Development of E-Module Based on Mathematical Literacy Skill in Statistical Materials

Shindy Amelia Efendi[1], Yulia Haryono[1], Anna Cesaria[1*]

[1]Mathematics Education, Sains and Technology, Universitas PGRI Sumatera Barat, Indonesia

Email Correspondence: annacesaria13@gmail.com

ARTICLE INFO	ABSTRACT
	This research aims to produce an E-Module with math literacy-based questions that are valid and practical for 10th-grade statistics in SMA Negeri 3 Padang. The type of research conducted is development research using the ADDIE development model. Data analysis techniques include interview analysis, E-Module validation analysis, and E-Module practicality analysis. The results of the research show that mathematics learning using the E-Module, which facilitates mathematical literacy questions, is both valid and practical. Based on the data analysis, it was found that the developed E-Module had a validity score of 92.31%, categorized as highly valid. The final practicality score for teachers was 85%, categorized as highly practical, and the final practicality score for students was 88.26%, also categorized as highly practical.

1. Introduction

Mathematics is a fundamental subject that plays a crucial role in human life and the advancement of science and technology (STEM). It serves as the foundation for all fields of knowledge dealing with abstract concepts. Therefore, the presentation of mathematical materials in education is often linked to everyday life, with the aim of enabling students to discover concepts and develop their mathematical skills based on their experiences and existing knowledge (Agustina, 2019). Learning mathematics is one of the means to foster scientific and logical thinking and is essential in efforts to enhance the quality of human resources (Maghfiroh & Rohayati, 2020).

The concept of a free curriculum becomes intriguing in the context of technological advancements and skills needed in the 21st century. Students are

required to acquire various 21st-century skills, abbreviated as 4C: critical thinking and problem solving, creativity, communication skills, and the ability to work collaboratively (Andiani et al., 2020). One of the fundamental aspects considered in the development of a free curriculum is mathematical literacy. The goal is to help students develop mathematical ideas in their everyday lives and solve contextual problems, making mathematics education more meaningful for students.

The results of mathematical literacy skills among students at SMA N 3 Padang in the topic of statistics are generally considered low and moderate. This is because most students fall into levels 2 and 3. Level 2 represents basic mathematical abilities, including communication, mathematization, and representation. Level 3 includes advanced mathematical skills such as communication, mathematization, representation, reasoning, and the use of mathematical tools. There are still some students at level 1, indicating limited mathematical abilities focused on communication and representation. However, some students have reached level 4, where they have fulfilled all basic mathematical skills, including communication, mathematization, representation, reasoning, problem-solving strategies, the use of operations and symbolic language, formal language, technical language, and the use of mathematical tools (Afrilina et al., 2022).

The low level of students' mathematical literacy skills is due to learning obstacles that occur in students (Jelvindo et al., 2022). Learning obstacles are divided into three factors: mental readiness to learn (obstacle of ontogenic origin), teacher education and teaching system (obstacle of didactical origin), and limited student knowledge (obstacle of epistemological origin) (Cesaria dan Herman, 2019).

The level of mathematical literacy among students at SMAN 3 Padang shows consistent results between the studies conducted (Jelvindo et al., 2022) and (Afrilina et al., 2022). The learning barriers identified among students with varying levels of mathematical literacy include ontogenic obstacles, where students at literacy levels 1 to 4 commonly struggle due to a lack of understanding of prerequisite materials. Didactical obstacles are also prevalent among students with mathematical literacy levels 1 to 4, as they often face challenges associated with incomplete coverage of the curriculum by their teachers. Additionally, epistemological obstacles are frequently observed in students with mathematical literacy levels 1 to 4, as they tend to struggle with incomplete conceptual comprehension of the subject matter (Jelvindo et al., 2022).

However, there are several issues identified in the learning process. One key problem is that the focus is not placed on understanding the correct concepts and problem-solving methods; rather, it often centers solely on obtaining the correct answers. This issue can be attributed to students' limited grasp of mathematical concepts, a tendency to rush through assignments, difficulty determining the principles or formulas to apply, and a habit of not providing detailed responses to questions. As a result, students frequently struggle when presented with different problems by their teachers. Additionally, students are not accustomed to solving mathematical problems by applying standard mathematical problem-solving processes, which could guide them in effectively addressing mathematical challenges.

