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Development and Usability of V-Math as a Teaching Aid for the Topic of Three-Dimensional Geometrical Shapes

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ABSTRACT

Underperformance in the subject of Mathematics as well as pupils' low performance in the area of geometry are common in previous findings in the education area. These problems occur because pupils have difficulty in understanding the concepts learned because of the teaching strategies used are not suitable for the lesson conducted. Hence, this study is conducted to develop a teaching aid (V-Math) and to determine its usability in learning Three-Dimensional Geometrical Shapes in mathematics subject in Form Two in the aspects of achievement of learning objectives, comprehension, user-friendly and interest. This study is a quantitative study that adapts developmental research design (DRD) as the research design. As many as 100 mathematics trainee teachers are taken into consideration as the population of this study and 80 of them become the sample of this study chosen by random sampling technique. The questionnaires are administered as the instruments that being used to collect data of this study. The data are analysed descriptively by percentage, mean score and standard deviation. The findings of the study showed that the respondents' evaluation on the usability of V-Math as the teaching aid in learning Three-Dimensional Geometrical Shapes is high with an average mean for mastery of learning is 3.73, comprehension is 3.70, user -friendly is 3.61 and interest is 3.69. As the findings of this study portray a high level of the usability of V-Math as a teaching aid in learning Three-Dimensional Geometrical Shapes, this suggested that teaching aid can be an alternative for teachers to deliver knowledge and concepts of geometrical shapes and hence may diversify techniques and approaches in teaching mathematics.

Keywords: mathematics, Three-Dimensional Geometrical Shapes, teaching aid, usability

1. INTRODUCTION

Mathematics curricular for secondary school in Malaysia has been revised from *Kurikulum Bersepadu Sekolah Menengah* (KBSM) into *Kurikulum Standard Sekolah Menengah* (KSSM) which gradually started from 2017 and has been fully used in 2021. The syllabus for Mathematics focusing in five areas that are number and operations, measurement and geometry, relationship and algebra, statistics and probability as well as discrete mathematics (Bahagian Pembangunan Kurikulum, 2016). Geometry is a branch in mathematics that study lines, angles, shapes and spatial. The field of geometry is one of the branches in mathematics that is being emphasized from the early learning in childhood education until the higher education level and become the components in many disciplines (Abdullah & Leow, 2017). This is because learning geometry is important to improve one's mathematical and

spatial ability (Rohendi & Wihardi, 2020). The concepts in geometry are useful in many areas such as in arts, science, architecture, computer, and even in medical (Patkin & Levenberg, 2012; Singh & Kumar, 2022).

Teaching aids is any materials or resources that used to help teachers in conducting teaching and learning in order to achieve the learning outcomes. The use of teaching aids in teaching and learning session not only less time consuming, but also may create interesting learning experience and thus attract students' interest and increase their motivation towards the learning (Ordu, 2021). However, it is common to hear that students could not understand well and mastering the concepts in geometry since people's stigma on mathematics as a difficult subject (Rohendi & Wihardi, 2020; Zaharin et al., 2021) and hence this may influence their interest and performance towards this subject. Three-Dimensional Geometrical Shapes is a topic in Mathematics for Form Two which grasp the concepts related to of three-dimensional shapes such as their properties, nets, areas and volumes (Bahagian Pembangunan Kurikulum, 2016). Learning this topic require students to analyse, describe, visualize, construct and thinking critically (Ismail et al., 2020; Ibili et al., 2020). However, several studies found out that students have difficulties in mastering the concepts involving three-dimensional shapes in the level of primary school (Ping & Hua, 2016; Sharma, 2019; Fujita et al., 2020; Ng et al., 2020) as well in secondary school (Ozerem, 2012; Alghadari et al., 2020; Nadzeri et al., 2022).

Ubi et al. (2018) stated that there are many factors that contribute to students' difficulties in learning geometry including lack of reasoning skill, poor comprehension on the geometry language, lack of abilities in visualizing, existing or background knowledge of the students as well as teaching method. According to Mohd Faizal Nizam Lee Abdullah and Leow (2017), without an understanding of characteristics and the relationship between characteristics deep geometry, the difficulty of students in learning geometry will getting worse in upper secondary as they will learn more difficult geometric concepts. Kakoma Luneta (2014) mentioned that geometry is considered as a problematic topic in secondary schools in South Africa because the pupil is unable to relate the properties of geometry to other sciences to solve the problem. In addition, it was found that students often draw conclusions general about a certain geometric shape and do not fully understand the concept of angles formed from parallel lines (Mohd Faizal Nizam Lee Abdullah and Leow, 2017). Nadzeri et al. (2022) found that students find it is difficult to draw the nets of 3D shapes without the existence of the sample of the real objects which lead to the lack of visualizing the shapes besides having difficulties in remembering the name of the shapes and their characteristics.

Teachers approach and activities conducted during teaching and learning may become one of the factors that contribute to the difficulties in learning three-dimensional shapes (Ismail et al., 2020) such that the usage of teaching aid whether it is in the form of concrete teaching aid or with the help of technology (Sharma, 2019) may attract students towards the lesson session (Ping & Hua, 2016; Roshidan et al., 2020) and hence would make the teaching more efficient (Hamdi, 2018; Suanto et al., 2019). With the current trends that technology become a part of our life has normalise technology in teaching and learning activities and thus create virtual learning environment. The use of technology in learning geometry may provide benefits in learning process since it offers explanations, relational knowledge and students may hold revisable and extensive web explanations (Ozerem, 2012). The integration of technology as a teaching aid in mathematics particularly in learning geometry has widespread and thus increase students' interest (Ornbaevna, 2020; Syafril, 2021; Jia Ling & Mohd Matore, 2021). Therefore, this study is conducted to develop and determine the usability of a technology-based teaching aid in the topic of Three-Dimensional Geometrical Shapes that is called as V-Math.

