# DEVELOPMENT OF TEACHING MODULES TO ENHANCE SECONDARY SCHOOL STUDENTS' STATISTICAL LITERACY

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## *Abstrak*

Penelitian ini bertujuan untuk mengembangankan dan menghasilkan modul ajar matematika untuk memperkuat literasi statistika siswa SMA yang memenuhi kriteria valid dan praktis. Jenis penelitian ini merupakan penelitian pengembangan yang mengikuti langkah-langkah pengembangan 4D, yaitu pendefinisian, perancangan, pengembangan dan diseminasi. Proses dan hasil pengembangan produk ajar tersebut divalidasi dengan menggunakan lembar validasi ahli dan lembar validasi praktis pembelajaran atau guru. Pengumpulan data dilakukan dalam dua tahapan dengan masing-masing menggunakan teknik dokumentasi untuk pendefinisian dan perancangan produk dan teknik angket untuk menguji kevalidan dan kepraktisan produk. Uji kevalidan produk dilakukan melalui ahli dengan dua orang dosen, dan uji kevalidan produk juga dilakukan melalui dua orang guru matematika sekaligus dengan uji kepraktisan produk. Hasil penelitian menunjukkan bahwa modul ajar yang dikembangkan memenuhi kriteria kevalidan dan kepraktisan. Hal ini ditunjukkan oleh hasil analisis penilaian validator yang mencapai rata-rata total kevalidan 98,3% masing-masing 89,9% untuk isi dan 97,7% untuk tampilan. Rata-rata kepraktisan adalah 87,6% masing-masing 92,2% untuk isi dan 83% untuk tampilan. Dapat disimpulkan bahwa modul ajar yang dikembangkan sudah dapat digunakan dan diterapkan dalam proses pembelajaran materi statistika SMA. Modul ajar yang dikembangkan melalui penelitian ini disarankan untuk digunakan oleh para guru matemtika SMA di Aceh dengan menyesuaikan konteks di lingkungan sekolah masing-masing untuk pengembangan materi dan pengajuan masalah untuk pengembangan kemampuan menalar dan berpikir kritis dan evaluasi hasil belajar. Modul ajar ini juga dapat memandu guru dalam pengembangan materi pembelajaran yang dapat memperkuat keterampilan berpikir kritis siswa dalam memahami fakta yang tersaji dalam kehidupan mereka.

**Kata kunci: M**odul ajar, literasi statistika

## *Abstract*

This research aims to develop and produce mathematics teaching modules to strengthen high school students' statistical literacy that meets validity and practicality criteria. This type of research is development research that follows the 4D development steps, namely the define, design, develop, and dissemination stage. The processes and the results of developing teaching products are validated by experts and teachers using validation instruments. Data collection was carried out in two phases using documentation techniques for product definition and design, and questionnaire techniques to test product validity and practicality. Product validity testing was carried out through experts with two lecturers, and product validity testing was also carried out through two mathematics teachers as well as product practicality testing. The results showed that the teaching module developed meets the criteria for validity and practicality. This is shown by the results of the validator assessment analysis which achieved an average total validity of 98.3%, respectively 89.9% for content and 97.7% for appearance. The average practicality is 87.6% respectively 92.2% for content and 83% for appearance. It can be concluded that the teaching module developed can be used and applied in the high school statistics learning process. The teaching module developed in this research is recommended for use by high school mathematics teachers in Aceh by adapting the context in their respective school environments for developing material and posing problems for evaluating learning outcomes. This teaching module can also guide teachers in developing learning materials that can strengthen students' critical thinking skills in understanding the facts presented in their lives.

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## Introduction

Literacy is one of the basic abilities that everyone must have in the current industrial revolution 4.0 era. With good mastery of literacy, other abilities will also be mastered (Amalia et al., 2020). However, in reality, the literacy skills of Indonesian students are still quite low. This is evidenced by the PISA score data in 2022 which shows that Indonesia is ranked 70 out of 81 countries surveyed with an average score of 366 below the average score of all OECD countries which is 472.