Another challenge is that students often encounter confusion when

reading data presented in the form of diagrams, tables, and graphs during statistics lessons. This is largely due to inadequacies in the learning materials provided to students. While students are required to have only one printed curriculum book, some students with strong mathematical abilities possess two different printed curriculum books. Consequently, other students rely solely on the printed curriculum book and explanations from their teachers. According to students, the printed curriculum book is difficult to understand because it lacks completeness in its content and uses formal language. Furthermore, the Learning Activity Sheets (LKPD) provided to students only cover specific subtopics and lack comprehensive explanations. These challenges highlight the need for improved teaching methods and learning materials in the statistics curriculum to enhance students' understanding and proficiency in mathematical literacy.

The concept of "merdeka belajar" aims to improve educational access and services through infrastructure improvements and technology-based education. The use of learning media as a support for the learning process is one of the advantages of technology in education. Learning media is a tool used to convey and deliver messages to users in order for them to engage in planned learning processes efficiently and effectively. This generates a favorable learning environment, allowing students to grasp the subject more quickly and pique their interest in further study (Purba & Harahap, 2022).

One of the most effective, efficient, and student-centric media is the E-Module. Modules are considered self-directed learning tools because they come with instructions for independent learning. This means that students can engage in learning activities on their own without the direct presence of an instructor. Based on research conducted (Yunus et al., 2022), the development of E-Modules enhances students' self-directed learning and leads to effective learning outcomes even before formal interventions are introduced.

Recognizing the issues at hand, the researcher was motivated to develop electronic instructional materials known as E-Modules. There are various software options available for creating E-Modules, and one of them is Flip PDF Professional. Flip PDF Professional is reliable software designed to convert PDF files into digital flip publications, making them visually appealing and resembling a physical book. Flip PDF Professional offers several advantages, including its user-friendly interface and the ease of operating the final product it generates. It can be published offline, allowing it to run on computers, and it can also be uploaded online, enabling access on smartphones. This accessibility makes Flip PDF Professional a viable option for individuals who may not be familiar with HTML programming languages (Seruni et al., 2019).

The research conducted aligns with previous studies on developing E-Modules using *Flip PDF Professional*, as demonstrated (Meliana et al., 2022). However, this research expands on that by utilizing nearly all the features available in Flip PDF Professional. Consequently, the E-Modules developed in this study incorporate audio, video, quizzes, and interactive elements, making them even more engaging. Moreover, accessing and using these E-Modules is not complicated, as they are published online and can be accessed on both smartphones and computers with a reliable internet connection.

Based on the background mentioned above, the author is considering the development of teaching material that can be used in a valid and practical

learning process. This material will take the form of an E-Module development that facilitates mathematical literacy-based questions.

2. Method

This research was conducted at SMAN 3 Padang and aimed to develop an E-Module based on mathematical literacy skills for the subject of statistics. The research subjects included 12 students in phase E for small group testing. Phase E represents the level of competence of each student in the context of an independent curriculum designed for 10th-grade students in high school or equivalent (SMA/SMK). The research methodology used in this study is research and development (R&D), employing the ADDIE development model. The ADDIE model consists of five stages, which are:

2.1. Analyze

In this stage, the research team conducts two activities: field studies and literature reviews (Rayanto & Sugianti, 2020). Field studies involve examining issues in the learning process, learning objectives, student capabilities, student characteristics, teaching implementation, and learning outcomes. Literature reviews involve relevant studies, the analysis of textbooks, and the analysis of student worksheets (LKPD). After collecting data, self-evaluation is performed to refine the analysis results.

2.2. Design

Self-evaluation and refinement of the framework design involve creating a storyboard and initial interface using the analyzed software and providing mathematical literacy-based questions. In the product design phase, the process begins with creating the cover and introduction using Canva. Subsequently, various components like learning activities, summaries, bibliographies, glossaries, and biographies are developed using Microsoft Word. Additionally, supplementary elements, such as quizzes and feedback presentations, instructional videos, and interactive buttons, are incorporated using the Flip PDF Professional application before the digital publication in PDF format. During this stage, the development of assessment instruments for validation sheets is also carried out, which are reviewed by experts.

2.3. Development

Further development is based on the initial design, which includes creating practical instruments and validating the development results through expert reviews, including content validators, subject teachers, and media validators. This revision process ensures that the final product is valid. The output product is in the form of HTML5 or Flash files.

2.4. Implementation (Implementasi)

After validation, the implementation phase tests the practicality of the product. Limited testing is conducted with students and teachers to determine its practicality.

2.5. Evaluation (Evaluasi)

Evaluation in this research is primarily formative, focusing on improving the development product through validation and practicality testing.

