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Develop Numeracy E-Modules on Statistics Content Oriented to Critical Thinking Skills and Mathematical Disposition

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Abstract

The learning revolution that shifts to numeracy learning affects the availability of the need for teaching materials that include numeracy learning linked to technology in the current digitalization era to encourage students' learning outcomes that are still relatively low, due to students' critical thinking skills and mathematical disposition that still need to be improved. This can be resolved by providing media through the aims in this research, namely to develop numeracy e-modules on statistics content oriented to critical thinking skills and mathematical disposition of grade VIII junior high school students that are appropriate for practical use. This research is a development research with ADDIE model. Data were gathered based on questionnaires and mathematical critical thinking skills tests. The research results show that the numeracy e-module meets the validity criteria in terms of media (medium) and material (high). Practicality level assessment by teachers by 95% (very practical) and students by 90.2% (very practical). Pretest and Postest results from the critical thinking skills test and students' mathematical disposition increased in N-Gain in the interval $g \geq 0.7$ with a high category. It is concluded that the developed e-module is feasible to use in terms of validity, practicality and effectiveness.

Keywords: *Critical Thinking Skills; E-Modules; Mathematical Disposition; Numeracy; Statistics*

Introduction

Mathematics is an important part of education and life. However, students' achievements in the Programme International Student Assessment (PISA) test results organized by the Organization for Economic Co-operation Development (OECD) in the 2003-2018 period were below the proportion of 500 (OECD, 2019). This is because students are not accustomed to solving real problems and are unable to analyze information in various forms (Ambarwati & Kurniasih, 2021). The test content on PISA assumes real problems in the context of mathematical literacy, so that in Indonesia it revolutionizes learning into numeracy learning, where mathematical literacy has a relationship with numeracy (OECD, 2014; Stacey, 2011).

The numeracy benchmark in Indonesia is promoted in the Minimum Competency Assessment (MCA) program. However, many students still experience difficulties in numeracy (Mahmud & Pratiwi, 2019). In general, numeracy is related to information in everyday life that is presented in the

form of diagrams, graphs, symbols (Andrianti & Rahayu, 2022), which is contained in statistical material. However, there are still students who have difficulty in solving statistical problems.

The results of research by Ate & Lede, (2022) explained that 87% of students were unable to answer numeracy-based statistics questions in the context of "patient data by age" in question number 3 with indicators of analyzing information displayed through various forms of graphs, tables, charts, diagrams. Learners are unable to read and understand the data contained in the diagram, because students have not maximally developed mathematical critical thinking skills, in line with the observations found at SMPN Sleman. Basically, mathematical knowledge tends to be critical in processing various contexts (OECD, 2012), so it is necessary to develop mathematical thinking skills.

In addition, the development of critical thinking skills is certainly related to the attitudes and perspectives of students in the process (Zenker, 2018), so it is necessary to support a positive view called high mathematical disposition in learning mathematics. Mathematical disposition includes a genuine interest in learning mathematics, perseverance in finding problem solutions, willingness to look for alternative solutions or strategies and appreciation for mathematics (Yaniawati et al., 2019). Revolution also requires learning media that is closely related to technology, this can be used in the form of e-modules. So that researchers are interested in taking research with the title Development of Numeration E-modules on Statistics Material Oriented Critical Thinking Skills and Mathematical Disposition of Learners.

Method

This research is a Research and Development or R&D development research with the ADDIE model to produce a product in the form of a numeracy e-module on statistics material that is feasible/appropriate for class VIII students of SMP N 1 Depok, Sleman, totaling 32 students, with a research time of 18 March - 02 April 2024. The ADDIE model development procedure can be seen in Figure 1.

