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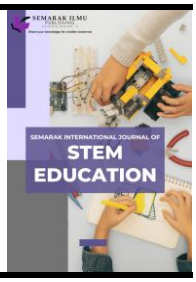

Development and Usability of the Geometry Kit Integrating Inquiry Learning Based Project in the Topic of Space Year Four

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ABSTRACT

This study aims to develop and test the usability of the Geometry Kit (GeoKit) integrating project-based inquiry learning in the topic of Space for Year 4 Mathematics. This study uses a development study design by applying the ADDIE model which consists of five phases namely analysis, design, development, implementation, and evaluation. The sample selection was carried out by simple random sampling of 124 samples consisting of fourth year students in two schools in Batang Padang, Perak. Data was collected through three research instruments, namely a needs analysis questionnaire, content and face validity of GeoKit questionnaire and usability of GeoKit questionnaire. Validation of GeoKit was performed by four experts. The findings of the expert evaluation were analyzed using the Content Validity Index (CVI) while the data of GeoKit needs analysis and usability were analyzed descriptively through frequency, percentage, mean and standard deviation. The findings of the study show that the developed GeoKit has satisfactory validity with I-CVI and S-CVI/Ave values of 1.00. The findings of the study also show the mean score and standard deviation of GeoKit's usability for the construct of usefulness (M=3.43, SD=0.37), easy to learn (M=3.46, SD=0.39), easy to use (M=3.49, SD=0.50) and satisfaction (M=3.60, SD=0.38) are high. In conclusion, the developed GeoKit has satisfactory validity and high usability. Hence, it implicates that GeoKit that integrates project-based inquiry learning becomes one of the alternative kits that supports active student learning and provides a meaningful learning experience for students in mastering the topic of Space.

1. Introduction

Geometry is one of the most important areas in mathematics education, which includes learning about shape, size, space and properties related to geometric objects [1]. Geometry learning can help improve students' cognitive level, where good knowledge and mastery of geometry can help students improve their ability to analyze and interpret the environment, in addition to applying geometry knowledge to solve problems in everyday life [6]. However, Thahirah *et al*., [14] found that most

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students, especially those in lower grades, often face difficulties in understanding geometry concepts. According to Mohamad Basri *et al*., [12], this is due to students' limited knowledge in understanding basic concepts related to geometry. In addition, weak visualization skills also make it difficult for students to learn geometry well [14]. Kmetová and Lehocká [10] found that one of the factors that make it difficult for students to master geometry learning is the lack of use of learning materials that are in accordance with students' abilities and needs. Geometry learning focuses more on textbooks and blackboards that encourage students to learn through memorization methods without really mastering real geometry concepts [3]. In fact, this method cannot stimulate the development of students' cognitive skills according to their abilities and needs [4].

The use of learning materials is very important when learning geometry. According to Bassette and Bouck [5], the use of appropriate learning materials can improve memory and a deeper understanding of geometry concepts. Based on a study conducted by Junthong *et al*., [8], the use of learning materials in geometry learning is very effective in improving students' mastery in geometry learning, in addition to improving students' visualization skills. The use of learning materials can also not only create a fun learning environment, but even be able to challenge students' minds to explore and produce high creativity in learning geometry [2]. The results of the study by Trimurtini *et al*., [16] found that the use of learning materials can enhance students' cognitive abilities in solving more abstract problems, in addition to creating a very active learning environment.

In addition, the use of learning materials also allows students to apply concepts in geometry learning to the real world. According to Hartini *et al*., [7], learning geometry is not only about mastering geometry concepts alone, but geometry learning should emphasize the application of concepts throughout the geometry learning process so that geometry concepts can be properly mastered and then geometry learning will be more meaningful. With appropriate learning materials, students can relate geometry concepts to real world situations [3]. This will make the mastery of geometry learning more meaningful.

In this regard, the purpose of this study is to develop GeoKit (Geometry Kit) by integrating project-based inquiry learning, where the activities performed are focused on the project-based inquiry learning approach. According to Quigley [13], appropriate learning methods in the application of learning materials can help students to represent mathematical ideas and improve the level of students' thinking skills.

1.1 Project-Based Inquiry Learning

Project-based inquiry learning is a combination of the inquiry learning approach and the project-based learning approach. According to KPM (2016), the project-based learning approach is one of the inquiry learning strategies implemented in the classroom. Project-based inquiry learning is a learning method that emphasizes scientific skills and attitudes, high-level thinking skills, creative problem solving, design and construction based on technological objects, and encourages students to communicate and cooperate in groups [11]. Project-based inquiry learning is also a type of learning that uses a constructivist approach in which students seek to develop thinking skills, explore and find solutions, and collaborate in building and producing creations [15]. This project-based learning approach was chosen to encourage students to learn geometry through exploration, and to produce designs based on the geometry concepts they have learned.

There are four phases in the project-based inquiry learning approach, namely (1) exploration, (2) recognition, (3) design and (4) reflection. In the Inquiry phase, learning begins by stimulating students with stimulating materials such as pictures, video clips or authentic materials to encourage students to ask questions and create curiosity in students. In addition, some questions are posed to students

to increase their curiosity. In the exploration phase, students explore and seek information from different sources to obtain information related to the project to be produced. This should help students to develop their knowledge. Once they have all the information they need, students begin to design, create and prepare materials for their project. In the design phase, students begin to develop the design that has been framed and designed in the lighting phase. Students create and develop their project and then test the effectiveness of the resulting product to answer the question posed in phase one. In this phase, students manipulate GeoKit to produce their projects collaboratively. In the reflection phase, students will present and display the projects they have created and reflect on the learning process. At the same time, students need to be encouraged to express opinions, awareness and appreciation of what they have done. The four phases of project-based inquiry learning applied to geometry learning are designed to develop students' understanding and mastery of geometry learning through exploration, investigation, application of knowledge, creation and assessment in a more meaningful learning context.

