DEVELOPMENT OF INDONESIAN REALISTIC MATHEMATICS EDUCATION-BASED DIGITAL MODULE ON MATHEMATIC IN ELEMENTARY SCHOOL

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Abstract

The development research aims to produce an Indonesian realistic mathematics education-based digital module on the Material of lowest common multiple (LCM) and greatest common factor (GCF) for Grade IV Elementary School (SD) which is valid, practical, and effective. In this research, the method used is research and development. The subjects in this study is students of class VI SD 247 Palembang, 25 student. The digital module developed using the ADDIE model; (1) Analysis (2) Design (3) Development, (4) Implementation, and (5) Evaluation. Data collection techniques is carried out with validation questionnaire sheet, response questionnaire sheets from students, and learning outcomes test. The results of data analysis is obtained that the first, digital module developed is very valid category based on the validation questionnaire from media expert, material expert, and linguists with an average validity value of 91.09%. The second, a digital module developed with a very practical category based on student's response questionnaire with an average practicality value of 98.3%. The third, the digital module developed is very effective category based on the test result toward students by an average value of 84%. Based on the result of validation, practicality, and effectiveness, and test results, it can be concluded that the development of PMRI-based digital module on the LCM and GCF material for grade IV of elementary school can be used in mathematics learning.

Keywords; Development, Digital Module, Realistic Mathematics Education

Abstrak

Penelitian pengembangan ini bertujuan untuk menghasilkan Modul Digital berbasis Pendekatan PMRI pada Materi kelipatan persekutuan terkecil (KPK) dan faktor persekutuan terbesar (FPB) kelas IV Sekolah Dasar yang valid, praktis, dan efektif. Metode yang digunakan dalam penelitian ini adalah metode penelitian dan pengembangan (research and development). Subjek dalam penelitian ini adalah siswa kelas VI SD 247 Palembang yang berjumlah 25 orang siswa. Modul digital yang dikembangkan menggunakan model ADDIE, yaitu: (1) Analysis (2) Design (3) Development, (4) Implementasi, dan (5) Evaluation. Teknik pengumpulan data dilakukan dengan lembar angket validasi, lembar angket respon siswa, dan tes hasil belajar. Hasil analisis data menunjukkan bahwa pertama modul digital yang dikembangkan dengan kategori sangat valid berdasarkan lembar angket validasi para ahli media, ahli materi, dan ahli bahasa dengan nilai rata-rata kevalidan sebesar 91,09%. Kedua, modul digital yang dikembangkan dengan kategori sangat praktis berdasarkan lembar angket respon siswa dalam uji coba dengan nilai rata-rata kepraktisan sebesar 98,3%. Ketiga, modul digital yang dikembangkan dengan kategori sangat efektif berdasarkan hasil uji lembar soal siswa dengan nilai rata-rata keefektifan sebesar 84. Berdasarkan hasil validasi, kepraktisan dan keefektifan, serta hasil uji coba dapat disimpulkan

bahwa pengembangan modul digital berbasis PMRI pada materi KPK dan FPB kelas IV SD dapat digunakan dalam pembelajaran matematika.

Kata Kunci; *Pengembangan, Modul Digital, Pembelajaran Matematika Realistis*

INTRODUCTION

Along with the development of science and technology increasingly has made transformation to use technology in the education aspect. Technology is used as a learning medium, a learning resource, and can be used as teaching material to learning process. In education, technology is a system used to support the learning process to achieve learning purpose (Lestari S., 2018).

In Indonesia, education has an important role to develop quality individual abilities (Maretta, 2019). According to Law No. 20 of 2003 years is stated that education is an effort made to realize a learning process for student to be effective and to develop self-potential in order to have religious spiritual strength, self-control, and skill. In Indonesia, formal education has several compulsory subjects which one of it is mathematics.

The purpose of mathematics learning is to develop the ability to measure, derive, count, and operate mathematical formulas in daily activity. However, mathematics is one of the subjects which student's low interest. It is be able to be seen from the research conducted by Putri (2019) that there are several factors influencing the low interest in learning mathematics including internal and external factors. Therefore, mathematics is more seen as a rigid science, many symbols, mathematical concepts, theoretical knowledge, many formulas which confusing, and an unpleasant learning experience.

