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Designing Geometry Teaching Materials Using Malay Batik Patterns on the Topic of Geometric Transformation

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ABSTRACT

Many mathematics books presented in an abstract way and ended in student's perception of difficult subject for mathematics. The goal of this research was to develop geometry learning instruction by using Malay batik patterns on the topic of transformation for junior high school students. The use of local context expect helping student in learning. The ADDIE model which consist of analysis, design, development, implementation, and evaluation is used in this R&D research. A validation sheet serves as the validity instrument, which evaluates the accuracy of the instructional materials. The validity of teaching materials was determined with the average score was 3.57, which was considered to be valid. The practicality tool is a worksheet for utilising instructional resources. This study's implementation was carried out for a limited sample, the practicality percentage value is 89.61%, with a very practical category. The development of the research's end product has led to the creation of geometry transformation teaching materials for junior high school ninth graders that are both valid and practical and are based on Riau Malay batik themes.

Keywords: *ADDIE Model; Geometry Transformation; Mathematics Learning; Malay Batik Patterns*

1. Introduction

A foundational subject, mathematics plays an important part in both education and daily life [1]. Numerous pupils frequently believe that math is a challenging topic. This phenomena is likely caused by the initial assumptions that many students have about mathematics, which is that it is a difficult subject. Mathematics is perceived as an abstract and difficult subject to understand, which has been made worse by the lack of books published in Indonesia that present math problems in a more contextual setting [2]. According to Iqbal et al. [3], mathematics instruction in schools is different from what kids encounter in their daily life. Gaining a higher grade on the final test is frequently emphasized as a learning goal in Indonesian education. In order to get the best learning results, it is therefore required to make modifications to both the learning process and the resources available for learning. Freudenthal's [4] viewpoint on realistic mathematics education, highlights the fact that mathematics is essentially a human activity. According to Siregar & Dewi [5], introducing mathematical ideas in the context of daily life can help pupils develop a morally upright, well-behaved, and accountable personality.

Geometric transformation is one of the mathematical concepts that may be learned from the actual world. Many students now believe and think the subject of geometric transformations to be difficult to learn [6], and scored poorly on this particular issue [7][8]. In addition, children did not comprehend how a shape is mirrored or reflected, according to study by Andriliani et al. [9]. One of the fields of geometry known as geometry transformation explores the identification of changes in an object or geometric field, including their position, size, and shape [10]. According to Afnenda et al. [11] students had trouble grasping the ideas and variations that were present in the questions as well as recognizing different forms of transformation, such as translation, reflection, rotation, and combinations of these transformations.

The problem is that only a few mathematics textbooks present mathematical problems in context, so mathematics is often considered abstract and challenging to understand the subject [12]. Suastika & Rahmawati [13] found only about 10% of contextual questions in mathematics textbooks for junior high school students in Indonesia. Apart from that, based on the findings of Ningrum & Suparman [14], the teaching materials used are provided by government, teachers used the teaching materials without determine which teaching materials are appropriate.

Teaching materials are essential in the teaching and learning process, it was not only act as learning components that must be analyzed, studied and understood by students, but also will provide learning guidelines for students [15]. Teaching materials are one component of learning sustainability used by teachers to facilitate learning activities [16][17]. Abstract mathematical material can make it difficult for students to understand the material, one solution that can be done is to design teaching materials that present the material in a more realistic context so that it is easy for students to imagine [18].

The success of the learning process is significantly influenced by the teacher's capacity to provide instructional materials [19]. The learning resources utilized in the classroom include teaching materials, which are organized systematically to provide a positive learning environment for the students [20]. One strategy for producing high-quality learning is to construct the teaching materials in accordance with the students' cognitive abilities, age level, an attractive appearance, a systematic structure, and the use of clear vocabulary so that students can understand it well [21].

By using the students' culture, additional contextual learning materials are being used to assist pupils better comprehend mathematical ideas. The research by Roza et al. [22] that found that learning materials having a contextual and cultural focus can help students comprehend the lesson more quickly. The use of Indonesian batik is asba local wisdom has spread to both significant occasions and everyday activities. For example, batik is now used to decorate homes and to symbolize weddings and funeral rites [23]. Indonesian batik patterns come from every location, as a result batik is given regional names, each of which has distinct qualities and connotations [24]. Indonesian batik has been recognized and declared by UNESCO as a cultural property [25].

