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MODULE DEVELOPMENT FOR CURVED SIDE 3D GEOMETRIC SHAPES BASED ON STEAM APPROACH

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Abstrak

Siswa kelas IX SMP Negeri 4 Takengon umumnya merasa kesulitan pada saat memahami materi pembelajaran matematika yang terdapat di buku paket sekolah, selain itu guru juga merasa bahwa buku paket sebagai bahan ajar masih kurang membantu siswa dalam pembelajaran baik di sekolah maupun mandiri, sehingga sangat diperlukan adanya bahan ajar lain yang dapat mengatasi hal ini. Oleh karena itu peneliti merasa penelitian ini sangat cocok untuk dilakukan. Penelitian *Research and Development* (R&D) ini menggunakan model pengembangan Rowntree yang tujuannya ialah untuk mengembangkan modul matematika dengan pendekatan STEAM pada materi bangun ruang sisi lengkung yang valid dan praktis untuk digunakan dalam pembelajaran matematika SMP. Proses pengembangannya terdiri atas tiga tahapan, yaitu tahap perencanaan, pengembangan dan juga evaluasi yang menggunakan prosedur evaluasi formatif dari Tessmer. Berdasarkan tahapan pengembangan ini, telah dihasilkan modul matematika dengan pendekatan STEAM yang memuat materi bangun ruang sisi lengkung dan telah dapat dikategorikan sangat valid (validasi isi 4,54 dan validasi media 4,75) dan juga sangat praktis berdasarkan *one to one evaluation* (respon guru 96,96% dan respon siswa 98,97%) serta *small group evaluation* sebesar 92,11%.

Kata kunci: *STEAM, Pengembangan Modul, Rowntree*

Abstract

Class IX students of SMP Negeri 4 Takengon generally find it difficult to understand the mathematics learning material contained in the school textbook, besides that the teacher also feels that textbooks as teaching materials still do not help students in learning both at school and independently, so it is very necessary to have other teaching materials that can overcome this. Therefore the researcher felt that this research was very suitable to be carried out. This Research and Development (R&D) research uses the Rowntree development model whose goal is to develop math modules with the STEAM approach on curved side space material that is valid and practical for use in junior high school mathematics learning. The development process consists of three stages, namely the planning, development and evaluation stages using the formative evaluation procedure from Tessmer. Based on this development stage, a mathematics module with the STEAM approach has been produced which contains curved side geometrical material and can be categorized as very valid (content validation 4.54 and media validation 4.75) and also very practical based on one to one evaluation (teacher response 96.96% and student response 98.97%) and small group evaluation of 92.11%.

Keywords: STEAM, Module Development, Rowntree

Introduction

The order of life in the 21st century has undergone various essential changes (Etistika Yuni Wijaya et al., 2016). One form of change that we can feel immediately is an essential shift at the level of philosophy, direction, and purpose of education, with the most visible feature being the very rapid development of science to create various synergies that are very beneficial for mankind.

Based on the 21st-century national education paradigm formulated into three parts, it can be said that mathematics is one of the most important subjects in the 21st century. The need to master mathematics has become an international agreement, with the majority of countries agreeing that its characteristics are to equip students with creative, critical, logical thinking and problem-solving (Fitriati & Novita, 2015). However, something concerning is happening in Indonesia. Based on existing data, it can be said that the quality of Indonesian mathematics education is in the "low" category (Wahidah, et al, 2013). Therefore, it takes hard work from various parties such as teachers who are expected to be able to determine appropriate and meaningful learning approaches for their students. One approach that according to researchers can be used as an alternative solution is the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach.

STEAM is an approach in education that integrates Science, Technology, Engineering, Art, and Mathematics and focuses on solving problems in professional community life (Devi, et al, 2018; Tia, 2019;). The STEAM approach in learning can link two or more fields of scientific study that are interconnected, or link them with other fields of the study found in schools (Hyonyong Lee et al., 2014; Sanders, 2009). The results of research conducted by Septiani (2016) show that the application of STEAM can train students' cognitive, skill, and affective development well. These results make the STEAM approach worthy of being one of the solutions to learning problems. In STEAM learning, students are taught both theoretically and practically. This certainly can bring students to the actual learning process so that they have the opportunity to expand their thinking skills such as critical, creative, structured thinking, and others (Anwari et al., 2015).

In addition to the appropriate method/approach, the success of a lesson is also influenced by the learning tools used. Permendikbud No. 22 of 2016 concerning Basic and Secondary Education Process Standards, one of which regulates learning planning which implicitly expects teachers to develop teaching materials and use them in the learning process. Teaching materials can help students understand and master a predetermined competency so that learning objectives can be achieved optimally and serve as guidelines for teachers as a learning evaluation tool (Nasrani, 2018; Baskoro, 2015).

Based on the facts, the development of teaching materials that are following the needs of students is very necessary, because teaching students to use textbooks has not given satisfactory results. This is in line with the results of observations and interviews conducted by researchers at SMPN 4 Takengon and SMPN 1 Takengon, with the conclusion that the majority of class IX students have difficulty in learning mathematics material in textbooks coupled with the absence of teaching materials that suit the needs of students in class.