2. Methods

This study employs a development study design that is based on the ADDIE instructional design model. The ADDIE model comprises five phases: analysis, design, development, implementation, and evaluation. The implementation of this ADDIE model-based research is presented in Table 1. This study employs a quantitative methodology to assess the efficacy of GeoKit as a learning material for geometry.

Table 1
ADDIE Model

Analysis	• It would be beneficial to ascertain whether the development of a learning kit for the Year Four Space topic would be a worthwhile endeavor. • What are the defining characteristics of the learning kit and the most effective learning method that has been developed? • (Based on the perspectives of teachers and students)
Design	• Produce a suitable GeoKit design based on the Standard Curriculum and Assessment Document (DSKP) of Mathematics Year Four and project-based inquiry learning approach.
Development	• The first step is to construct a GeoKit, which is a set of tools and activity modules. The next step is to obtain expert validation of the GeoKit.
Implementation	• A pilot study should be conducted to assess the reliability of the instrument. Following this, the actual study should be carried out.
Evaluation	• Determine the usability of GeoKit as a learning material in learning the topic of Space

The study was conducted among fourth-year students in Batang Padang, Perak. A total of 124 students from two schools were selected as the study sample through convenience sampling. The data were collected through three research instruments: the needs analysis research question, the GeoKit face and content validity research question, and the GeoKit usability research question. The objective of the needs analysis research question was to gather information that would inform the development of an appropriate GeoKit for geometry learning. The GeoKit face and content validity research question was designed to obtain expert validity. The investigation of GeoKit usability

comprises four constructs, namely usefulness, ease of use, ease of learning, and satisfaction. These were adapted from Lund's (2001) usability model. Subsequently, expert validity was ascertained for each instrument, thus establishing the validity of the instruments employed in this study.

3. Result and Discussion

The development of the GeoKit was based on the needs assessment analysis that was carried out on teachers and students in the analysis phase. The GeoKit contains several tools and an activity module. Figure 1 (a) and (b) presents the actual GeoKit that has been built in this study.

Fig. 1. (a) Developed GeoKit, (b) List of items in GeoKit

The developed GeoKit was subjected to an assessment by experts with a view to determining its face and content validity. The face validity of the GeoKit tools and modules was evaluated to assess the output aspects and usage effects. The content validity of the GeoKit as a whole was assessed to determine the extent to which the developed GeoKit covers the domains and concepts that should be measured in this study. This validity was conducted by four experts and analyzed using the CVI method. The results demonstrated that the Item-Content Validity Index (I-CVI) and Scale-Content Validity Index/Average (S-CVI/Ave) values obtained were 1. As outlined by Polit and Beck (2007), a CVI value of 1 signifies a high level of consensus among the assessment experts regarding the suitability of the items for measuring the constructs and for implementation in the study.

The usability of GeoKit was evaluated through the use of a research question instrument comprising four constructs: usefulness, ease of use, ease of learning, and satisfaction. The reliability of the instrument was ascertained through a pilot study. The Cronbach's Alpha value obtained was 0.922 for all constructs of the GeoKit usability research instrument. As stated by Bond and Fox (2015), a Cronbach's Alpha value exceeding 0.70 is considered to be very good and acceptable. Furthermore, the usability of GeoKit was evaluated in a study involving 124 fourth-year students. The data were subjected to descriptive analysis in order to obtain the minimum score value and the skill side. The descriptive statistical interpretation of the minimum score in this study was adapted from the study of Saizatul Akmar (2022), which demonstrated that respondents exhibited a high level of approval if the minimum score was between 3.26 and 4.00.

Table 2
Analysis of the usefulness of GeoKit according to constructs

Usability Construct	N	Minimum	Maximum	Mean	Standard Deviation
Usefulness	124	2.63	4.00	3.43	0.367
Ease of Use	124	2.45	4.00	3.46	0.391
Ease of Learning	124	2.00	4.00	3.49	0.497
Satisfaction	124	2.57	4.00	3.60	0.376
Overall Total	**124**	**2.41**	**4.00**	**3.50**	**0.408**

Table 2 presents the results of the analysis of the usability of GeoKit for the min score value and the standard deviation value according to each construct. The results of the analysis presented in Table 2 indicate a high level of agreement between the mean of the min score value and the standard deviation value for each construct on the usability of GeoKit in learning the topic of Space. This is evidenced by the high mean scores for the constructs of usefulness (M=3.43, SD=0.367), ease of use (M=3.46, SD=0.391), ease of learning (M=3.49, SD=0.497) and satisfaction (M=3.60, SD=0.376).

The overall usability of the GeoKit was evaluated by calculating the sum of the minimum scores for the four constructs. The overall sum of the minimum score values for the usability of this GeoKit is 3.50, which indicates that the usability of this GeoKit as a student learning kit in learning the topic of space is highly satisfactory.

4. Conclusions

The developed GeoKit has been subjected to a rigorous testing process to ascertain its validity and usability from four key perspectives: usability, ease of use, ease of learning, and satisfaction. The findings of the study indicate that the utilization of GeoKit can be regarded as an effective learning aid, particularly in the context of learning. The utilization of GeoKit can enhance students' active engagement, interest, and comprehension in the subject of Fourth Year Space. The results of this study are expected to inform educators and researchers in the production of learning kits that have an impact on mathematics education. With the collaboration and dedication of educators, the transition from traditional learning methods to more contextual, interactive, and student-centered approaches can be achieved in a gradual and sustainable manner. This necessitates a dedication to ongoing adaptation to the most recent advancements in education, in addition to a readiness to alter existing methodologies to cultivate a more qualified human capital.

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