Through Regional Regulation of Riau Province Number 12/2013, the government promotes the incorporation of local knowledge in learning in high schools [26]. Riau batik pattern are one of the aspects of Riau culture that are most familiar to the pupils, because batik pattern have been used for years on school uniforms. The batik designs may be utilized as a teaching tool to help students understand the idea of geometric transformations, as seen in Figure 1.

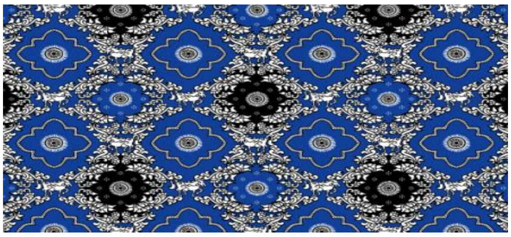

Figure 1. Batik school uniform pattern

The geometric transformation laws of reflection, translation, rotation, and multiplication may be used to explain the regularity of the arrangement of the batik designs. According to [27], the Siger motif, tree of life motif, and ship motif are only a few of the batik motifs that are connected to the notion of transformation geometry, the usage of batik patterns will surely help students comprehend mathematical ideas. This is consistent with the reality principle, which is the central tenet of realistic mathematics education. It emphasizes that students learn mathematics through the solution of real-world problems, and it gives them the chance to comprehend the significance of the mathematical constructions they have created as a result [28]. Aini et al. [29] discovered that culturally relevant learning materials might boost students' motivation and enthusiasm in studying mathematics.

A new teaching material to teaching mathematics that incorporates local culture is required, in light of the facts above, so that mathematical assignments can be solved as contextual problems fusing mathematics and culture. The use of local culture in learning mathematics is expected to increase student's knowledge of local culture. In addition, this teaching material is expected to increase students' motivation and enthusiasm in learning geometry transformation material. That is the rationale for this work, as for the purpose of this study, which involves creating math teaching materials for ninth-graders in junior high schools using Malay batik themes that are valid and practical to use.

2. Method

The research in this study uses R&D designs [30]. In order to teach ninth students in junior high schools about geometry transformation, math teaching materials based on Malay batik themes were developed. The development processes adhere to the five steps of the ADDIE model: analysis, design, development, implementation, and evaluation as shown in Figure 2.

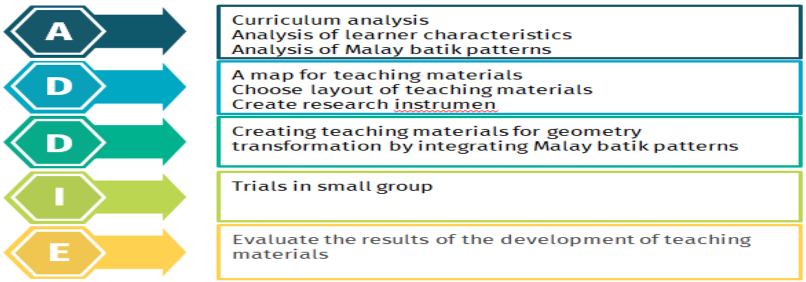

Figure 2. ADDIE Development Model

Curriculum analysis was done throughout the analysis phase. Analysis of learner characteristics and Malay batik motifs connected to the subject of geometry transformation was conducted for either the mathematics curriculum or the local content curriculum. At the design stage, the researchers organized a map of the requirements for teaching materials, chose the layout of the teaching materials, and created research instruments in the form of validation sheets and questionnaires for student responses. The actions at this stage involved creating instructional materials in accordance with the original plan. Riau Malay batik patterns can be found in the instructional resources created. The created instructional materials were verified by three validators to ensure their validity. The implementation portion of the procedure was carried out immediately after the validity of the instructional materials was established. Trials in both small and big groups were carried out at this point. By using the students' responses to questionnaires, the experiment was done to evaluate the usefulness of the instructional materials. Nine high school students of SMPN 1 Tembilahan Hulu in the ninth grade served as the study's test subjects. Following the test, the study process went on to its last phase, assessment. At this point, the generated instructional materials were evaluated and assessed using the results of the student response surveys.

The instruments used in this study consisted of validation sheets and student response questionnaires. Both quantitative and qualitative data were collected for this investigation. The quantitative statistics were derived from the validators' scores. The validators' recommendations and remarks are where the qualitative data originates. The findings of the validation sheets and the student response questionnaires were analyzed as part of the study's data analysis methodologies. A Likert scale with four alternative answers—not appropriate, less appropriate, appropriate, and very appropriate—was utilized for the validation instrument's evaluation. These options were 1, 2, 3, and 4. The formula for data analysis was taken from Sugiyono [30]. The total scores received from all validators were added together, and the results were divided by the total number of validators to determine the average score of the validator's evaluation results.