Based on observations conducted at SD Negeri 247 Palembang, the students do not understand real problem of essay questions of lowest common multiple material (LCM) or KPK, and the greatest common factor (GCF) or FPB. Students' difficulty occurs when working on essay questions on LCM material, there is an error in the answers, the answers of essay questions about LCM should look for larger quadrate number, but the students look for smaller quadrate number. As explained by Sarah, Risnawati, & Amir MZ (2018), the students have not understand mathematical concepts, and also have not applied mathematical concepts in solving mathematical problems. Learning difficulties of mathematics in LCM and GCF material are difficulties to comprehend problem, to plan solution, to re-examine, and to take conclusions.

According to Maretta, Wahyuningtya, & Sesanti (2019), the problem experienced by students in mathematics, LCM and GCF material, is solving essay question. So, to overcome the factors of learning difficulty is needed a learning innovation by using tools to learn the material, so that students can comprehend and realize the material in daily life. These tools are designed as attractive as possible so that they can understand easily and make them no bored in learning. One of the auxiliary media used to explain the material is a teaching material as a module designed attractively and creatively, and the comprehensive material easily comprehended by students.

According to Khairunnisa & Masruroh (2020) learning using module makes learning material is more optimal to be comprehended by students because they will be guided to be active and learn independently, and a material is systematically arranged by language that is easily understood by students. The module needs an approach to make material easier comprehended by students. One of the approaches is PMRI. According to Fachruraz (2017) learning mathematics using PMR allows students to find concept of KPK and FPB studied and learning is more meaningful so that it can improve students' understanding. According to Rohaeti (2019: 5), the realistic mathematics approach is an approach in which learning activity is carried out based to the real life situation in the surrounding environment of students. So, in learning mathematics, teachers has to relate mathematical concept to real context or realistic problem in daily life.

As long as there have been several studies on the development of learning module. The first, the research conducted by Yuni & Afriadi (2020) produced a conditional learning module which is one of the offline learning solutions (outside network) during covid-19 pandemic. The second, research conducted by (Atmaji & Maryani, 2018) produced e-module based on scientific literacy that is suitable used in the learning process in schools. The third, the research conducted by Feriyanti (2019) is development of mathematics e-modules for students of elementary school".

From those studies, there are same as variable with this research, namely development of e-module or digital modules. However, previous researcher developed the e-module or digital module in PDF form which is moved to Android so that student can easily learn it, while this study developed the e-Modul or digital module by *Flip PDF Professional application*, in the form of a link, and there is an explaining video of material developed. Through PMRI approach-digital module development is hoped the student is able to understand real problems in essay questions of LCM and GCF material. This module can make learning more interesting because there is learning video and online quizz.

RESEARCH METHOD

The research method is research and development method. This research is conducted in the 2021 academic year on fourth grade students of SD Negeri 247 Palembang. The development model used to develop the digital module is the ADDIE (Analysis, Design, Devolopment, Implementation, and Evaluation). Data is collected by observation, questionnaire, documentation, and test. The product is validated by material expert, media expert, and language expert. It is analyzed to determine the validity of the digital module that has been developed. The Product is also tested on fourth grade students at SD Negeri 247 Palembang to determine the practicality of the product through a student response questionnaire. Furthermore, the product also analyzed the effectiveness level of the digital module through test given to students.

RESEARCH RESULT AND DISCUSSION

PMRI approach-based digital module on LCM and GCF material at Class IV Elementary School is developed in several stages, the first is analysis. It is the initial stage to develop a digital module by several analyzes as curriculum analysis, student needs analysis, and material analysis. This stage aims to determine the needs that focus on the current condition, a problem, and problem solving. Curriculum analysis is conducted to know the curriculum used in learning at SDN 247 Palembang. It aims to understand curriculum scope used in elementary school. The curriculum used in the school is Kurikulum 2013. In the implementation of this curriculum emphasizes more meaningful learning for students. In addition, in this curriculum, students are required to be more active in learning and teachers have to be creative and innovative in making teaching materials so that learning becomes interactive and not boring. Furthermore, analyze the core competence (KI) and basic competence (KD) in the syllabus in this curriculum which covers the scope of the material developed, namely the LCM and GCF.

At the syllabus analysis stage, researchers conduct an analysis to LCM and GCF material at class IV such as basic competence and indicator in the material. Based on the description above, the researchers develop a digital module to those material by some basic competencies which are developed in the module. The material developed is LCM and GCF material. The basic competencies are explaining factor and multiple of a number, explaining prime numbers, explaining and determining common factors, LCM and GCF from two numbers related to daily life, identifying factor and multiple of a number, identifying prime numbers, and solving problems related to common factor, LCM and GCF, from two numbers related to daily life.