Therefore, efforts are needed to improve the literacy skills of Indonesian students (Amalia et al., 2020). As it should be in the current era of information technology, there are various news and data spread in various media that are not guaranteed to be valid. People must be able to filter and assess the truth of the news or information they receive. One way to filter such information is by using various means of information analysis, one of which is through statistical literacy skills. As stated by (Wallman, 1993) that 'Statistical literacy is the ability to understand and critically evaluate statistical results coupled with the ability to appreciate the contributions made through statistical thinking to make public, personal, professional and personal decisions. So, statistical literacy is one type of literacy that is needed to support the ability to assess the truth of information from various fields presented in a quantitative format.

Statistical literacy is demonstrated by the ability to interpret, critically evaluate and communicate statistical information and messages. These skills are essential for high school students to strengthen previous related skills developed at secondary schools and connect to more skills needed while studying at universities. Statistical literacy has to be well-implemented to get a good understanding of every course subject at a university.

In line with Schield (2006), evaluating information is the main element of information literacy through statistical and data literacy, (Andriatna et al., 2021) concluded that statistical literacy includes interpreting graphs, and reading and understanding statistics presented in mass media. Statistical literacy skills are very important because they are closely related to everyday life. In this digital era, a lot of information and news is presented in the form of data and graphs. If someone is not able to interpret the data presented, it will cause misunderstanding of the information they receive. One of the important factors of statistical literacy is so that people can filter information properly and can make decisions from the data obtained (Marina Angraini et al., 2021) Statistical literacy skills must continue to be taught systematically and contextually through valid and practical planning that includes all learning tools.

Learning tools are tools in the form of sheets that are arranged systematically as preparation for teachers in learning activities. Learning tools can make it easier for teachers to understand everything that must be done during learning activities that are structured for one school year and understand learning objectives (Marina Angraini et al., 2021). Teaching tools

or learning devices are tools or equipment used as guidelines for teachers to learn effectively. Learning tools become a guide for teachers in carrying out learning both in the classroom and outside the classroom (Zuhdan et al., 2013). One of the things that affects the success of the learning process in the classroom is the existence of learning tools that are arranged so that the interaction between teachers and students is optimal (Sitio, 2022). Therefore, learning tools are very important for teachers because they can facilitate teachers in carrying out a systematic and effective learning activity process.

One of the learning tools that teachers must have is teaching modules. Modules are one type of learning tool that contains lesson plans to help direct the learning process to fulfill all the learning outcomes (LOs) set. The government sets the Learning Outcomes (LO) of the independent curriculum in phases, namely Phase A for grades 1 and 2, phase B for grades 3 and 4, phase C for grades 5 and 6, phase D for grades 7, 8, and 9, phase E for grade 10 and phase F for grades 11 and 12 (Indrayana et al., 2022). The components that are at least listed in the teaching module are learning objectives, learning activities, assessment of learning outcomes, as well as sources and references. The teaching module should be able to assist teachers in carrying out learning systematically to fulfill all the specified LO.

Based on the researchers' initial findings on one of the teaching modules that the researchers have observed, namely the first teaching module is Teaching Module 6 SMA / MA Mathematics Phase E prepared by Bariati in 2022, that this teaching module already contains the components needed for a teaching module, but this module does not contain student and teacher reading materials and there is no Learner Worksheet (LKPD) because learning activities do not use LKPD. This teaching module also does not contain statistical literacy questions.



Picture 1. Part of the Teaching Module Developed by Bariati

Based on the initial conditions of the teaching module prepared by Bariati, there is no teaching module that contains literacy questions that can strengthen students' statistical

literacy skills, the modules compiled still use contextual questions that do not have accurate references.

The results of research conducted by Bayu Irwandi, Yenita Roza and Maimunah with the title 'Analysis of Statistical Literacy Skills of Minimum Competency Assessment (AKM) Participants' show that the statistical literacy skills of AKM participants are still low as evidenced by the average test score obtained which is 57.14. This value is still far from the KKM determined by the school, which is 75. The low indicator of statistical literacy ability is because some students still cannot understand statistical concepts properly so they are unable to present data and provide appropriate statistical conclusions (Irwandi et al., 2022).

