such as digital literacy, critical thinking, creative, innovative, effective communication as well as spiritual aspect (Sukor et al., 2010). Education system is not only responsible to increase students' skills, but also to obtain the right concept to fulfill the education goals and face the 21st challenges (Pratiwi et al., 2019) (Westerdahl et al. 2020).

The 21st century has been the main base for the aspect of life of all modern humans. The development of the 21st century is characterized by the daily use of technology, communication, and information. Every aspect of life relies on today's technology, changing the skills and abilities of an increasingly competitive workforce (Wulandari & Azka, 2018). The 21st century focuses on the development of the 4.0 industrial revolution era in which knowledge is the main pillar. Internships are expected to expand job opportunities in the 21st century and expand employment opportunities for Indonesians as qualified and superior human resources. The training of talented people requires educators who are willing to teach and educate through 21st century learning and in line with the development of the Industrial 4.0 era (Nisa et al., 2020).

The quality of education in Indonesia is currently very concerning. This is because several problems in the Indonesian education system have caused a decrease in the the education quality in Indonesia (Fadia & Fitri, 2021). For example, weak education administration, the disparity between educational institutions and educational institutions in urban and rural areas, weak government support, outdated community thinking, poor quality teaching documentation, and poor academic standards. These are some of the factors that cause the low education quality in Indonesia (Hidayat & Irwandi, 2022).

Indonesian education curriculum has always been changing all the time. One of solutions that the government does to advance education system is by applying curriculum 2013. The curriculum 2013 for junior high school / madrasah tsanaiyah, in science learning has the aim of emphasizing the remaining experience of the surrounding environment and nature using the scientific method. Science is a learning that is able to involve students in obtaining direct, contextual, and student-centered experiences, so that students can independently discover various concepts related to science subjects (Ainun et al., 2021).

Teaching materials affect the learning process thus it is necessary to choose the right material for the class. There is a strong evidence that the selection of teaching materials has more impact on student learning than teacher effectiveness. Modules as a complete unit of curriculum material can also be combined with the achievement of larger tasks or long-term goals that will greatly assist teachers and students in learning activities (Zulaiha & Kusuma, 2020). A module is a component that has an important role in the learning process. The availability of modules can help students in obtaining information about learning materials. Modules are learning tools or facilities that contain material, methods, limits, and ways to evaluate which are systematically designed and attractive to achieve the expected compotency (Angraini, 2022).

STEM stands for Science Technology Engineering Mathematics. Kelley & Knowles (2016) define STEM as an approach to actually teaching two or more STEM subjects in a practically relevant way to increase students' interest in learning. A STEM approach implemented in schools can teach students that the education they receive is important and can help them deal with current real-world problems and situations (Rizka et al., 2021).

STEM approach is a learning approach used by teachers with a certain systematic to achieve the desired learning objectives in the fields of science, technology, engineering, and mathematics. STEM-based module is a module that has the characteristics of the STEM learning syntax. It aims to make students know the relationship between their knowledge and

its application in real life which can be known by reading, recording, researching, and conducting scientific research (Ainun et al., 2021).

The integration of STEM subjects will be more effective if we take a strategic approach in its implementation. It helps students learn better, stimulates the development of meaningful experiences, helps students think and solve problems at a higher level, and improves retention (Izzah et al., 2021). Establishing a strategic approach to integrate STEM concepts requires a strong conceptual and fundamental understanding of how learners learn and implement STEM (Aguilera, 2021; Diani, 2021). The implementation of STEM-oriented learning trains students in problem solving, renewal, finding/designing innovations, understanding themselves, carrying out logical thinking, and mastering technological elements. The implementation of STEM in learning both used in learning approaches, learning models and embedded in the lesson through teaching materials is widely applied in developing countries (Sari et al., 2022).

STEM-based module is a learning module that integrates related disciplines. Learning in the exact fields of Science, Technology, Engineering and Mathematics can occur through STEM, which is learning between the sciences to learn academic concepts combined with the real world as an application of these fields. In STEM learning, students are required to solve problems, innovate, discover/design new things, understand themselves, do logical thinking and master technology. STEM learning is not very popular, but the integration of various disciplines has begun to appear in the 2013 curriculum (Angraini, 2022).

Mulyasari dan Sholikhah (2021) state that a module development can be used if it is appropriate. The possibility of applying the STEM-based module that is developed based on the expert test, meets the criteria of passing the material test, mass media and evaluation experts. Student responses to the practicality of e-modules are measured by student response questionnaires to STEM-based e-modules on the material of motion (Mulyasari & Sholikhah, 2021). The purpose of the study was to determine the effectiveness of using STEM-based modules and the efficiency of using STEM-based modules for students.

Method

This study uses the SLR (Systematic Literature Review) method with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analysis) model. The steps in the prism method are formulating (identification), systematically searching for literature (screening), filtering or selecting articles that are considered suitable for the researcher's title (eligibility) and analyzing articles that have been selected (included) (Savec & Mlinarec, 2021; Zarate et al., 2022). For the best composition results this report relies on the exploration question (RQ). The research questions (RQs) in this study are summarized in table 1.