The data types in this study include qualitative and quantitative data. Qualitative data in this research are derived from field observations and interviews conducted with teachers and students, while quantitative data are collected from validation sheets and practicality questionnaires. Data analysis techniques for assessing validity and practicality involve the use of a Likert scale. The validity of the data obtained from the validators is calculated using the following formula:

$$Validity\ value = \frac{Number\ of\ scores}{Maximum\ score} \times 100\% \tag{1}$$

The level of validity of the E-Module developed is interpreted using the following criteria in Table 1 below.

Table 1. E-Module Validity Category

Precentage (%)	Criteria
$0 \leq NV \leq 20$	Invalid
$20 < NV \leq 40$	Not valid
$40 < NV \leq 60$	Fairly valid
$60 < NV \leq 80$	Valid
$80 < NV \leq 100$	Very valid

Source: modified from (Riduwan, 2010)

The selection of research subjects is based on the students' level of ability, as categorized in Table 2 below.

Table 2. Category Of Practical Subjects

Value range	Category
$80 \leq x \leq 100$	High
$55 < x < 80$	Average
$0 \leq x < 50$	Low

Source: (Rezky et al., 2022)

The practicality of the E-Module, as assessed by practitioners, is determined by calculating the practicality level of the E-Module using the following formula:

$$Practicality\ value = \frac{Number\ of\ scores}{Maximum\ score} \times 100\% \tag{2}$$

The level of practicality of the E-Module being developed is interpreted using the criteria in Table 3 below.

Table 3. Category Practicality E-Module

Precentage (%)	Criteria
$0 \leq NP \leq 20$	Not practical
$20 < NP \leq 40$	Not practical
$40 < NP \leq 60$	Quite practical

Precentage (%)	Criteria
$60 < NP \leq 80$	Practical
$80 < NP \leq 100$	Very practical

Source: modified from (Riduwan, 2010)

3. Result and Discussion

The final product is the development of electronic-based teaching material, namely the E-Module, which facilitates mathematical literacy-based questions for the topic of statistics. The software used is Flip PDF Professional, which contains content such as a cover, an introduction, learning activities, supporting activities, summaries, final evaluations, and a conclusion. The research development process follows the ADDIE stages, adapted from (Tegeh et al., 2014) and (Puspasari & Suryaningsih, 2019). The results and discussions of the research are described below.

In the **Analysis** phase, efforts are made to obtain information about the issues present in the field through a literature review. Based on the field analysis, which includes the analysis of student characteristics, observation analysis of the learning process, and interviews, it was found that students had difficulty understanding problems, lacked a solid grasp of concepts, rushed through assignments, and struggled to determine problem-solving strategies. Additionally, students often had the misconception that mathematics had no relevance to their everyday lives.

As for the literature analysis, it was found that the teaching materials used by educators in schools included print textbooks and participant worksheets (LKPD). In LKPD, problems were presented directly without accompanying materials to assist participants. Meanwhile, in the textbooks, there were mathematical literacy-based questions, but they lacked variety, and not all of them related to real-life situations. Additionally, based on the analysis of textbooks and LKPD, it can be concluded that the statistics teaching materials are aligned with the Competence Standards (CP). However, the material structure provided does not yet align with the Academic Process Standards (ATP).

This aligns with relevant research findings that the mathematical literacy skills of students at SMA N 3 Padang, specifically in the topic of statistics, are still considered low and moderate, as most students are predominantly at levels 2 and 3. The low level of mathematical literacy skills in students is attributed to learning barriers. Learning barriers identified in students based on their mathematical literacy abilities include ontogenic barriers, which affect students with mathematical literacy levels ranging from 1 to 4, generally because students do not understand prerequisite materials. Didactic barriers are encountered by students with mathematical literacy levels ranging from 1 to 4, primarily because the material taught by teachers is incomplete. Epistemological barriers are also found in students with mathematical literacy levels ranging from 1 to 4, mainly because their understanding of the concepts is incomplete (Afrilina et al., 2022) and (Jelvindo et al., 2022).

Based on the data mentioned above, the researcher decided to develop an E-Module that facilitates mathematical literacy-based questions to make the learning process easier for students. This E-Module with mathematical literacy-based questions presents content related to everyday life, enabling students to easily understand the material. Moreover, it's highly accessible as it can be used

on students' smartphones, making it convenient to carry and access from anywhere.