Therefore, according to researchers, the learning outcomes they have obtained so far have not been optimal and can still be improved in various ways.

According to the researcher, learning materials can be understood by students well if the teacher uses interesting teaching materials and by the needs of students so that they can develop their mindset and also encourage the emergence of motivation in them to learn independently. One of the teaching materials that can be used is the module. The module is a set of teaching materials that are presented coherently and systematically and equipped with instructions to make it easier for users to study the module with or without a teacher (Purnamasari, 2017). The modules in this study are printed teaching materials that can be used as independent learning resources that include a series of structured and continuous learning experiences. Modules can be designed systematically to help students achieve predetermined learning goals (Setiyadi, 2017).

Currently, the availability of modules, especially modules with the STEAM approach, is still very rarely used in schools. The module with the STEAM approach is designed to contain self-instructional, self-contained, stand-alone, adaptive, and user friendly (Directorate General of Water Resources, 2019). Therefore, the researcher felt this research should be done. This study aims to develop a mathematical module with a STEAM approach on valid and practical three-dimensional space geometry material so that it is suitable for use in junior high school mathematics learning.

Method

This research is a Research and Development (R&D) with the development method referring to the Rowntree development model. Rowntree model is a research development model that focuses on developing a product, especially for producing teaching materials (Sadly & Akhsan, 2023). The stages of this development model can be seen in chart 1 below.

Chart 1. Rowntree Research Model Stage

The Rowntree model consists of three stages, namely (1) the planning stage, at this stage the researcher conducts a needs analysis and formulates learning objectives, (2) the development stage, at this stage, the researcher develops topics and drafts of teaching materials to produce initial prototypes of teaching materials. and (3) the evaluation stage, at this stage the researcher uses the formative evaluation procedure from Tessmer, which starts with self-evaluation, expert review, one-to-one evaluation, and small group evaluation (Prawiradilaga, 2009). This research has been carried out with the planning stage from January 2021, the development stage from early February to March 2021, and the evaluation stage from March to 30 April 2021. Research data collection was carried out by walkthrough and questionnaires.

The mechanical walkthrough is a validation of data involving multiple experts (experts) who were asked to evaluate the product as a reference in revising the initial product developed. The instrument used is an expert validation sheet in the form of a Likert scale (Oktarinah et al., 2016).

Sheet questionnaire used at the time of test products in stage one to one evaluation (trial of one-on-one) and also small group evaluation (trial small groups). The results of the questionnaire obtained from this stage were then analyzed using a Likert scale. It aims to measure the opinions of students and teachers on the developed module.

Result And Discussion

This study uses the Rowntree model which consists of three stages, namely the planning, development and evaluation stages. For the evaluation phase, Tessmer's evaluation was used which consisted of five stages, namely (1) *self evaluation,* (2) *expert review,* (3) *one to one evaluation,* (4) *small group evaluation,* and (5) *field test.* However, the researcher limited the evaluation stage to the *small group evaluation stage.* The results obtained from each of these stages will be described as follows.

1. Planning Stage

At this stage the researcher carried out a needs analysis which included interviews, observations and literature studies on matters related to the process of developing mathematics modules with the STEAM approach to this curved side geometric material. Based on the results of the needs analysis, the researcher proceeded to the formulation of learning objectives so that a description of competence was obtained which became a reference for researchers in developing mathematics modules with the STEAM approach on curved side geometric shapes.

2. Development Stage

At this stage the researcher carried out topic development, drafting, to production of a prototype 1 math module with the STEAM approach on curved side geometric shapes.

Figure 1. Display of the Developed Module

3. Evaluation Stage

The evaluation phase began in March 2021 by conducting *a self evaluation.* Based on this stage, a mathematics module with the STEAM approach has been produced on curved side geometric shapes which has a very good level of validity and practicality.

The level of validity of the module is obtained based on validation results from two experts, which include content validation as well as media validation. The results of validating the contents of this module can be seen in Table 1 below.

Table 1. Content Validation Results

Assessment criteria	**Average**	**Category**
Content Eligibility Aspects	4,44	Very Valid
Presentation Feasibility Aspects	4.47	Very Valid
Contextual Component	4,6	Very Valid
STEAM	4.67	Very Valid
Average	**4.54**	**Very Valid**

Based on Table 1 above, it is known that the mathematics module with the STEAM approach that has been developed can be categorized as "Very Valid" based on its content validation which obtains an average of 4.54 . Likewise, based on media validation, the developed module is in the "Very Valid" category. For more details will be presented in Table 2 below.

Table 2. Media Validation Results

Assessment criteria	**Average**	**Category**
Cover	4.89	Very Valid
Layouts	4,41	Very Valid
Pictures and Illustrations	4.73	Very Valid
Color	5	Very Valid
Average	**4.75**	**Very Valid**

The level of practicality of the mathematics module with the STEAM approach to this curved side-space construction material, was obtained from the *one-to-one evaluation stage* and also *the small group evaluation* . The results obtained from *the one to one evaluation stage* can be seen in table 3 below.