In the material analysis stage, researchers must adjust to the syllabus analysis used to develop a product. The material used to develop digital module has to be accordance with the syllabus in class IV. The material developed in the module is factors and multiple of numbers, prime factorization, LCM and GCF in Class IV. Furthermore, the researchers carry out an analysis of student's needs to know student's characteristic, ability, and interest in learning mathematics by observation at SD Negeri 247 Palembang on June 10, 2021. From observations which have previously been made, it is found that students do not understand the real problems of essay question in mathematics, especially in the LCM and GCF material, and low interest in learning. It is caused by the lack of attractive learning media used in the learning process and the learning activity is still monotonous so that students feel bored. Based on the analysis conducted above, the researchers look for solution to the problem so the learning process is easily comprehended by students. Using the PMRI (Indonesian Realistic Mathematics Education) approach can make students easier to understand the learning material, because this approach applies real activities in students' live.

The second is design. This stage aims to plan a product developed from the problems that occurs, to analyze, to formulate learning objectives, and to establish the strategies used in learning. From the analysis results, it provides a solution with a PMRI-based digital module using the *Flip PDF Professional application* which is used as the initial framework before developing the product. In this stage is carried out to produce the maximum module and as expected. In the material design stage, the materials selected to be developed are LCM and GCF based on the PMRI approach. In module process development is needed a concept map or sequence of material to be developed so the material can be easier comprehended by student. Before entering the learning material, there is a real/contextual problem which is used to make it easier for students to relate the material and question.

After observing and reading contextual problems, student is given question examples to reason from the problem. Furthermore, there is an explanation of the learning material and a learning video displayed to be understood by students.

Figure 1. Learning Material

In display design stage of module, it is designed cover display, layout, material layout, video, and others. Applications used to create digital module are only assisted by technology such as hand phone and laptop. A cover is designed by the researcher as attractive as possible, which includes the title of the book, logo, picture, and class. The picture below is a display of prime factor material and its explanation, and a learning video.

Figure 2. Display of Prime Factor Material and Learning Video

The third is development. It is carried out to develop design as cover, concept map, K LCM and GCF material based on the PMRI approach into digital module in the form of link made by *Flip PDF Professional application*. The application can be used by students with hand phone or laptops connected internet. In this stage, Researchers have created a prototype I with an attractive design by *Flip Pdf Professional application*. Furthermore, prototype I is validated by experts (validator) namely the fields of material, media, and language. After validating, researchers get comments or suggestions to be used as reference to revise prototype I. Researchers revise product according to those. The prototype I which has revised can be seen in the table below:

Table 1. Description of Prototype II Digital Module

Digital Module		
Before Revision	**Revision**	**After Revision**
	In the logo section before the revision used the university logo, then changed to the curriculum logo. After that in the compiled section, the word in the arrangement is deleted. Then the title should not cover the image, so the title is placed above the image. Explain more clearly the example of the problem.	

The analysis of the validation questionnaire sheet from the 6 validators that have been previously appointed can be seen in the table below.

Table 2. Analysis of Validation Questionnaire

No	Expert	Validator		Rata-rata
		1	**2**	
1.	Material Expert	82,7%	-	82,7%
2.	Media Expert	100%	97,5%	98,75%

3.	Language Expert	87,5%	-	87,5%
4.	Educator	97,7%	93,18%	95,44%
Total				364,39
Average				91,09%

From the validation results by nine validators is obtained an average value of 91.09%. According to interpretation criteria of the validity score, it can be concluded that the previously developed digital module categorized as very valid and can be used for the learning process. Furthermore, the product is tested in small group to get practical data from the developed module. At this stage, it is carried out to 10 students in a small group. Researchers distribute response questionnaires to 10 students.

The results of the students' response questionnaire at the Small Group stage conducted by 10 students can be described in the following table:

Table 3. The Result of The Students' Response Questionnaire

No.	Nama	Score of Question					
		1	2	3	4	5	6
1	ABA	4	3	4	4	4	4
2	ANL	4	4	4	4	4	4
3	ANK	4	4	4	4	4	4
4	ASJ	4	4	4	4	4	4
5	AFE	4	4	4	4	4	4
6	DF	4	4	4	4	4	4
7	DNN	4	3	4	4	4	4
8	ENP	3	4	3	4	4	4
9	ELN	4	4	4	4	4	4
10	FR	4	4	4	4	4	4
Total		39	38	39	40	40	40
Percentage		97,5%	95%	97,5%	100%	100%	100%
Totality Percentage = 98,3%							

The table above is a table of data from students' response questionnaire have been carried out by previous researchers by obtaining the overall percentage value from 10 students with an average value of 98.3%. Based on the practicality score interpretation criteria, it can be concluded that the digital module which has been developed can be categorized as very practical to use in learning. It is same as a research conducted by Heru, Yuliani, & Giastuti (2019) which produced a mathematic module for flat shape for student class IV using a student response questionnaire to determine the practicality of the module.