To assess the level of applicability of the created instructional materials, the results of the students' replies were assessed. Practicality analysis was carried out using the following formula:

$$V_p = \frac{T_{sp}}{T_{sh}} \times 100\% \quad (1)$$

Description:
V_p = Percentage score from student response questionnaires
T_{sp} = Total score obtained from students
T_{sh} = Total highest possible score

The practicality analysis criteria used can be seen in Table 1.

Table 1. Criteria for practicality of teaching materials

Interval	Category
$85.00\% < V_p \leq 100.00\%$	Very Practical
$70.00\% < V_p \leq 85.00\%$	Practical
$50.00\% < V_p \leq 70.00\%$	Less Practical
$01.00\% < V_p \leq 50.00\%$	Not Practical

Source: [31]

3. Result

The outcomes of this development research take the form of mathematics teaching resources with basic competencies (BC). These resources focus on two key concepts: describing geometric transformations (reflection, translation, rotation, and dilation) developed with contextual problems, and solving contextual problems related to geometric transformations (reflection, translation, rotation, and dilation).

According to Babakr et al. [32], the analysis of the students' characteristics includes activities to look at the students' stages of understanding mathematics learning using Piaget's theory of cognitive development, adjusting the materials and teaching methods used to maximize the students' potential.

The examination of Riau Malay batik motifs includes looking at how the motifs are arranged in relation to the subject of geometric transformations. The outcomes of the analysis are depicted in Figures 3 and 4. Teaching materials frequently feature the bunga berisi batik design seen in Figure 3. According to Figure 3, the bunga berisi batik motif has a pattern layout that complies with reflection requirements. The x-axis and y-axis both reflect each blossom.

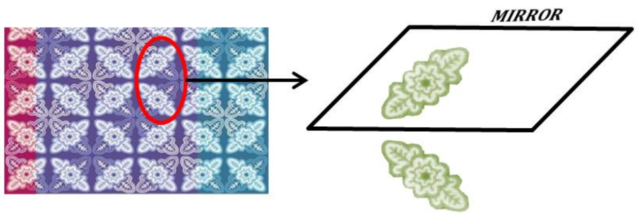

Figure 3. 'Bunga berisi' (filled flower) batik pattern

The sardine fish batik pattern is seen in Figure 4, and it is utilized to create the instructional materials. The sarden fish batik pattern features an arrangement of motifs that adheres to the principles of rotation, as can be seen in Figure 4. 45° of rotation around the clock is applied to each fish.

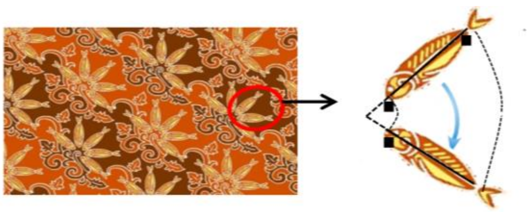

Figure 4. Sardine fish batik pattern

Four learning materials and eight sub-materials were turned into learning activities in the teaching materials after the researchers established an initial design of the teaching materials by collecting a map of the teaching materials demands. Reflection, Translation, Rotation, and Dilatation are the subjects of the lessons. Three sections—the introduction, the instructional materials, and the conclusion—were used in the creation of the teaching materials. A preamble, a table of contents, a description, Fundamental Competencies (BC), Competency Achievement Indicators (GPA), concept maps, and perspectives make up the introduction.

The creation of teaching materials on geometry transformation for junior high school's ninth grade was done throughout the development stage. The basic design that was produced was followed in the creation of the instructional materials. The 2013 Curriculum and its 2017 revision served as the basis for the creation of the instructional materials. The following is an explanation of how researchers contributed to the creation of instructional materials.

3.1. Front Cover and Introduction Section

Following the basic design, the front cover and introduction section was created. Introduction includes the title, school level, class, researchers' names, and supporting photos with batik Malay's pattern. The teaching materials' introduction part was created by giving descriptions, fundamental skills, indications of competence attainment and idea maps. Figure 5 displays the opening chapter of the book.

Figure 5. Front cover, introduction session and concept map

The concept map, as seen in Figure 5, includes a brief description of the instructional content displayed as a map. The learning method begins with necessary readings on the coordinate system before moving on to the subject of transformation, which includes everything from reflection to dilatation.