Table 3. Results of *One to One Evaluation* (Teacher)

Assessment criteria	**Score (%)**	**Category**
Ease of Use	98.88%	Very practical
Learning Time Efficiency	90%	Very practical
Benefit	97.78%	Very practical
Total	**96.96%**	**Very practical**

The table above shows the results of *the one to one evaluation stage* with the teacher trial subject. The results of *one to one evaluation* with student test subjects can be seen in Table 4 below.

Table 4. *One to One Evaluation* Results (Students)

Assessment criteria	**Score (%)**	**Category**
Ease of Use	98.66%	Very practical
Benefit	100%	Very practical
Total	**98.97%**	**Very practical**

Furthermore, from *the small group evaluation stage* the results were also obtained in the form of the practicality level of the module, with details that can be seen in table 5 below.

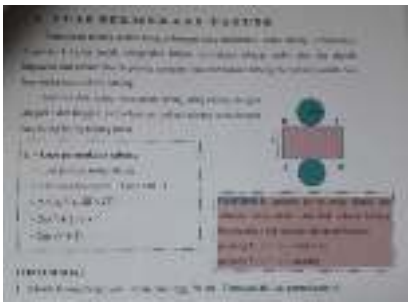
Table 5. *Small Group Evaluation* Results

Assessment criteria	**Score (%)**	**Category**
Ease of Use	91.5 %	Very practical
Benefit	94.16 %	Very practical
Total	**92.11%**	**Very practical**

The module validity test was carried out twice involving 3 validators who assessed the content and media aspects of the developed module. The average total score of the three validators in the second stage was 4.54 in content validation and was included in the "Very Valid" category. This result has increased by 0.41 from the results of the content validation stage 1. Meanwhile, the media validation value was 4.75 and was included in the "Very valid" category. This result also increased by 0.32 from the results of stage 1 media validation. The validators gave permission to continue at the next evaluation stage after revisions were made according to the validators' suggestions.

The evaluation stage that is carried out after *the expert review stage* is *the one to one evaluation stage*. Example of validation results in the following Figure

Before Revision



After Revision

This stage involved 6 respondents with details of 3 math teachers and also 3 students from class IX-2 of SMPN 4 Takengon. Trials at this stage were carried out with the aim of seeing the practicality of prototype 2 from the user's point of view through filling out a questionnaire for the practicality test of the math module with the STEM approach on curved side space constructs. The practicality value of using prototype 2 was obtained from the teacher's assessment of 96.96% with the criteria "Very practical" and from the student's assessment of 98.97% with the criteria "Very practical".

Then a *small group evaluation stage was carried out* which involved 16 students of grade IX-3 SMPN 4 Takengon. The students were asked to briefly study the prototypes of the 2 mathematics modules that had been developed. Afterwards they were also asked to fill out

the same practicality test questionnaire as given to students in *the one to one evaluation stage* . The assessment given by the students towards the mathematics module with the STEAM approach to the curved side space material at this stage was very good so that the practicality value of the prototype 2 module was obtained at 92.11% with the criteria "Very practical".

The STEAM study contained in this mathematics module is divided into several sub-materials, namely (1) Tubes, in this sub-material the researcher relates the STEAM study field to the beduk/Beduk Pendowo theme, (2) Cones, in this sub-material the researcher links the fields of STEAM study with Mbaru Niang's house in Wae Rebo, (3) Bola, in this sub-material the researcher linked the STEAM study field with satellite/Sputnik 1, and (4) Combined curved side geometric shapes, in this sub-material, the researcher linked the STEAM study with earthquake resistant houses or better known as teletubbies/ *dome houses.*

Based on the explanation above, it is known that the module developed has entered the very valid and very practical criteria. The results of this study are similar to previous studies conducted by Utami et al. (2018) who developed a module with the STEAM approach to quadrilateral material, with the results showing that the expert judgment was very appropriate (87% material experts, 89% media experts and 92% linguists) and the teacher and student responses were very interesting (89% small group, 87% field test and 90% teacher). The same thing was also found by Aminingsih & Izzati, (2020) who developed a STEM-based module on set material, with a feasibility level of 92%, and attractiveness of 76.77% from teacher responses and 84.99% from students.

Conclusion

The process of developing math modules with the STEAM approach on valid and practical curvilinear material consists of three stages, namely (1) planning, (2) development, and (3) evaluation stage. Based on these three stages, a mathematics module with the STEAM approach has been produced on curved side material that can be categorized as very valid (content validation 4.54 and media validation 4.75) and also very practical based on *one to one evaluation* (teacher response 96 .96% and student response 98.97%) and *small group evaluation* of 92.11%.

The process of developing a math module with the STEA M approach on the material of curved side shapes does not reach the evaluation stage *of the fly test*. Therefore it is hoped that there will be further research on this module to the *fly test stage* separately in order to obtain an even better module.

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