In the **Design** phase, the researcher prepares reference books related to statistics and mathematical literacy-based questions, constructs the framework for the E-Module, determines the initial interface design, explores the needs, and designs the layout. The instructional material product in question combines text, images, and videos. Some supporting applications used in the design process include Canva and Word, while Flip PDF Professional is used in the publication process to incorporate instructional videos, evaluations, and interactive buttons. The teaching material created is tailored to meet the needs and curriculum requirements.
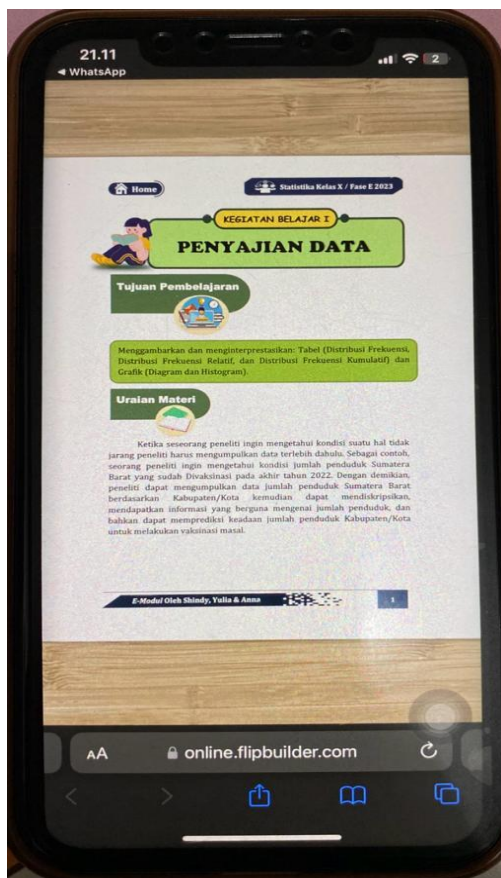
Figure 1. E-Module Design with Flip PDF Professional

Translate:

Learning Activity 1
Data Presentation

Purpose of learning
Describes and interprets: tables (frequency distribution, relative frequency distribution, and cumulative frequency distribution) and graphs (diagram and histogram).

Material Description
When a researcher wants to understand the condition of something, it is often necessary to collect data. For example, a researcher might want to know the number of people in West Sumatra who have been vaccinated by the end of 2022. In this case, the researcher can gather data on the population of West Sumatra based on districts or cities. This data can then be used to describe and obtain useful information about the population. Additionally, it can be used to make predictions about the population in different districts or cities to plan for mass vaccination efforts. Data collection is a fundamental step in the research process, allowing researchers to gather the information they need to analyze, interpret, and draw conclusions about a particular phenomenon or situation.

Figure 1 illustrates the E-Module created using Flip PDF Professional, featuring an introductory description of the material that guides students in mathematical literacy within their daily lives. This E-Module, which facilitates mathematical literacy-based questions, is designed with procedures for solving mathematical literacy questions. It aims to simplify students' independent work

on mathematical literacy questions and enhance the learning process in schools.

In the **Developmen**t phase, the E-Module is created using Flip PDF Professional software and published in HTML format for online access. This allows the Module to be opened on both computers and smartphones. The process of using Flip PDF Professional and operating the final product is not difficult, and it can be used even by those who are not familiar with HTML programming, as stated by (Seruni et al., 2019) . The resulting product will undergo validation by content validators, user validators, and media validators. After validation, any necessary adjustments to the E-Module will be made based on the feedback and suggestions provided by the validators.
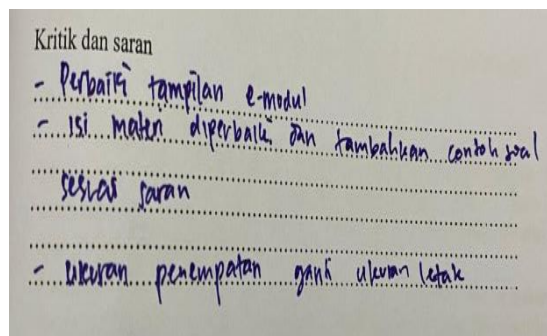
Translate
Criticism and advice
- fix the Module view
- The content of the material was corrected and added examples as suggested.
- position size replacement position size

Figure 2. The Revised E-Module

According to the results of the E-Module revision by expert reviewers (see Figure 2), the E-Module is considered good. However, there are suggestions for making the appearance of the E-Module more engaging and communicating the use of language in the introduction to help users find solutions to mathematical literacy questions. This is intended to aid students in understanding the problems and enable them to solve them using procedures that incorporate mathematical literacy skills.