The researcher also conducted an interview with one of the mathematics teachers at SMAN 4 Banda Aceh on 13 May 2023 and revealed that the teacher had not given statistical literacy problems to students during the learning process. In addition, the problems given by the teacher have not contained contextual problems sourced from accurate references. The researcher also conducted interviews with students on the same day and revealed that students did not know the importance of literacy and did not know about AKM. Students also stated that the questions given by teachers so far are contextual questions but are not sourced from accurate references such as the Central Statistics Agency (BPS) and other official institutions both under the auspices of the Government, NGOs and Government partners.

Statistical literacy skills in students have not gone according to what is determined. Students' literacy skills are still relatively low due to the lack of giving literacy questions to students. This is shown through research (Sari et al., 2022) which reveals student errors in completing statistical literacy tests which include errors in understanding questions, calculations and reading data presented in the form of tables and graphs reinforced by research (Arina Hidayati et al., n.d.) that students are less able to write information, draw conclusions and communicate data presentation. "Reading graphs and tables of rates and percentages is much more difficult than calculating a simple percentage in elementary school" thus "statistical educators have both the rules and the tools to teach students how to read, interpret and communicate summary data" (Schield, 2006). This condition can also be improved by designing learning media that strengthens understanding and trains the skills of 'critically evaluating and accurately communicating statistical information and messages' (Gal, 2002). and "statistical educators have both the rules and the tools to teach students how to read, interpret and communicate summary data" (Schield, 2006)

One of the learning media that can help strengthen students' statistical literacy skills is a teaching module that contains contextual-based literacy questions and trains middle and high-level thinking skills and abilities. Therefore, the researcher decided to develop a teaching module for learning statistics in high school by presenting examples of cases that are in the student's life environment such as statistics on the growth of the number of pilgrims, the gross enrolment rate of education, the poverty rate, the economic growth rate, the growth rate of commodity products and the growth rate of tourism in Aceh.

**Research Method**

This research and development follow the 4-D model which consists of 4 stages, namely: the defining stage (define), the design stage (design), the development stage (develop) and the dissemination stage (dissemination). However, the dissemination stage only provides or distributes the product in softcopy form to the mathematics teacher of SMAN 4 Banda Aceh. The define stage includes four main steps: the initial analysis, concept analysis, task analysis, and specifying instructional objectives. This analysis was carried out to determine what kind of open modules teachers and students need to support the learning process. The initial analysis was carried out in three kinds of activities namely analysis of the availability of teaching modules, interviews with mathematics teachers, and interviews with students.

Validation testing of the developed products was carried out using expert validation sheets and practitioner (teacher) validation sheets.

1.  Expert Validation Sheet

This validation sheet is used to measure the level of validity of teaching modules to strengthen statistical literacy in high school students developed by researchers referring to the instruments of several previous relevant studies. The validation sheet was given to expert validators, namely lecturers of statistics material experts and mathematics learning media experts. Validation conducted by expert validators aims to determine the validity of the content and construct of the teaching modules developed.

2.  Teacher Validation Sheet

This validation sheet is used to measure the level of practicality of the module. The validation sheet was made to obtain an assessment from the mathematics teacher as a learning practitioner of the teaching module that had been developed. The development of this instrument also refers to some previous relevant research. The assessment aspects on the teacher validation sheet have the same assessment criteria as the experts' validation sheet.

The data analysis technique used in this research is descriptive analysis technique by describing the data collected as it is without intending to make generalisations.

1.  Analysis of Module Validity

The validation sheet used in this study is in the form of a rating scale. The rating scale is an attitude scale that provides statements with answers in the form of numbers that have been provided. The module validation sheet contains assessment criteria which are divided into four levels, namely score 4 categories are very suitable, score 3 categories are suitable, score 2 categories are less suitable and score 1 category is not suitable.

