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Development of K-Visual GKT Module for Improving Visualization Skill Based on The Art of Origami for Technical Drawing Subjects

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ABSTRACT

Visualization skill is essential abbilites for every students who learn technical drawing, and mathematics in general. This skill could be improved through practical learning. K-Visual GKT designed to enhance students' visualization skills through activities involving the art of origami and kirigami. This module, based on the Sidek Module Development Model, integrates origami and krigami to engage students in producing 3D paper folds independently. This paper will examine the validity and realibility of the module. This research conducted quantitatively and involves expert and students. The data collected will be analysis. The findings showed that the modules produced high validity values from experts (88%) and high reliability from all students (α=.846). The results affirm the effectiveness of the K-Visual GKT Module in enhancing students' visualization skills, providing a promising solution to address challenges in technical drawing education. Further examination of the module's potential impact on students' visualization skills is proposed, contributing to the ongoing efforts to improve visualization skills.

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Introduction

The ability to visualize is crucial in technical drawing education, as highlighted in studies on the subject, such as GKT (*Grafik Komunikasi Teknikal or technical drawing subject*) (Ariffin et al., 2020; Sorby et al., 2020). A proficient visualization skill is key for students to excel in technical drawing (D. R. Sanchez et al., 2020). Students lacking in this skill often struggle to apply concepts and theories to produce drawings, impacting their success in technical drawing subjects (Lee Gooh Mo et al., 2012). Further study affirm that Malaysian students face difficulties in producing drawings, especially in topics requiring high visualization skills (Yahya et al., 2021).

To master technical drawing, students must grasp the basic concepts, which, in turn, rely on visualization skills (Lee Gooh Mo et al., 2012). Despite the importance of visualization, studies reveal a prevalent low level of this skill among Malaysian students (Mohd Safarin Nordin & Muhammad Sukri Saud, 2007) Spatial orientation elements like mental rotation, cutting, and folding remain challenging for engineering students (Rambe et al., 2021).

Efforts to improve visualization skills are crucial, and studies suggest that visualization is teachable and can be enhanced through activities (Asamoah, 2022). However, conventional teaching methods in Malaysia often lack emphasis on visualization skills (Omar & Ali, 2016). The absence of suitable teaching modules and aids contributes to students' disinterest and lack of understanding in technical drawing (Marji et al., 2019).

Recognizing the importance of visualization in technical drawing, various measures, including origami activities, are proposed to enhance students' visualization abilities (Arıcı & Aslan-Tutak, 2015; Hanada, 2022). Origami, a Japanese paper folding art, has proven effective in improving visualization skills, particularly in math education (Arıcı & Aslan-Tutak, 2015; Krisztián et al., 2015a). In response, the researchers developed the K-Visual GKT Module, incorporating origami to enhance visualization skills in technical drawing students. Prior to implementation, the module's validity and reliability were rigorously assessed to ensure its efficacy in improving students' visualization skills in technical drawing. This research will examine the potential reliability of using the K-Visual GKT module as a solution to enhance visualization skills.

Technical Drawing

Technical drawing is a graphical representation of objects and structures, used to communicate complex technical ideas with precision for mass production and interchangeability of parts. It provides necessary information about the shape, size, surface quality, material, tolerance, and manufacturing process of a design (J.M, 2015). Technical drawing encompasses a wide range of concepts, including solid geometry, advanced geometrical construction, conic sections, intersection of surfaces, and principles of tangency, among others . It is a fundamental language for future engineers and is used in various engineering courses and future employment (D. T. Sanchez et al., 2020).

Technical drawing is an essential practical skill in technical education. Meanwhile, in the context of mathematics education, the ability to draw technically is also related to learning materials such as geometry (Lowrie et al., 2019; Pietropaolo & Araújo De Oliveira, 2021)

Visualization Skills

Visualization skills refer to the ability to mentally manipulate and create visual images of objects and spatial environments (Arslan & Dazkir, 2017). These skills are crucial in various fields such as design, engineering, art, and architecture, as they are linked to higher-level thinking and creativity, which are essential for success in these disciplines. Factors that influence visualization skills include previous experiences, training, and cognitive abilities. Research has shown that spatial visualization skills can be developed with training and practice (Prieto & Velasco, 2004; Sanati, 2020).