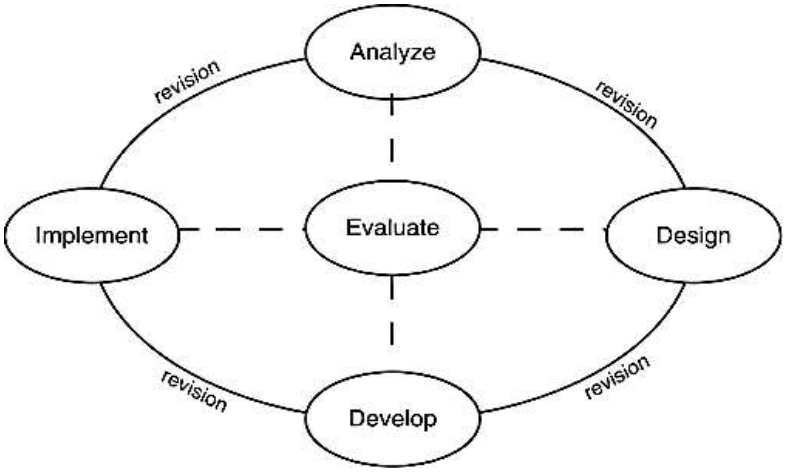

Figure 1. The ADDIE model development procedure (Branch, 2009)

Data collection instruments in this study are based on several criteria to be achieved, namely based on the criteria of validity, practicality and effectiveness, as listed in Table 1.

Table 1. Data collection instruments

Criteria	Instruments
Validation	a. Numeracy e-module material validation questionnaire b. Numeracy e-module design validation questionnaire c. Teacher and learner assessment instrument validation questionnaire
Practicality	a. Practicality questionnaire of numeracy e-module (teacher) b. Practicality questionnaire of numeracy e-module (students)
Effectively	a. Test of students' mathematical critical thinking skills b. Learners' mathematical disposition questionnaire

Furthermore, the results of the validation assessment of material experts and media experts are calculated using the formula:

$$V = \frac{\sum s}{n(c-1)}$$

It is categorized.

Table 2. Interval validity category

Interval	Category
V > 0,8	Low
0,4 < V ≤ 0,8	Medium
V ≤ 0,4	High

Source: Retnawati (2016)

Analysis of practicality using the formula:

$$P = \frac{R}{SM} \times 100\% \ (2)$$

Description:

P : Practicality score

R : Score obtained

SM : Maximum score

It is categorized..

Table 3. Interval of practicality category

Interval	Category
$P > 84\%$	Very Practical
$68\% < P \leq 84\%$	Practical
$52\% < P \leq 68\%$	Practical Fairly
$36\% < P \leq 52\%$	Less Practical
$P \leq 36\%$	Very Less Practical

Source: Widoyoko (2019)

Analysis of practicality using formula:

$$g = \frac{S_{post} - S_{pre}}{Skor\ maksimal - S_{pre}}$$

It is categorized.

Table 4. Interval of effectiveness category

Interval	Category
$g \geq 0{,}7$	Low
$0{,}3 \leq g > 0{,}7$	Medium
$g < 0{,}3$	High

Source: Hake (2002)

Results

The numeracy e-module on statistics material was developed using the ADDIE model which includes 5 stages.

1. Analysis Stage, At the analysis stage of this research, the needs, curriculum, and learner characteristics.
2. The planning stage (Design) involves the design of the content, strategy, appearance and instruments used in product development, including designing the form of e-modules, teaching module as a producer to apply the e-module, compiling the required assessment instruments needed.
3. Development Stage, develops the results of the e-module design that has been compiled at the design stage, through the use of the Canva application combined with liveworksheet. The following is an outline of the appearance of the e-module designed by the researcher.

1) Cover, Use of e-modules

Figure 2 Cover view, E-module Usage, Concept Map

2) Description of learning syntax using e-modules and skills achieved, learning syntax using the Problem Based Learning (PBL) learning model and skills achieved, namely mathematical critical thinking skills with relevance to the numeracy context used in this e-module.

