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Development of Hands On Mathematics Module Based on Journal Review to Promote Student Involvement in Merdeka Curriculum

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Abstract: The massive development of technology in education has led to the implementation of digital-based learning. However, the impact of the pandemic and the implementation of online learning by utilizing digital technology has caused problems in the form of learning loss. The Merdeka Curriculum as an effort to resolve this learning loss has actually created new problems, that is, teachers' difficulties in implementing differentiated, fun, and meaningful student-centered learning. More specifically, this difficulty occurs for math teachers who do not have references to various mathematics activities that support meaningful learning. One alternative solution to solve this problem is to have a special module that contains references to various mathematical activities and games. The purpose of this research is to develop a hands-on mathematics module based on journal studies which becomes a teaching module in the manipulative mathematics media course. The research and development model to be implemented is 4D Thiagarajan which consists of 4 stages, these stages are define, design and develop. The dissemination stage was not carried out in this period due to research limitations. The results showed that the developed module met the validity criteria with a score of 2.71, met the practicality criteria with a score of 87% and met the effectiveness criteria with a score of 91,6. It's concluded that the hands on mathematics module was feasible to use and met the criteria of valid, practical, and effective. The results of the study are expected to be a recommendation for further development research and for teachers in designing mathematics learning.
Keywords: Hands on mathematics; Merdeka Curriculum; mathematics activity; mathematics games; mathematics aid teaching.

Pengembangan Modul Hands On Mathematics Berbasis Review Jurnal untuk Mendorong Keterlibatan Siswa dalam Kurikulum Merdeka

Abstrak: Masifnya perkembangan teknologi di bidang pendidikan telah mendorong implementasi pembelajaran berbasis digital. Namun dampak pandemi dan penerapan pembelajaran daring dengan memanfaatkan teknologi digital menimbulkan permasalahan berupa learning loss. Kurikulum Merdeka sebagai upaya mengatasi learning loss ini justru menimbulkan permasalahan baru, yaitu kesulitan guru dalam melaksanakan pembelajaran yang berpusat pada siswa yang berdiferensiasi, menyenangkan, dan bermakna. Lebih khusus lagi, kesulitan ini terjadi pada guru matematika yang tidak memiliki referensi berbagai aktivitas matematika yang mendukung pembelajaran bermakna. Salah satu alternatif solusi untuk mengatasi permasalahan tersebut adalah dengan memiliki modul khusus yang berisi referensi berbagai aktivitas dan permainan matematika. Tujuan penelitian ini adalah mengembangkan modul hands-on matematika berbasis kajian jurnal yang menjadi modul ajar pada mata kuliah media matematika manipulatif. Model penelitian dan pengembangan yang akan diterapkan adalah 4D Thiagarajan yang terdiri dari 4 tahapan, tahapan tersebut adalah mendefinisikan, merancang dan mengembangkan. Tahap diseminasi tidak dilakukan pada periode ini karena keterbatasan penelitian. Hasil penelitian menunjukkan bahwa modul yang dikembangkan memenuhi kriteria validitas dengan skor 2,71, memenuhi kriteria kepraktisan dengan skor 87% dan memenuhi kriteria efektivitas dengan skor 91,6. Disimpulkan bahwa modul hands on mathematics layak digunakan dan memenuhi kriteria valid, praktis, dan

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efektif. Hasil penelitian diharapkan menjadi rekomendasi penelitian pengembangan selanjutnya dan bagi guru dalam merancang pembelajaran matematika.

Kata Kunci: Hands on Mathematics; Kurikulum Merdeka; Aktivitas matematika; Permainan matematika; alat peraga matematika.

INTRODUCTION

The rapid development of technology alongside the prevelance of the Covid-19 pandemic has an impact on all aspects of life, including education. The massive presence of digital-based technology in the learning process forces the world of education to transform quickly and adaptively (Kurniawan & Wardhani, 2021). Changes in learning media, including changes in learning resources to digital forms, force all education stakeholders to adapt and leave their comfort zones (Maksum & Fitria, 2021). The advantages of digital media in learning, especially in learning mathematics, are able to provide concrete illustrations of abstract concepts (Mardati, 2021). Yet, The digital mathematics games in which linked representations and possibilities for linked physical activities were not included as design components did not create substantial benefits (Moyer-Packenham et al., 2019). The concrete description of the material, especially in mathematics, can be fully accommodated with manipulative media. The utilization of manipulative media in mathematics learning can improve problem solving skills, creative thinking, and visual thinking in students (Khairunnisa & Ilmi, 2020). Manipulative media can be maximized through project-based learning so that students can achieve meaningful understanding and have an impact on increasing mathematics learning outcomes (Setyowati & Mawardi, 2018). Pan et al. (2022) revealed that math learning games not only enhanced the desired learning outcomes (with 21 out of 27 research indicating positive results), but also boosted students' motivation and positive attitudes toward mathematics learning (14 out of 17 studies verified beneficial impacts).