Furthermore, based on the assessments from the three expert product reviewers, the developed E-Module has achieved product validity and is deemed suitable for use with minor revisions and improvements, as per the recommendations of the validators. The E-Module received a validity score of 90% for content suitability, 89.58% for presentation, 90% for language, 100% for appearance, and 91.67% for user-friendliness. The average percentage of validity ratings is 92.25%, indicating that the E-Module based on mathematical literacy skills is highly valid. These results are consistent with previous research, which found that E-Modules created using Flip PDF Professional are suitable for learning with a percentage of 86.11% (Meliana et al., 2022).

In the **Implementation** phase, the validated E-Module is considered suitable for use by mathematics teachers and students. The objective here is to assess its practicality, which is evaluated through practicality questionnaires. This product trial aims to determine whether the developed product is effective and can be used in schools. To assess practicality, questionnaires are distributed to students and teachers, allowing for an evaluation of the developed teaching material's practicality in line with the research implementation (Razak et al., 2023).

Based on the sample selection tailored to the theory (Rayanto & Sugianti, 2020), which suggests conducting field trials with small groups of students,

typically comprising 10-15 students, to assess the practicality and benefits of the developed instructional media, The practicality assessment by the students yielded practicality values for the E-Module as follows: ease of use aspect scored 90.83%, time efficiency aspect scored 87.5%, and benefit aspect scored 86.46%. The average percentage of practicality ratings is 88.26%, indicating that the E-Module based on mathematical literacy skills is highly practical. Consequently, observations during the learning activities show that students are delighted, especially as they use an E-Module for the first time. The presence of an E-Module with mathematical literacy-based questions, including example questions facilitating the problem-solving process, makes it easier for students to solve the given problems.

Similarly, based on the practicality assessment by mathematics teachers, the E-Module received practicality scores of 80% for user-friendliness, 87.5% for time efficiency, and 87.5% for usefulness. The average percentage of practicality ratings is 85%, indicating that the E-Module based on mathematical literacy skills is highly practical. Observations by teachers during the learning activities indicate that the E-Module is beneficial in various ways. It helps teachers deliver content and makes their role as facilitators more efficient. Teachers also noticed that students are enthusiastic about learning when using the E-Module. The research findings obtained are relevant to (Kurnia et al., 2019), who state that instructional materials are considered practical if the practicality assessment results fall into the "good/practical" category according to predefined criteria. If the results do not meet the practicality standards, improvements will be made based on the feedback provided by the respondents.

In the evaluation phase, the researcher conducts formative evaluations at each of the previous stages. (1) During the analysis and design stages, the researcher evaluates the work personally; (2) In the development stage, validation is carried out by experts to assess the validity of the E-Module based on mathematical literacy skills and gather feedback for improvement; (3) In the implementation stage, evaluation is based on the responses of the participants to assess the practicality of the E-Module. This approach aligns with the findings of previous research (Puspasari & Suryaningsih, 2019) that solely conducted formative evaluations. Formative evaluations are linked to the stages of research and development to enhance the resulting developmental product. Additionally, in this phase, the researcher assesses how students' attitudes change when using the E-Module. It helps determine whether the provided E-Module is effective in increasing students' knowledge and understanding.

4. Conclusions and Suggestion

Based on the research and data analysis conducted, it can be concluded that the E-Module with mathematical literacy-based questions on the topic of statistics is highly valid, with a validity rate of 92.31%. It is also practical, with a practicality rate of 85% according to teachers and 88.26% for students, which falls into the category of highly practical. This demonstrates that the use of the E-Module with mathematical literacy-based questions can be effectively utilized by both teachers and students in the learning process for statistics after being tested.

Based on the research findings and conclusions, the following recommendations can be made:

1. The E-Module that was tested should be further implemented in all classes and schools.
2. The E-Module with mathematical literacy-based questions on the topic of statistics should be continued for further effectiveness assessments.
3. The E-Module with mathematical literacy-based questions on the topic of statistics, which is both valid and practical, can be used as a teaching resource for teachers when delivering statistics lessons to students in Grade X Phase E of high school.

The challenges faced during the research and development process included time constraints, particularly during the practicality testing, which limited the extent to which the E-Module's content could be effectively delivered to the students.

Author Contributions
All authors have sufficiently contributed to the study, and agreed with the results and conclusions.

Acknowledgment
You're welcome! If you have any more questions or need further assistance in the future, feel free to reach out. Good luck with your research, and I hope your E-Module based on mathematical literacy skills proves to be a valuable resource for both teachers and students. Have a great day!

Declaration of Competing Interest
No conflict of interest is declared by authors.

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