To improve visualization skills, individuals can engage in activities that involve mental rotation, manipulation, and transformation of visual stimuli. Training programs, such as those used in engineering graphics courses, have been found to enhance spatial visualization skills. Additionally, the use of computer-aided design (CAD) and model making has been shown to influence the development of visualization skills in disciplines like interior architecture. Furthermore, research suggests that exposure to 2D and 3D technical drawings, along with

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practice in creating and interpreting these drawings, can contribute to the improvement of visualization skills.

Visualization skills are crucial in the field of mathematics as they play a significant role in the learning process, understanding, and reasoning (Rathour et al., 2022). Visual representations aid in presenting mathematical ideas, developing students' abilities in mathematical communication, and contributing to the development of conceptual understanding (Rathour et al., 2022). Moreover, visualization can be a powerful tool for exploring and solving mathematical problems.

In the context of mathematics education, the use of visualization facilitates the perception and understanding of educational material by students, helps to develop interest in mathematics, and connects theoretical information more closely with practice. The method of visual teaching of mathematics plays a significant role in combating the formalism of school knowledge and its isolation from practical applications.

To implement visualization in learning, multimedia tools such as animations, films, and simulations can be used to capture dynamism and engage the entire perceptive apparatus of the teaching process(Rathour et al., 2022). Additionally, visual representations can be integrated into various areas of mathematics, including geometry, trigonometry, analytical geometry, real functions, differential and integral calculus, to encourage visual thinking (Rathour et al., 2022). By incorporating visual representations into the teaching of mathematics, educators can enhance students' understanding of mathematical concepts and their problem-solving abilities.

K-Visual GKT Module

A study conducted by (Arici & Aslan-Tutak, 2013) found that the use of origami methods can improve visualization skill, geometric achievement and even geometric understanding among students. Meanwhile, (Krisztián et al., 2015b) stated that the use of origami in education can improve the level of rotating and folding skills in the mind, both of which are important elements of visualization skill. Looking at the potential use of origami in enhancing the level of visualization skill, the researchers developed a K-Visual GKT Module to enhance the visualization skill of technical drawing students using the origami method. This module was developed based on the Sidek Module Development Model (Sidek Mohd Noah & Jamaludin Ahmad, 2005).

Figure 1. K-Visual GKT Module

In this module, students will be invited to learn the art of origami and krigami and independently produce 3D paper folds. The goal of various activities in this module is to enhance the students' visualization skills, which will be assessed at the final stage of the GKT module activities.

The k-visual GKT module consists of three phases: pre-activity, activity, and post-activity. In the pre-activity phase, the teacher ensures that all the necessary equipment and materials for paper folding activities are available. Then, in the activity phase, students are first shown a video demonstrating the steps of paper folding and then perform the activity independently. Meanwhile, after the paper folding activity is completed, the teacher reflects on the conducted activity and collects the products produced by the students.

Figure 2 Activitiy sample

Method

The study uses a quantitative study design and is divided into two parts. The first part which is module validity study was conducted on 5 sample people using the 5-point likert scale validity questionnaire. Two of the sample were lecturers of public universities in Malaysia with PhD education backgrounds while the other 3 were GKT technical drawing teachers with more than 10 years of teaching experience then will the data will be analaysis using descriptive analysis. For the second part, the reliability study of the module was conducted using 9 samples of Form 4 students who took the subject of GKT at one of the secondary school in Johor Bahru. These students have participated in the activities of the module through the pilot studies conducted. After the completion of all the module activities, they have filled out a 5-point likert scale reliability questionnaire to assess the reliability of the modules they have been working on. All data from the first and second parts are quantitatively analyzed using the IBM SPSS Statistics software.

Results

This first part will show the findings of the study for the validity of the module based on the expert validityn form that has been completed by 5 selected experts. The requirement to determine that a module has good validity is to achieve a minimum score of 70% of the total number of experts who evaluate the module (Sidek Mohd Noah & Jamaludin Ahmad, 2005). A validity score of 70% is considered to be a sufficient score for a module before it can be used.