The impact of the covid-19 pandemic and the implementation of online learning by utilizing digital technology have created new problems in the form of learning loss in several aspects of education (Andriani et al., 2021). The presence of the independent curriculum initiated in 2021 is one of the government's efforts to solve the problem of learning loss due to the pandemic (Jojor & Sihotang, 2022). However, the implementation of the Merdeka curriculum presents new problems for teachers to implement differentiated learning to realize student-centered learning (Kurniati & Kusumawati, 2023). Differentiated learning provides opportunities for students to learn naturally and efficiently with teachers who are able to collaborate with the methods and approaches needed (manggalastawa, 2023). One alternative solution to this problem is the availability of sufficient references for teachers about activity or project-based mathematics learning to support teaching performance. there are two major things that that underlie the development of the module. Namely: 1) the change in curriculum to an independent curriculum which encourages students to be more involved in the preparation / planning of school mathematics learning based on an independent curriculum, 2) field observations that have been carried out in 10 schools in the kendal, Semarang and Demak areas that have begun to implement an independent curriculum

show that teachers experience obstacles including: not having experience implementing an independent curriculum (28%), lack of references (14%), implementing method differentiation (11%) (Kurniati & Kusumawati, 2023).

The contribution that can be offered by researchers as mathematics education lecturers in institutions that produce prospective teachers is to provide good references so that students can keep up with the latest educational developments, especially the implementation of the independent curriculum. The Prospective mathematics teachers consider that their training programmes have adequately prepared them to perform effectively as teachers and should place more emphasis on topics such as designing a lesson and conducting a classroom (Ariza Muñoz et al., 2023). The existing teaching module covers the theory of manipulative media development along with some examples of math manipulative media. However, the theory is not in line with differentiated learning as emphasized in the independent curriculum and the examples presented do not consider new trends in mathematics education research and development. The development of the Hands on Mathematics Module is based on the results of a review of articles that have been published in national journals within the last 5 years so as to provide a summary of the latest information related to the use of manipulative teaching aids, mathematical games and mathematical activities in mathematics learning. The developed module is a provision for prospective teacher students in enriching alternative applications of teaching aids, mathematical games and mathematical activities to increase student involvement in designing mathematics learning based on differentiated learning according to the independent curriculum. Designing a lesson is an effective approach in pre-service teacher education for increasing student teachers' understanding of what successful teaching entails and how to plan for it (Gravett & van der Merwe, 2023).

METHODS

This is a Research and Design (RnD) project, and the product developed in this study is a hands on module that meets the criteria of valid, practical, and effective. The research and development of this product refers to Thiagarajan's 4D development model. There are 4 main steps in the implementation of this research namely: define, design, develop and disseminate. Due to limited time and funding, disseminate activities cannot be implemented in this study. Disseminate activities will be carried out as a follow-up to the research results. The research procedure is described as follows.

Activities carried out in Define stage, namely: observation, studying theories of module development, reviewing the structure of the independent curriculum, and reviewing national journals on mathematics education regarding the implementation of mathematical activities, mathematical games and teaching aids. The article review was conducted using the SLR (Systematic Literature Review) method with 3 main stages, namely: Planning, Conducting, and Reporting.

The activities carried out at the design stage are selecting the results of the literature review to be determined as material references, further processing the results of the journal review to select hands on mathematics activities that are suitable for use in implementing independent curriculum mathematics learning. At the design stage, a lesson plan for the manipulative media course was produced which became the basis for module development. Draft 1 of the module is compiled completely according to the framework that has been made, compiling all the planned instruments by developing the indicators that have been made. The instruments that are used in this study are validation sheets, module practicality sheets, student response questionnaires and independent curriculum understanding tests.

The activities carried out before conducting the trial were to ask experts for an assessment of the Draft 1 module and draft instruments using a validation sheet. Validation was carried out by two experts, the validation sheet contained 5 aspects, such as the module format, content, language, illustration and layout, and the use of module. There are a total of 19 items with a rating scale of 0-3. The assessment criteria are as follows: mean score of more than 2 means valid (the module can be used for testing); score of 1 to 2 means less valid (needs minor revision); and score of less than 1 means invalid (needs major revision). The validation results were analyzed and then Draft 1 module was revised into Draft 2 module. The trial was conducted in the manipulative math media course. The trial was conducted for 3 meetings. The remaining meetings written in the module were carried out by students independently outside of lecture hours. The practically test and module practicality sheet.