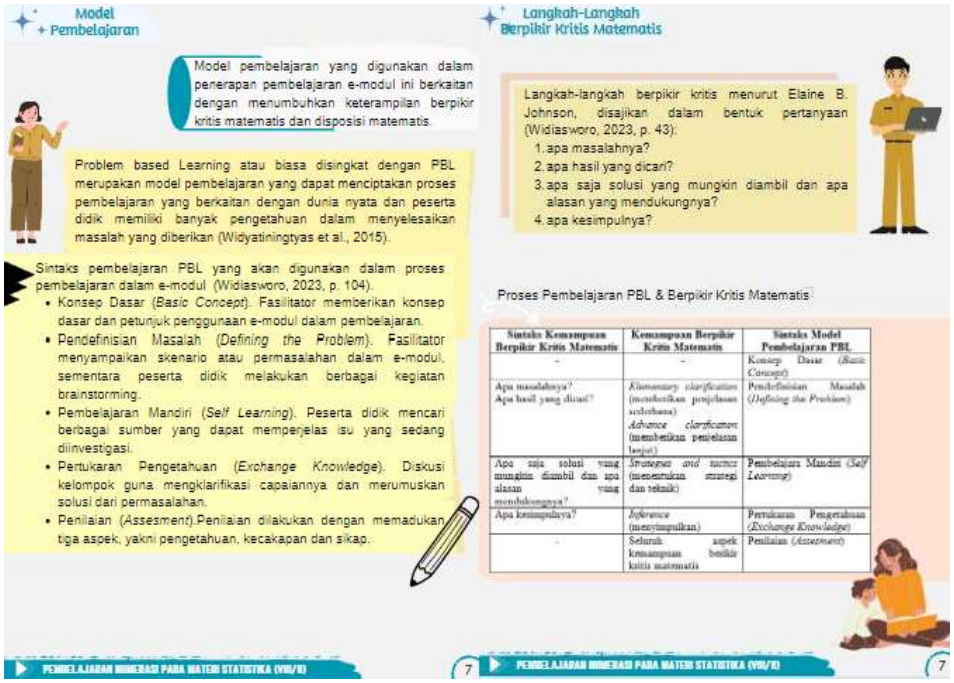

Figure 5 Display of PBL Syntax and Mathematical Critical Thinking Skills

3) Learning menu is a path for students to access each learning activity and practice questions according to the learning that will be learned at the meeting.

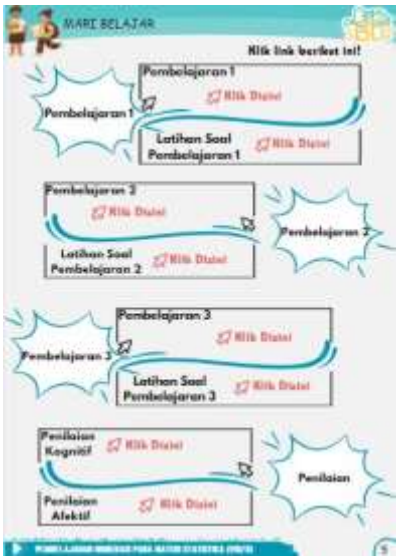

Figure 7 Display of Learning Menu

The data obtained at this stage are product and instrument validation with the acquisition of a material validation score of 0,78 in the "Medium" category or $0{,}4 < V < 0{,}8$. Meanwhile, the media aspect is 0,81 with the category "High" or $V > 0{,}8$.

4.The Implementation stage is carried out to obtain data used to test the e-module in the learning process through 2 stages of trials, namely small scale (6 students) and large scale (32 students). At this stage, the data obtained, namely the practicality of the trial, can be seen in Table 5.