From the results of the students' response questionnaire conducted by 8 students, 375 students is obtained an overall score of 375 from a maximum assessment number of 416 or 90.14%, so that it can be concluded that module based on the PMRI approach is "Practical". It is in line with research conducted by (Auliah, Syaiful, & et al, 2020) which produced a digital module for learning mathematics based on an open ended approach to improve practical mathematical creative thinking

skill, from the results of a questionnaire analysis from students' perceptions to digital module, got 67% which is categorized as practical.

The fourth is implementation. At this stage is carried out a field test stage to obtain the effective module which has been developed. It is conducted by giving test questions to students. The last stage is a field test using essay question given to students. The number of essay question is 5 questions to find out the learning result by using digital module in learning.

The students' average score from the result of the question which have been worked is 84. According to interpretation criteria of the feasibility score, the effectiveness of module is 84, so it is categorized as very effective to use in learning process. It is in line with research conducted by (Khairunnisa & Masruroh, 2020) on the development of a mathematics module based on the RME approach to obtain students' evaluation test result. The effectiveness result of the independent module obtained from the calculation of the effectiveness formula is 3.14. It can be concluded that the multiples and number factor modules are effective and can be used as independent teaching materials for grade IV Elementary School.

The fifth is evaluation. This stage is an evaluation stage of the development of digital module carried out by researchers starting from the curriculum analysis stage, student needs analysis, and material analysis. Next, the researchers design a digital module from the previous design, then the implementation stage to module in the learning process, and find out the advantage and disadvantage of digital module. After carrying out several stages of revision in accordance with the suggestions from the validator, validation questionnaire sheet from student, and learning outcome test sheet from student, researchers conducted data analysis to determine the validity, practicality, and effectiveness of the digital module.

This research was directly conducted or face to face to students at state elementary school, SD Negeri 247 Palembang. Research conduct different trials as one to one, small group, field test with 5 questions. Every trial, students are very enthusiastic and enthusiastic to learn by using the digital module. Actively, they ask about lowest common multiple (LCM) and greatest common factor (GCF) material because they interest to digital modules in the learning process. They give well response to digital module both verbally and textual because digital module is interesting, and there is an explanation video about LCM and GCF material, and a quiz which students easier work it.

From the validation result, the researchers get a score from media expert of 98.75, material expert of 82.7, linguistic expert of 87.5, and educator of 95.44. Based on those percentage values obtained is more than 80, so the conclusion of the product is very valid. Based on the average value of students' response (3 students) in the one to one stage carried out by, the average score is 96% and from small group stage (10 students) is carried out an average score of 98.3, so the average percentage is more than 80. So, the digital module which has been developed by researcher can be categorized as very practical and can be used in the learning process. On the field test trial (12 students) is obtained an average score of 84. Because it is more than 80, the digital module is categorized very effective in the learning process.

This research proves that realistic mathematics education-based electronic digital mathematics module is effective to implement in learning process. According to other research by Turnip, Rufi'i, & Karyono (2021) produced a valid e-mathematical module which can improve critical thinking skills. A research conducted by Chuseri, Anjarini, & Purwoko (2021) resulted a valid HOTS Realistic-based mathematics module. Atmaji & Maryani's research (2018) produced literacy-based e-module which is very eligible and suitable to use in learning. Research conducted by Al Azka, Setyawati, & Albab (2019) produce realistic mathematics education-based learning module to LCM and GCF which is valid, practical, effectively, and suitable to use in the learning process. Also, research conducted by Dewi & Agustika (2020) stated realistic mathematics

education approach can make students more motivated in learning and they can understand a mathematical concept through concrete media without have to think abstractly.

CONCLUSION

This study shows that the development of realistic mathematics education-based digital module on the material for lowest common multiple and greatest common factor, using the Flip PDF Professional application in the form of module link, learning videos, and online quizzes, is valid, practical, and effective. The module make mathematics learning more interesting and students can more easily solve real problems on lowest common multiple and greatest common factor material.

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