The practicality test was obtained through a module practicality questionnaire consisting of 15 statement items from 7 aspects. Namely Self-Instruction, Self-Contained, Standalone, Adaptive, User-Friendly, Time Allocation, Learning conditions. The questionnaire was filled in on a scale of 1 to 4. Analysis by finding the percentage with a decision of more than 90% means very high implementation; 80%-<90% means high implementation; 70%-<80% means moderate implementation; 60%-<70% means low implementation; and <60% means very low implementation.

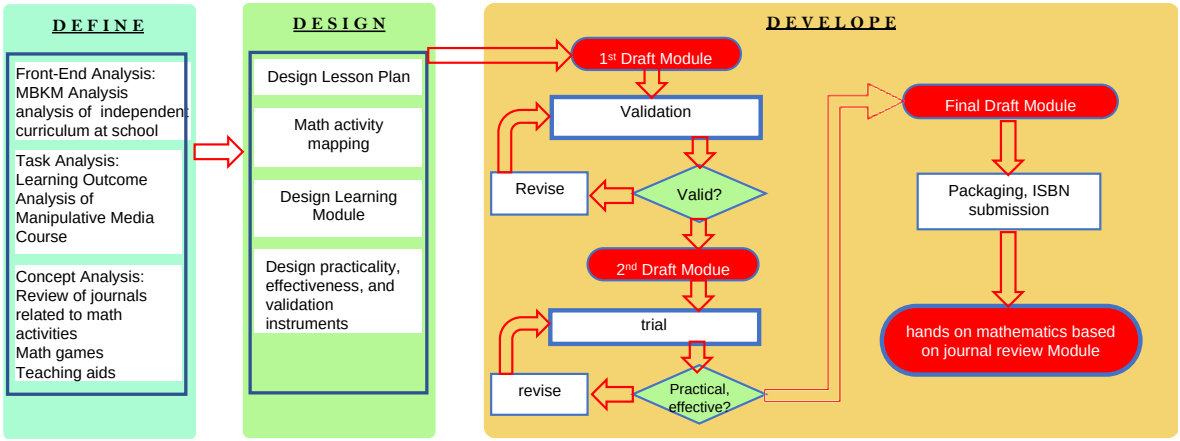

Figure 1. research flow diagram

The module was developed to promote student involvement in independent curriculum-based mathematics learning. One of the indicators for the effectiveness of the module is determined using a manipulative media development performance assessment. Module development is effective if student achievement in this performance assessment exceeds 80. The results obtained from the in-class trial were revised at this stage so that a valid, practical, and effective module was produced. From the explanation above, the research stages can be presented in Figure 1.

RESULT AND DISCUSSION

The results of the implementation of research and development are described in each stage as follows.

Define

In the front end analysis, observations are made to be able to analyze the MBKM. this activity resulted in a revision of the CPMK (course learning outcomes) document for the manipulative mathematics learning media course. the updates to the CPMK are: students are expected to be familiar with the independent curriculum at the school level, and students can design differentiated learning based on mathematical activities. analysis of the independent curriculum at school includes the curriculum structure, and elements of mathematics subjects in the independent curriculum. Following a preliminary examination, a theoretical research of module development was conducted.

At the end of this stage, a review of the national journal of mathematics education on the implementation of mathematical activities, mathematical games and teaching aids is carried out. there are 2 ways to do this, namely through journal mapping and through the google scholar search engine. journal mapping was carried out by selecting 15 journals for review. the journals were selected based on the sinta rank and the location of journal publication. 1 S1 journal, 5 S2 journals, 5 S3 journals and 4 S4 journals were selected which included 1656 articles that had been published in the period 2019 to 2023. selection through google scholar was carried out by writing the keywords "math games" and "math teaching aids" found a total of 1270 articles. some articles that did not meet the requirements were discarded, such as articles for early childhood and primary school, or articles that did not focus on media development and its implementation. Finally, by The SLR method, 25 hands on mathematics were selected to be used as teaching materials in the developed module.

Design

Activities that have been carried out in this stage are designing instruments and preparing materials. The lesson plan is designed for 16 meetings as follows: 1st meeting: introduction to the independent curriculum, which contains the curriculum structure and elements of learning mathematics phase A-F; 2nd and 3rd meetings: discussing hands on mathematics, starting from the definition, types, to matters that are considered in its

development and implementation; 4th meeting: mathematics learning media development procedures; 5th meeting: analysis of learning based on mathematics teaching aids; 6th meeting: analysis of mathematics activity-based learning; 7th meeting: analysis of math game implementation; 8th to 14th meetings: development of mathematics learning media based on hands on activity; 15th to 16th meeting: product presentation.

The instruments compiled are validation sheets, module practicality sheets, student response questionnaires, student response questionnaires and independent curriculum insight questionnaires.