Table 5. Practicality trial results

Trial	Value(P)	Criteria
Teacher	95%	Highly Practical
Small Scale	87%	Highly Practical
Large Scale	90,2%	Highly Practical
Average	92,59%	Highly Practical

5. The Evaluation stage is carried out to measure and see the improvement obtained from before using the e-module to after using the e-module, through the calculation of SPSS application assistance. the data obtained are:

a. Mathematical Critical Thinking Skills Test

Table 7. Normality Test Output Results on PreTest and PostTest Data on Mathematical Critical Thinking Skills Test for Students

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil Keterampilan Berpikir Kritis Matematis	PreTest	,111	32	,200*	,958	32	,249
	PostTest	,141	32	,106	,941	32	,082

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The results of the normality test output in Table 7 show that the pretest and posttest data on the mathematical critical thinking skills test respectively have a significance value (0,200 and 0,106) > the significance level (0,05) which means the hypothesis H_0 is accepted so that the data on students' mathematical critical thinking skills come from a normally distributed population. Then the paired sample t test was conducted with the following results.

Table 8. Paired Sample T Test Results of Mathematical Critical Thinking Skills

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Sebelum - Sesudah	-42,51531	19,55747	3,45731	-49,56653	-35,46409	-12,297	31	,000

Based on the results in Table 8, the significance value (0,000) < 0,05 which means H_0 is rejected so that there is a significant difference in the average value of the pretest (before treatment) and posttest (after treatment). Furthermore, the homogeneity test obtained the following results.

Table 9 Homogeneity Test Results of Mathematical Critical Thinking Skills

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28920,829	1	28920,829	103,744	,000
Within Groups	17283,787	62	278,771		
Total	46204,615	63			

Based on the results in Table 9, the Significance value (0,000) < 0,05 which means H_0 is rejected so that the data group of the pretest results (before treatment) with the posttest (after treatment) of students' mathematical critical thinking skills are included in different variant groups. The last calculation on the N-Gain results.

Table 10 Descriptive Statistics of N-Gain Score of Mathematical Critical Thinking Skills

	N	Minimum	Maximum	Mean	Std. Deviation
NGain	32	,38	1,00	,7576	,17295
Valid N (listwise)	32				

Based on Table 10, the mean or average of the N-Gain score of 0,7576 is categorized as "High" or g ≥ 0,7.

b. Mathematical Disposition Questionnaire Data

Table 11. Normality Test Output Results on PreTest and PostTest Data on Students' Mathematical Disposition

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil Disposisi	PreTest	,096	32	,200*	,968	32	,452
	PostTest	,141	32	,105	,910	32	,011

The results of the normality test output in Table 11 show that the pretest and posttest data on the mathematical disposition questionnaire data respectively have a significance value (0,200 and 0,105) > the significance level (0,05) which means the hypothesis H_0 is accepted so that the data on students' mathematical disposition questionnaire data respectively come from a normally distributed population. Then the paired sample t test was conducted with the following results.

Table 12. Paired Sample T Test Results of Mathematical Disposition

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Sebelum - Sesudah	-32,219	14,455	2,555	-37,430	-27,007	-12,608	31	,000

Based on the results in Table 12, the significance value (0,000) < 0,05 which means H_0 is rejected so that there is a significant difference in the average value of the pretest (before treatment) and posttest (after treatment). Furthermore, the homogeneity test obtained the following results.

Table 13 Homogeneity Test Results of Mathematical Disposition

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16608,766	1	16608,766	135,974	,000
Within Groups	7573,094	62	122,147		
Total	24181,859	63			

Based on the results in Table 13, the Significance value (0,000) < 0,05 which means H_0 is rejected so that the data group of the pretest results (before treatment) with the posttest (after treatment) of students' mathematical disposition questionnaire data are included in different variant groups. The last calculation on the N-Gain results.

Table 14. Descriptive Statistics of N-Gain score of Mathematical Disposition Questionnaire

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	31	-20,50	18,50	1,1596	8,25307
Valid N (listwise)	31				

Based on Table 10, the mean or average of the N-Gain score of 1,1586 is categorized as "High" or $g \geq 0,7$.