The preconditional components for geometric transformations, Cartesian coordinates, are contextually problematic in perception. Students were instructed to record the coordinates of each district in Riau on a table as shown in Figure 6 after the researchers displayed a map of the province of Riau to them.

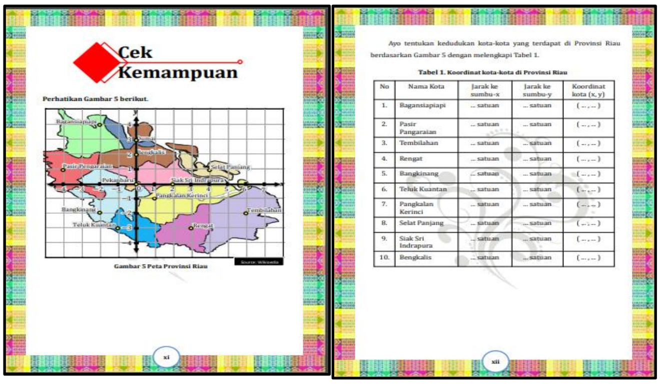

Figure 6. Apperception

3.2. *The Content Section*

Four lesson themes were used to construct this teaching material. Each learning tool includes practice questions, example questions, and learning exercises. A scientifically based explanation of the subject that pupils have learned is also included in the learning activities. As seen in Figure 7, the initial stage involves inviting pupils to inspect an object. The arrangement of batik motifs follows the geometric transformation principles which are introduced at the start of the learning activity to inspire students about the advantages of geometric transformation. By examining how these batik designs are transformed into a single batik fabric, students carry out the first stage of the scientific method.

As seen in Figure 7, the section on sample questions includes challenges and solutions to the issues raised. The example questions are provided to help the students comprehend the course material. Questions pertaining to the lesson are included in the practice area. The activities are provided after the course is given, and the example questions are used to gauge students' aptitude and comprehension of the subject.

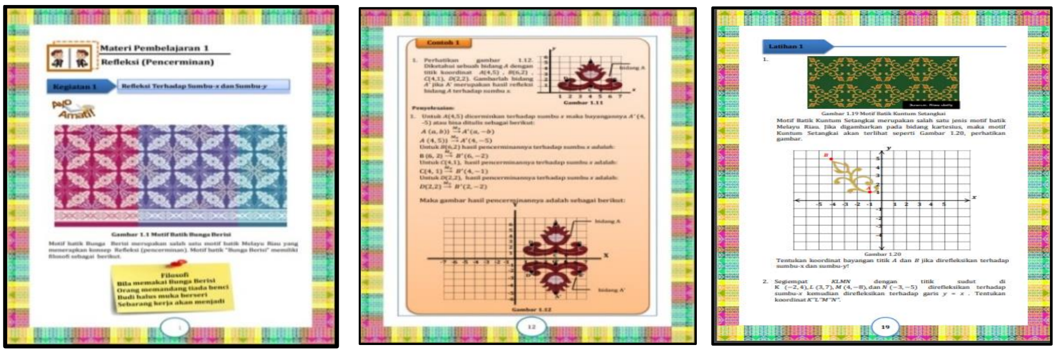

Figure 7. Learning activities section and sample questions section

3.3. *Validation and Practicality of the Mathematics Teaching Materials*

Three validators validate the generated teaching materials. After then, the instructional materials were updated in accordance with the validator's recommendations. Figure 8 depicts the outcomes of the validation of instructional materials.

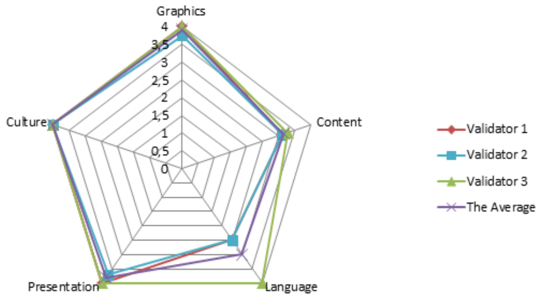

Figure 8. Validation results of the teaching materials

Figure 9. Results of students response questionnaire

The validity value, 3.57 was determined based on the total average and was deemed to be extremely valid. The validators provided comments and suggestions on several parts of the training materials they evaluated, including the language aspect, which got the lowest validation rating of all the aspects at 3.00 but still had a valid category. According to comments and recommendations, there are a lot of typos and unsuitable language usage, which accounts for the poor validation rating of this language element. The Riau Malay cultural element had the highest validation score of 4.00, which was considered to be extremely valid. The appropriateness of using Riau Malay batik motifs in the Geometry Transformation material is demonstrated by the high value of the validation of the Riau Malay cultural feature.