The Module consists of 3 modules, the module format developed is as follows. Module 1 Independent Curriculum, Module 2 Mathematics Learning Media, Module 3 Hands on Mathematics Analysis. Each module consists of 3 parts, namely material discussion, summary, and practice questions along with the answer key. Especially for Module 3, at the end of each Hands on Mathematics activity, a reflection sheet is completed by students. Reflection sheet questions include: estimation of time needed, student abilities that can be developed, differentiation that can be applied in these activities.

Develope

Each instrument used in this study was validated before being employed in research. Validation was carried out by two validators, who were both mathematics academics with competence in learning media and mathematical education. The validation of each instrument takes several factors into account. Validation results are presented in table 1..

Table 1. Instrument validation results

Aspect	1st validator	2nd validator	average
module format	3,00	2,67	2,83
content	2,75	2,50	2,63
language	2,67	2,67	2,67
illustration and layout	2,67	2,67	2,67
the use of the module	3,00	2,50	2,75
			2,71

Validation of the instrument obtained an average validation score of 2.71, which means that the instrument is valid and can be used with some revision regarding the writing format and suitability of illustrations in the module (table 1).

The practicality questionnaire was filled in by practitioners (lecturers of manipulative math media courses) and 12 students. This questionnaire consists of 17 questions based on 7 module characteristics. The highest score is 3.85 for the aspect of learning conditions because this module can be flexibly studied anywhere and anytime. The practicality value obtained is 87% which means that the practicality value of the module is high category (table 2). It can be concluded that the developed module is suitable for use in learning.

Table 2. Practicality Questionnaire results

Aspect	Score
Self-Instruction	3,69
Self-Contained	3,46
Standalone	3,85
Adaptive	3,23
User-Friendly	3,08
Time Allocation	3,31
Learning condition	3,85
Average Score	3,49
Percentage	87%

The module's effectiveness was determined using performance assessment. The assessment of student performance includes media design following the topic and suitability with mathematical concepts, media development process, simulation of media implementation in classroom learning and preparation of media development practicum reports. The average student performance score is 91.6 better than the minimum criteria of 80. Thus, it is concluded that the module developed is effective.

There is an additional instrument, namely the module effectiveness response questionnaire. After completing the Hands on Mathematics module, a total of 12 students filled their response. There are 20 statements with a 5-point Likert scale response. The average questionnaire result is 4.6, indicating that students are very positive towards the effectiveness of the Hands on Mathematics module.

The analysis conducted by students at the end of each activity in Module 3 includes the right situation in the implementation of the activity, the estimated time required, the skills of students that can be developed, and the differentiation that can be applied in the activity. Students have first-hand experience with the content and take ownership of their learning (Seage & Türegün, 2019). As Van Katwijk et al., (2023) said that knowing about research & development and performing practitioner research oneself improves teaching quality. By conducting this analysis, students will have a deeper consideration in choosing hands on mathematics activities that are in accordance with the learning objectives. By increasing their knowledge about hands on mathematics, students can also develop activities that students can do at home to increase their sense of mathematics. This was also revealed by (Throop Robinson et al., 2022) when conducting research during the pandemic that the implementation of variations in hands on mathematics learning carried out by prospective teachers helped the implementation of mathematics learning at home.

Hands on mathematics can facilitate students with various learning styles and various backgrounds (Budiyanto et al., 2020). Hands on mathematics can also improve students' problem solving skills (Suriani & Z, 2022), (Putra, 2017). Students' preconceptions can be overcome, and the learning environment can become a place that they enjoy, which can have a good impact on learning (Şahin & Danaci, 2022). Similar thing is said by Coskun Karabulut et

al., (2023) that hands-on activities positively affected pre-service teachers' learning and provided an enjoyable learning environment.

CONCLUSION

Based on the research findings, the following conclusions were obtained. a hands on mathematics module based on journal review has been developed that meets the criteria of valid, practical, and effective. Development adheres to the 4D stage with the following steps: (a) Define which includes a study of the MBKM and Merdeka curriculum, and systematic literature review on the topic of mathematical activities, the use of mathematical teaching aids and mathematical games in 15 Mathematics Education journals; (b) Design which includes module design and supporting instrument design; (c) Develop includes validation and trial activities. These stages resulted in a hands on mathematics module that met the criteria of valid (score 2.71), practical (87%), and effective (91,6).

Lecturers are advised to use this module as one of the teaching materials in mathematics manipulative media courses. Not only that, this module can also be used as a reference by teachers in preparing differentiated mathematics learning. In fact, students can also simply practice hands on mathematics activities anywhere to further increase their love for mathematics. This module can be expanded and utilized in a broader context. This module is only limited to the study of mathematics journals in Indonesia, so it is suggested that other researchers expand it to cover the study of international journals.

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