Discussion

The results of the data analysis obtained state that the numeracy e-module meets the aspects of validity, practicality and effectiveness so that it is feasible to use (Djamas et al., 2018; Rochsun & Agustin, 2020) and can be used in a wider environment in accordance with the purpose of developing the product (Hodiyanto et al., 2020). The developed e-modules are valid based on the appearance of the media used and the material presented by the experts. The developed e-module is practical based on trials conducted by teachers and students in the learning process to provide student learning efficiency (Sopian & Afriansyah, 2017), providing practicality in assisting teachers in delivering information and learning materials to students (Khairani, 2016) by presenting how to use, objectives and learning materials in written form in electronic format and useful for learning (Solikin, 2018).

Figure 8. Display of How to Use, Learning Objectives and Materials

In addition to the media and material presented, this e-module features a score or work result display in solving the problems given so that students can measure the achievement of mastery of their learning material independently and create interactive learning anywhere and anytime.

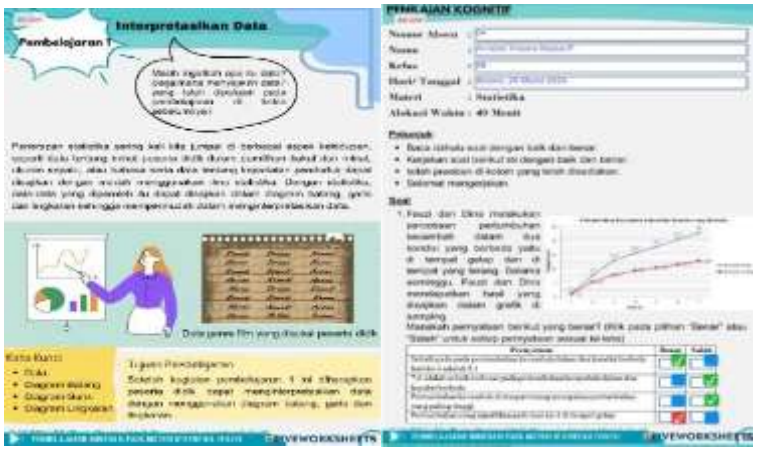

Figure 9. Display of Learners' work results in solving problems

In addition, the e-module developed is effective to use based on the improvement of students' assessment results in solving problems that adapt the context and numeracy content in statistics and mathematical disposition questionnaires. In line with the opinion of Djamas et al. (2018) that the utilization of interactive multimedia can improve students' critical thinking skills through the presentation of learning materials and problems that require critical thinking to be solved, so that students can train and get used to thinking critically in solving problems. One example of the numeracy context adapted in learning e-module 2 is shown in Figure 11 and described in Table 15.

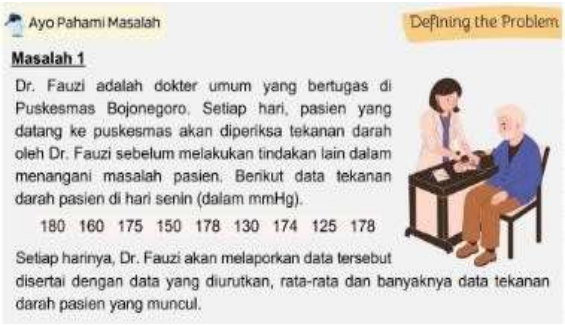

Figure 10 view of one of the numeracy problems in learning 2

Table 15 Numeracy Context of Learning 2

Problem	Numeracy Context	Topic
Problem 1	Science	Blood pressure check by a doctor

Conclusion

The numeracy e-module on statistics material oriented to critical thinking skills and mathematical disposition is declared valid, practical, and effective, and can improve students' critical thinking skills and mathematical disposition. The development of this numeracy e- module still has limitations such as trials in only one class so that there are few comparisons, the strength of the available internet network. For that, it is recommended to conduct trials on a larger sample, tested in areas that have adequate internet access, developed on materials other than statistics.

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