The validity of the teaching module is seen using descriptive statistical analysis based on the average score of the teaching module and research instruments that have been validated by the validator. The average score is obtained from the following formula:

The validity score of each validator by using the following formula:

$$V_{ai} = \frac{TSe}{TSh} x \; 100\%$$

Description:

$V_{ai}$ = The validity of the i-th expert

$TSe$ = Total empirical score (validation results from validators)

$TSh$ = Total maximum expected score

The total validity score uses the following formula:

$$V = \frac{\sum_{i=1}^{n} V_{ai}}{n}$$

Description:

$V$ = Total validity

$V_{ai}$ = The validity of the i-th expert

$n$ = number of validators

This total V value is used in the interval for determining the level of validity which can be seen in the following table:

Table 1. Validity Assessment Criteria

| Validity Level | Criteria |
| --- | --- |
| 81 % - 100 % | Very Valid |
| 61% - 80% | Valid |
| 41 % - 60% | Less Valid |
| 21 % - 40 % | Invalid |
| 0% - 20% | Veri Invalid |

If the validation results show an achievement level of > 60%, the teaching module developed can be declared valid and researchers do not need to make improvements to the developed product. If improvements are still needed, then what must be corrected is the part that is considered necessary. If the results of the validation show the level of achievement with a percentage score of 60%, the product is declared invalid and researchers need to make improvements to the teaching module to be developed.

2.  Module Practicality Analysis

The module practicality test analysis was conducted in the same way as the module validity test analysis. Then the practicality level interval can be seen in Table 2 below:

Table 2. Module Practicality Criteria

| Practicality Criteria | Practicality Level |
| --- | --- |
| 81 % - 100 % | Very Practical |
| 61% - 80% | Practical |
| 41 % - 60% | Less Practical |
| 21 % - 40 % | Not Practical |
| 0% - 20% | Not Very Practical |

Teaching modules are said to be practical if at least the criteria for practicality by teachers are practical. If it is less than the predetermined criteria, it needs to be revised. The practicality criteria for the module include the readability of the entire content, the suitability of the problems and contextual data raised, the validity of the data based on the sources referred to,

the suitability of the learning media used, and the suitability of the test items used to assess learning effectiveness.

**Research Results and Discussion**

The result of this research is a mathematics teaching module to strengthen the statistical literacy of high school students. The objectives of this development research are to: (1) develop mathematics teaching modules to strengthen the statistical literacy of high school students that are valid and practical (2) produce mathematics teaching modules to strengthen statistical literacy in high school students that are valid and practical.

This development research was conducted by following the 4D development steps with four stages of activities, namely the defining stage (define), the design stage (design), the development stage (develop) and the dissemination stage (disseminate).

**1. Define Stage**

   a. Initial analysis

Based on the interview with one of the mathematics teachers at SMA Negeri 4 Banda Aceh, teachers have never created teaching modules because they have never received training. Hence, they only use teaching modules available on the Internet. Teachers also rarely use contextual literacy test items because they are difficult to compose.

   b. Student analysis

Based on the interviews with several students show that they would be more interested in reading books or materials presented more concisely and interestingly. They also did not know the importance of literacy skills which is one of the abilities assessed on AKM. The reading materials and problem exercises the teachers give rarely contain literacy questions. Students also didn't know about literacy test problems and minimal capability analysis (in Indonesia, it is officially called AKM). Similar to this finding, (Afrilina et al., 2022) with their research title 'Analysis of Students' Mathematical Literacy Ability in Solving AKM Problems on Statistics Material' found that students' mathematical literacy was still at the low and medium scale because more dominant students were at levels 2 and 3 with the percentage for levels 2 and 3 were 40% and 37.17%, there are even some students who are at the lowest, namely level 1 with a rate of 14.28%.