Tabel 1. Pertanyaan Penelitian (RQ)

Research Question	Analysis
How does an effective STEM-Based module work?	At this stage, researchers analyzed articles on the development of STEM Modules, how to develop effective media. By looking at the methods and models that are being used.
Is STEM-Based Modul efficient to be applied to the students?	At this stage the researcher analyzes the article regarding how efficient it is to use the module.

Prisma

The study was guided by the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Conducting a PRISMA statement allows a clear research question that enables systematic research to be defined, while inclusion and exclusion criteria can be identified and a large database of scientific literature within a specified time can be examined (Sierra-Correa and Cantera Kintz, 2015). The PRISMA statement allows for a rigorous investigation of terms that relate to scientific creativity in schools and its impact.

Database/Source

In this study, the search series used in the systematic review process utilized databases from google scholar and crossef. It is summarized in table 2.

Table 2. Literature Search Formula

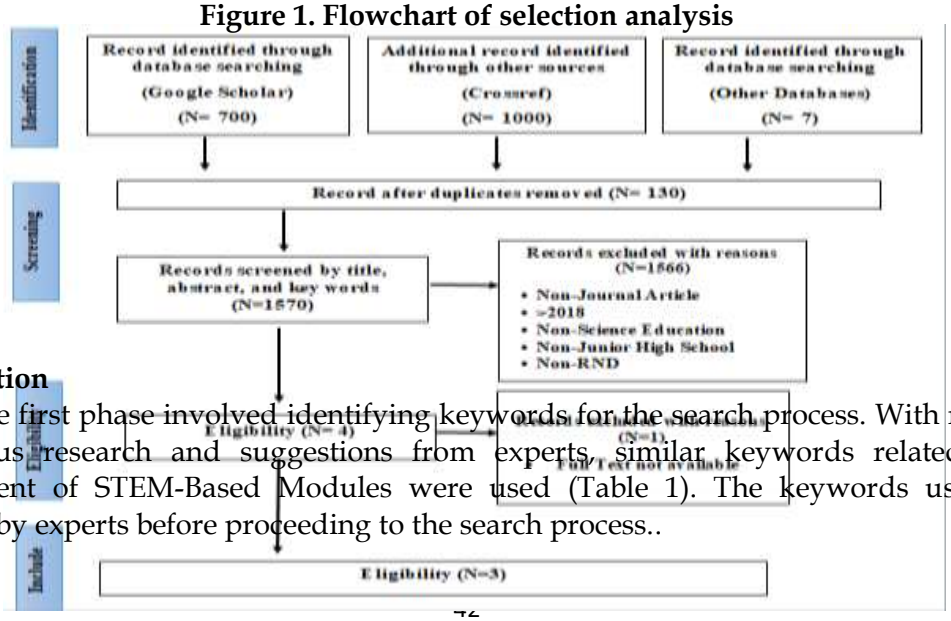
Database	Search String
Google Scholar	Keyword ((“Modul” OR “Modul IPA” OR “Pengembangan Modul” OR “Media Pembelajaran”) AND (“Discovery Learning” OR “STEM” OR ”Sains Technology Engeenering Mathmatics”))
Crossref	Keyword ((“Modul” OR “Modul IPA” OR “Pengembangan Modul” OR “Media Pembelajaran”) AND (“Discovery Learning” OR “Sains Technology Engeenering Mathmatics”))

In this method, there are several criteria in selecting articles that have been searched, namely inclusion criteria and exclusion criteria. Inclusion criteria are literature criteria that are in accordance with the title or purpose of the research conducted, for example, the year of publication of the article (ex: 2019-2023), article language (ex: Indonesian), school (ex: SMP), and others. Exclusion criteria are criteria that do not match the inclusion criteria set by the researcher (Ahmad & Junaini, 2020; Rahman et al., 2021). The following are the inclusion and exclusion criteria in this study.

Systematic Review Process

The review process is conducted in four stages. It consists of several stages, namely identification, screening, and eligibility. The following is the systematic literature review selection flow.

Figure 1. Flowchart of selection analysis



Identification

The first phase involved identifying keywords for the search process. With reference to previous research and suggestions from experts, similar keywords related to the development of STEM-Based Modules were used (Table 1). The keywords used were validated by experts before proceeding to the search process..

Screening

The second stage was the screening stage. At this stage, a total of 1570 out of 1700 articles eligible for review were removed due to inclusion and exclusion criteria (Table 3). First, regarding the type of literature, only journal or journal articles were selected. This indicates that review articles, book series, and books were excluded. Secondly, in terms of time, a period of 5 years (between 2018 and 2023) was selected as it was considered sufficient time to focus on the latest STEM-based Module development research. In addition, this systematic review focused on science subjects taught in schools including biology, chemistry, and physics. Articles focusing on other domains or subject-specific creativity such as art, mathematics, history, Indonesian language, and computer science were effectively excluded.