The instructional materials were subsequently updated in light of the validators' feedback. The instructional materials created had been revised, and when it was finished, it had satisfied the standards for validity and was worthy of being tested on students. This study only used online small group trials; no large group trials were performed. In a small group experiment, nine students from SMPN 1 Tembilahan Hulu in the ninth grade with a range of abilities examined the practicality of the instructional materials. Figure 9 displays the outcomes of the small group trial analysis of the instructional materials.

It was discovered that the small group trials' average score from student response surveys was 89.61%, with extremely practical criteria showing that the instructional materials were simple to utilize. The element with the lowest percentage value also satisfies the extremely useful standard (85.28%). The display aspect, with a percentage value of 92.59% and a rating of "very practical," has the greatest percentage value. Based on the suggestions written by students in the student response questionnaire, it can be seen that students feel interested in using teaching materials with the context of Malay batik patterns. Students also gain new knowledge about the types and meanings of Malay batik patterns.

4. Discussion

In this study, the Malay culture of Riau was integrated into the geometry transformation curriculum for the ninth grade of junior high school, as well as the development of teaching materials based on context. This research and development employs the ADDIE model. According to the study's findings, the generated instructional materials have complied with relevant and useful standards. Since they are on their level (the ninth grade of junior high school), they can be utilized in the geometric transformation teaching materials.

These teaching resources for geometry transformation were created using Malay ethnomathematics and a realistic mathematics education method. Malay batik paintings that are used in real-world settings and adhere to the fundamental tenets of realistic mathematics education serve as an example of this [33]. The use of culture in RME-based learning has also been done in the past by Matondang [34] and Azmi [35], who used Mandailing and Acehnese culture to improve high school students' communication skills. Matondang's and Azmi's research revealed that culture-based teaching modules were effective in improving students' understanding of communication skills than those who use traditional learning.

The created geometry transformation teaching resources satisfies the standards for validity and applicability. The results of the Junior High School ninth graders' expert validity and practicality exams demonstrate this. The instructional resources were highly received by the students. Positive student answers demonstrate the curiosity and happiness that students experience, which helps them to become more motivated to learn [36]. According to Muslimah et al. [37] study, 85% of students indicated interest in studying geometric transformation material utilizing the pocket book they used, which included Indonesian batik themes.

This demonstrates that the designed mathematics teaching materials have a decent design and are furnished with images that are pertinent to the subject and are commonly used by students. Their selection of images, size, and form can stimulate pupils' interest in learning. Hilaliyah et al. [21] conclusion that the size, color scheme, and pictures of instructional materials are considered as indicators of the design's viability by students' ability to learn is supported by this. This demonstrates that the pupils enjoy the way the instructional materials look. The Riau Malay batik motifs used in the instructional materials are successful in piqueing students' attention.

These culturally-based teaching resources were also created by Dahlan & Permatasari [38], who came to the conclusion that societal norms and social values might aid a teacher in teaching mathematics. Applying cultural concepts to math instruction can also help students' personality traits. The incorporation of culture into educational materials, in the opinion of Nuraini and Setyowati [39], may both improve students' comprehension of the content being taught and help them become more aware of culture. Accordingly, the research findings of Marten et al. [40] demonstrate that incorporating culture into mathematics learning can make it simpler for students to grasp the topics being taught since learning becomes more meaningful. Mathematics helps students develop new perspectives on how mathematics, reality, and culture relate to one another [41]. Using the data, it is also determined that the generated mathematics teaching resources using Riau Malay batik themes are workable.

5. Conclusion

Based on the findings of this study, it can be said that mathematics teaching materials for ninth graders of junior high school based on Riau Malay batik motifs in the topic of Geometry Transformation have reached a highly valid criterion with an average score of 3.57. The developed teaching materials have reached a highly practical criterion by gaining an average percentage of 89.61%. The use of Malay batik patterns can increase student motivation in learning geometric transformation material as well as increase student knowledge about batik.

The following suggestions are then made in light of the results of this research project: (1) The developed teaching materials in this study can be used as an alternative learning resource to support learning activities in the topic of geometric transformation for ninth graders of junior high school because they have met valid and practical criteria; (2) The developed teaching materials can be a model for other researchers who want to develop teaching materials. After using these created teaching resources, further study may look at the efficacy and quality of mathematics learning.

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