Table 1 Module Validity Rasch Analysis

Statement	Expert's level of consent				
	P1	P2	P3	P4	P5

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The content of this module meets its population targets	5	4	4	4	5
The contents of this module can be run perfectly	4	4	4	4	5
The objectives of this module are appropriate and have a positive effect on the students	5	5	4	4	5
The content in this module corresponds to the allotted time	5	4	4	4	5
The activities carried out in this module are interesting and appropriate to be carried out by students	5	5	4	4	5
This module can help improve the level of students' visualization skill	5	5	4	4	5
The content of this module can improve the level of student achievement	5	4	4	4	5
The content of this module can change the attitude of students towards greater excellence	5	3	4	4	5
Total score	39	34	32	32	40
Percentage	97.5%	85%	80%	80%	100%
The validity of the entire module			88.5%		

Table 1 shows the degree of approval of the expert as well as the validity of the modules obtained as a result of the analysis that has been carried out. Almost all items are agreed by experts with a score of 4 (Agree) and 5 (Very agree). However, the last item gets a value of 3 (Not sure) from a P2 expert. P5 experts gave the highest validity with 100% while P1 gave the second highest validity at 97.5%. P2 is in the middle with a validity value of 85%. The lowest validity values are given by P3 and P4 with 80% validity respectively.

Overall, the average of the five validity values given by all experts is 88.5%. The validity value of 88.5% indicates that the modules produced are at a good level and significantly higher than the minimum validity set by (Sidek Mohd Noah & Jamaludin Ahmad, 2005) which is 70% validity. Although the validity values given from all five experts vary except from P3 and P4, the validity given by each specialist individually is higher than the minimum validity value of 70%. This suggests that all experts provide good validity score for the modules that have been produced.

In the second part, a analysis of the reliability of the module is carried outto find out the reliability coefficient of the module that has been carried out. For this study, the researchers submitted the module reliability questionnaire to 9 students involved after they carried out all the module activities in the pilot study. Alpha Cronbach analysis is used to find out the reliability coefficient of the module as can be seen in table 2.

Table 2 module reliability coefficients

Activities	item	Sample (N)	Alpha Cronbach Value
Activity 1	4	9	0.667

Activity 2	4	9	0.984
Activity 3	5	9	0.858
Activity 4	4	9	0.935
Activity 5	5	9	0.736
Total Alpha Cronbach value			0.846

Table 2 shows the results of the analysis that has been carried out to determine the reliability coefficient of the module. The findings showed that Activity 2 obtained the highest reliability coefficient with Alpha Cronbach value of 0.984. In second and third place, Activity 4 and Activity 3 were occupied with coefficients of 0.935 and 0.858, respectively. Meanwhile, Activity 5 scored Alpha Cronbach at 0.736 while Activity 1 obtained the lowest reliability coefficient with 0.667. Overall, the entire module obtained reliability score with an Alpha Cronbach value of 0.846. According to (Sidek Mohd Noah & Jamaludin Ahmad, 2005) the value of the reliability coefficient received must be in the range of 0.50 to 0.85. The higher the value of Alpha Cronbach, the higher the level of reliability of the module. Therefore, the value of 0.846 obtained by this module indicates that it has a high level of reliability and is still within the specified range.

Discussion

Based on data collection and interpretation, it should be noted that K-Visual GKT Module has high value of validity and reliability. This results also inherent with not only conducted quantitatively but also qualitatively. Students stated that learning activities conducted using K-Visual GKT Modul was "great" and "excellent" in helping them improve their visualization skills.

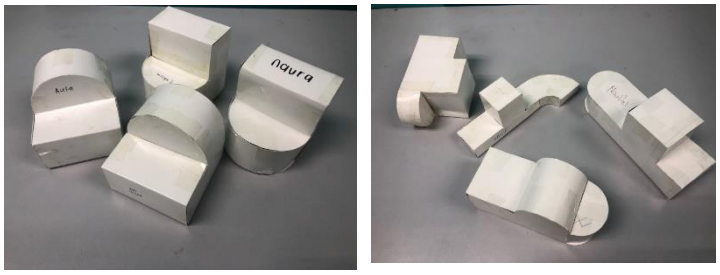

Figure 3 Product sample produced by students

Conclusion

Visualization skill has proven to be one of the main skills in the subject of technical drawing. Previous studies have shown that the use of origami art has proven to be able to improve the level of visualization skill of students. Therefore, the development of a module to enhance the visualization ability based on origami art (K-Visual GKT Module) is seen as potentially used to enhance the visualization ability of students for technical drawing subjects such as GKT. Based on the validity and reliability studies of the modules that have been carried out, it can be concluded that the modules that have been produced have a high level of validity and reliability. This module is of the appropriate quality and standard applied to technical drawing students to enhance their visualization skill.

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Conflict of Interest

The authors declare no conflict of interest

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