   c. Concept Analysis

This concept analysis is carried out by identifying the things presented in the teaching module to be developed by referring to Phase E Learning Outcomes. One of the outcomes based on the elements is data analysis and opportunities. Researchers chose data analysis and chance elements because this element contains statistical material consisting of data presentation, data concentration measures, placement measures and data spread measures. The results show that students can represent and interpret data by determining quartile and interquartile ranges. Students can explain opportunities and determine the expected frequency of compound events. They can also investigate the concepts of independent and mutually exclusive events, and assess their probabilities.

d.  Task Analysis

The activity carried out in task analysis is the formulation of learning objectives. This is done to analyse the main tasks that must be mastered by students in understanding statistics material. The Flow of Learning Objectives (ATP) is one example of an ATP on the *Kemendikbud* Website. The learning objectives in the data analysis element are presenting data using appropriate group data displays (frequency distribution tables and histograms), interpreting data based on data displays, determining the centredness measure of a data set (mean, median and mode) on group data, determining the placement measure of a data set (quartiles) on group data.

e.  Learning Objective Specification

The formulation of learning objectives is to summarise the objectives to be achieved with task analysis and concept analysis to produce solutions to problems by developing and implementing mathematics teaching modules to strengthen the statistical literacy of high school students. After formulating the learning objectives, the researchers then determined the achievement of the learning objectives. This criterion is an explanation of what abilities students need to demonstrate as evidence that students have achieved the learning objectives.

**2.  Design Stage**

At this stage there are several steps taken by researchers, namely, the selection stage of teaching tools, format selection and initial product design. The selection of teaching tools developed by researchers is in the form of mathematics teaching modules to strengthen the statistical literacy of high school students. Furthermore, the selection of the format for developing this teaching module is in accordance with the format on the Kemendikbud website. This teaching module was designed using Microsoft word 2010 and canva. Then the initial design of the product is done by making general information and this activity in Microsoft word. The preparation of teaching modules begins with formulating learning objectives and learning activities using the Problem Based Learning (PBL) model. In this teaching module, researchers limit the topics discussed, namely data presentation, data centering and quartiles. Then, the research conducted the preparation of student and teacher reading materials and continued the preparation of the LKPD designed in the Canva application. The LKPD designed also uses the Problem Based Learning (PBL) model and the questions used are contextual questions that have accurate references and the exercises on the LKPD are AKM questions.

**3.  Develop Stage**

At the development stage, the completed mathematics teaching module will be validated by expert experts and expert practitioners, to obtain comments and suggestions from validators for module improvement. This validation process involves four validators, namely two material expert lecturers, and two mathematics teachers. At this stage, the student trial stage was not carried out due to the limited time the researchers had because statistics material was taught in even semesters.

Expert validation was carried out by two lecturers. After getting suggestions and input from the two validators, the researcher made revisions and returned the teaching module to

the two validators. After the results of the revisions made by the researcher were in accordance with the suggestions and input from the expert validator then the researcher continued to conduct validation by two mathematics teachers at SMAN 4 Banda Aceh. Then, the researcher made revisions according to the teacher's suggestions and comments. The teaching module that has been revised based on the suggestions and input from the teacher is appropriate so that it is ready for use.

Data from the validation results of the mathematics teaching module to strengthen the statistical literacy of high school students to assess the validity aspects of the module filled in by validator 1 and validator 2 while to assess the practicality aspects of the teaching module filled in by validator 3 and validator 4. The researcher's analysis of the validator's assessment is 1) in the feasibility section of the teaching module content at point 3, namely learning activities in accordance with the Problem Based Learning (PBL) model, validator 1 gave a score of 3 with the suggestion that learning activities be written more clearly and in detail in each phase such as, 'the teacher says greetings and prepares students psychologically and physically to follow the learning process' to 'the teacher says greetings and prepares students psychologically and physically to follow the learning process by asking students' readiness to learn'. In addition, the suggestion from V1 to add triggering questions at the first meeting, such as 'what do you know about single data?', 'single data can be presented in any form?', 'what do you know from group data ?, "what is the difference between single data and group data?". 2) in the language feasibility section at point 17, namely the use of mathematical symbols written clearly, V1 and V2 gave a score of 3 with suggestions and comments on writing symbols and descriptions written more neatly. 3) in the presentation component section, V1 gave suggestions to add more statistical literacy questions in the form of AKM pa questions.