Table 3. Inclusion and Exclusion Criteria

Criterion	Eligibility	Exclusion
Literature Type	Journal (Research Article)	Journal (Systematic Review), Book Series, Book, Chapter in Book
Languange	Indonesia, English	Non Indonesia, Non English
Timeline	2018-2023	< 2018
Subjects	Science	Mathematic, PAI, Sejarah, Bahasa Arab, Bahasa Indonesia, Hukum Pidana, Akutansi, Manajemen, Geografi, Kewirausahaan
Research Respondent	School Students (Middle)	Teacher, University Student, School Student (Elementary and High School)
Design Riset	Rnd	Non Rnd
Open Acces	Full Text	Hanya Abstract

Eligibility

The third stage was eligibility where the full article was accessed. Several criteria of eligibility and exclusion were determined for this review. After a careful check, a further 5 articles were excluded as they were not relevant in content, methodology, or findings. The final stage resulted in a total of 5 articles being selected and used for in-depth analysis (Fig. 1). The remaining articles were assessed and analyzed. Careful and concentrated effort and attention were devoted to specific studies that addressed the formulated research questions.

Data Analysis

The remaining articles were assessed and analyzed. The attempts were centered on specific studies that answered the formulated questions. Data was extracted by reading the abstract first, followed by the full article (in-depth) to identify interventions used to enhance the development of Guided Inquiry-Based E-Modules.

Result and Discussion .

Based on the systematic literature review that has been carried out, articles that are worth analyzing are obtained. The articles taken are articles that contain the development of STEM-Based Modules. The following table 4 presents the analysis of the article

NO	Writer	Title	Year	Journal Title	Link

1.	Dinda Ainun, Pramudya Dwi Aristya Putra, Aris Singgih Budiarso	Pengembangan Modul Berbasis STEM (Science, Technology, Engineering, And Mathematics) Pokok Bahasan Alat-Alat Optik Dalam Pembelajaran IPA Di SMP	2021	Jurnal Literasi Pendidikan Fisika (JLPF)	http://dx.doi.org/10.30872/jlpf.v2i2.608
2.	Fitri Diana Sari, Dyah Ayu Fajarianingtyas, Anik Anekawati	Pengembangan Modul Ipa Stem Materi Cahaya Dan Alat Optik Kelas Viii Smpn 2 Kalianget	2022	LENSA (Lentera Sains): Jurnal Pendidikan IPA	http://dx.doi.org/10.24929/lensa.v12i1.185
3.	Ida Irmawati, Syahmani Syahmani, Ratna Yulinda	Pengembangan Modul IPA Pada Materi Sistem Organ Dan Organisme Berbasis STEM-Inkuiri Untuk Meningkatkan Literasi Sains	2021	Journal of Mathematics Science and Computer Education	http://dx.doi.org/10.20527/jmscedu.v1i2.4048

Based on the 3 literatures generated from the prism flow stage, there are observations in the field containing statements that there are no attractive and characterful module teaching materials and the modules used are not yet oriented towards a multi-disciplinary approach, namely the concept of the material taught is adjusted and combined with real life based on technological developments. Curriculum 2013 emphasizes that students can solve the problems of everyday life. By solving these problems, students will tend to improve their problem-solving skills and develop an argument and draw conclusions (Ainun et al., 2021).

STEM integrated learning can be a solution to support the achievement of science learning competencies. This learning can help students solve a phenomenon problem by applying through science, technology, engineering and math elements. Learning with this approach helps students apply the knowledge they learn to real life. The purpose of this learning can generate students who have the competence to master knowledge, so as to improve student learning outcomes. The results of observations show that students need independent teaching materials as a companion to school textbooks. This research develops independent teaching book products in the form of STEM modules so that students can identify and solve problems mathematically with the application of the STEM approach (Sari et al., 2022).

The aspects that are reviewed in the assessment are the format of the module, language, module content, presentation and benefits/usability of teaching materials which aim to measure the validity level of the module developed with language that is easy to understand in accordance with the rules of the General Guidelines for Good Indonesian Spelling with the content of organ systems and organisms based on STEM-based concepts and facts with an attractive presentation so that the module can be used as a guide for educators and students in learning, both in groups and independently. Based on the results of the percentage of agreement, this module shows a percentage of "very good" and an α value with "high reliability" criteria, meaning that each validator's assessment of the module does not have a large difference (Irmawati et al., 2021). Although the number and quality of Indonesian graduates with STEM skills is still low, the demand for a 21st century labor force skilled in STEM subjects is high. Education can be innovated to meet 21st century education standards and prepare a global workforce, including by integrating STEM approaches into learning. Graduates with STEM competencies are considered more competent and have high problem-solving abilities. With STEM expertise, the future workers are better prepared to do their jobs (Anggraini & Huzaifah, 2017).

Conclusion

Based on the literature review from the three articles above, it can be concluded that the method that was being used in the research is Research and Development study (R&D) with three articles, two articles use rnd with 4D mode and one article uses ADDIE. Most of previous researches do the module development for the learning process in the class until it reaches the implementation phase. In the previous research, it suggests that the next research will do a lot of research related STEM-based module.

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