Table 3. Validation Results by V1 and V2

| Assessment Aspect | V1 | V2 | Average |
|---|---|---|---|
| Content | 90,5% | 89,3% | 89,9% |
| View | 95,5% | 100% | 97,7% |
| **Total** | **93%** | **94,6%** | **93,8%** |

Based on the table above, the average validation score is 93.8% with a very valid category. This means that the teaching module is feasible and can be used with some revisions.

The practicality of the mathematics teaching module to strengthen the statistical literacy of high school students developed by the researcher is seen from the validation results of the mathematics teacher in the form of an overall assessment of the teaching module.

Table 4. Validation Results by V3 and V4

| Assessment Aspect | V3 | V4 | Average |
|---|---|---|---|
| Content | 92,2% | 92,2% | 92,2% |
| View | 75% | 90,9% | 83 % |
| **Total** | **83,6%** | **91,5%** | **87,6%** |

Based on the table above, the validation results by validator 3 and validator 4 obtained a score of 87.6% with very practical criteria. Although the assessment of the mathematic teaching module to strengthen the statistical literacy of high school students by two

mathematics teachers was obtained with a very practical category, there were still some suggestions for the teaching module developed by the researcher.

Tabel 5. Suggested from V3 dan V4

| Validator | Suggestions | Improvements |
|---|---|---|
| V3 | Modules are made more systematic | Modules are created using more tables |
| V4 | The questions in LKPD 2 should not be too far from the understanding and daily life of students who are still learning in phase E. Then the word "student" is changed to be "learner" in the teaching module. | Problem 1 in LKPD meeting 2 is corrected to a problem closer to students, namely a problem regarding the capacity of UIN Ar-Raniry. Then the word student in the teaching module is corrected to become a learner |

**4. Dissemination stage**

The dissemination stage was carried out by distributing the final product in the form of a mathematics teaching module to strengthen the statistical literacy of high school students via WhatsApp (WA) to the mathematics teachers of SMAN 4 Banda Aceh. Dissemination was also extended to other high school teachers through the help of this school's mathematics teachers when they met each other at inter-school academic events and through WA group messages among them. Teachers can use this module by adapting the problems that arise along with presenting factual data around their schools or where students live. Problems and related data can also arise from sources at the national, regional and global levels.

**Conclusion**

The results of the development of mathematics teaching modules to strengthen the statistical literacy of high school students obtained a very valid category based on the assessment of the validators. The results of expert validation showed that 89.9% for module content and 95.5% were highly valid criteria for both content and appearance. The results of teacher validation showed that 92.2% for content and 83% for appearance, each of which was categorised as very practical for content and practical for appearance. It can be concluded that the results of the development of mathematics teaching modules to strengthen the statistical literacy of high school students based on expert and teacher assessments are valid and practical. Thus, the teaching module developed is very feasible to be used to strengthen the statistical literacy skills of high school students.

The results of the development of this statistics learning teaching module by displaying examples of data found in the student's life environment such as the growth of the Hajj pilgrimage number, the gross education participation rate, the provincial and district poverty rates, the economic growth rate, the growth rate of superior commodity products and the growth rate of tourism implies the emergence of a lot of teacher creativity in developing contextual-based teaching materials. Such teacher creativity is believed to increase student learning motivation in statistical material. Students become accustomed to being sensitive to data in their environment, provided officially by the Government through district, provincial, and national offices, and data from regional and global sources. They also become skilled in understanding data through statistical literacy by applying middle and higher-order thinking skills.

This study has limitations on the emergence of contextualised problems and questions and intermediate and higher-order thinking to train data understanding and statistical literacy skills. Thus, it is recommended that teachers more widely explore statistical data available in the school environment or concerning the lives of local communities so that students become more impressed. Such data exploration can be done through data published by BPS in the form of provinces and districts in numbers as well as data from the websites of government agencies and private institutions.

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