This study is conducted in order to develop and determine the usability of a technology-based teaching aid in the topic of Three-Dimensional Geometrical Shapes that is called as V-Math. The usability of V-math is measured in the aspects of achievement of learning objectives,

comprehension, user-friendly and students' interest. This study is conducted by referring to the following research questions: (a) Is V-math having a good validation to be used as a teaching aid in the topic of Three-Dimensional Geometrical Shapes for Mathematics in Form Two?; (b) What is the level of the usability of V-math as a teaching aid in the topic of Three-Dimensional Geometrical Shapes for Mathematics in Form Two?.

2. METHODOLOGY

This study is a quantitative study using Developmental Research Design (DRD) focusing on the development of teaching aid (V-math) and analysing on the conditions that fulfil its use in teaching and learning (Richey et al., 2004) that embed ADDIE model which consists of five phases that are analysis, design, development, implementation and evaluation. This study was conducted at a public university in a West Coast of Malaysia that involved 100 mathematics trainee teachers as research population and 80 of them were selected by simple random sampling technique as sample of this study.

There are two sets of questionnaires used as the research instruments, that are the questionnaire on the validity of V-math and the questionnaire on the usability of V-math as a teaching aid for the topic of Three-Dimensional Geometrical Shapes which were adapted from Yusoff and Romli (2018), Sazilah (2017) and Ali and Mahamod (2016). The questionnaire on the validity of V-math is used to measure the validity of V-math as a teaching aid in facilitating teaching and learning for the topic of Three-Dimensional Geometrical Shapes in Mathematics for Form Two. This questionnaire consists of two parts, the first construct is the demography of the experts and the latter part is the content validity of V-math as the teaching aid for this topic whereby this part will measure the suitability of V-math with the students' ability as well as the contents included in V-math shall satisfy the content standards and learning standards for this topic. This questionnaire then given to three experts in the related fields which experienced more than 10 years in teaching Mathematics.

Another questionnaire that being used as the instrument of this study is the questionnaire on the usability of V-math as the teaching aid for Three-Dimensional Geometrical Shapes in the subject of Mathematics for Form Two. There are two parts of this questionnaire that are the demography of the respondents and the usability of V-math. This questionnaire consists of 18 items that constructed into four parts that are achievement of learning objectives, comprehension, user-friendly and students' interest. The questionnaire then administered to sample of this study in order to have their responses on the usability of V-math. Both instruments used 4-point Likert scale as represented in Table 1.

Table 1. 4-point Likert scale interpretation

Scale	Interpretation
1	Strongly disagree
2	Disagree
3	Agree
4	Strongly agree

Validation and reliability tests were conducted on the instruments of this study to ensure the instruments developed able to measure the things that need to be measured and qualified to be conducted on the targeted population. The validation test was steered by having the content validation index (CVI) and item-level content validity index (I-CV) by referring to Lynn (1986) and thus the CVI value for both instruments are 1, respectively. These implies that both instruments developed are able to measure the things that this study intent to measure. Pilot study was conducted on 30 samples taken from the research population. According to Johanson and Brooks (2010) as well as Cooper dan Schindler (2011), as much as 30 samples are suitable

for the pilot study. The Cronbach alpha with value of 0.81275 obtained by reliability test on the questionnaire to measure usability of V-math portrays that the instrument is suitable to be administered to the targeted research sample.

The data were then analysed accordingly by referring to the objectives of this study which are to develop V-math as a teaching aid for the topic of Three-Dimensional Geometrical Shapes with a good validation and hence to determine its usability. In order to determine the validation of V-math, the data were analysed using CVI as being mentioned by Lynn (1986) which stated that as a minimum sufficient number of experts is three with the validation index value of 1.00 shall be considered as a reasonable validation. The data on the usability of V-math were analysed descriptively using mean scores whereby the scale and interpretation of the mean scores that being used were referring to Jamora (2010) and Pimentel (2019) as in Table 2.

Table 2. Mean score interpretation Jamora (2010) and Pimentel (2019)

Scale	Mean Score Interpretation
1.00 – 1.75	Not much / Very bad
1.76 – 2.51	A little / Bad
2.52 – 3.27	Some / Good
3.28 – 4.00	A lot / Very good

3. RESULTS AND DISCUSSION

As this study focusing on the development and the usability of V-math as the teaching aid for the topic of Three-Dimensional Geometrical Shapes for Mathematics in Form Two, this part presents three parts that are the development of V-math, the validation of V-math and the usability of V-math.

3.1. The development of V-math as the teaching aid for the topic of Three-Dimensional Geometrical Shapes

The development of V-math guided by ADDIE model that consists of five phases that are analysis, design, development, implementation and evaluation. V-math is developed with the purpose to help students in learning the topic of Three-Dimensional Geometrical Shapes independently at any places and any time individually or with peers and might as well with their teachers. V-math may help students to strengthen their understanding towards this topic and teachers can use V-math to highlight or repeat some parts or concepts in this topic since it gives freedom to its users to manage and control it.

Figure 1 below show the feature of V-math whereby it fulfils the elements of a multimedia. Thus, V-math may help students with different learning styles. The contents of V-math fulfil the learning standard and learning outcomes (as in Figure 1(a) and (b)) that embed the elements of multimedia in it such as video, graphic, animation, audio and interactive button. Videos and simple notes that summarize the concepts (in Figure 1(c) and (d)) for each learning standards included in V-math will help students to learn and do their revision independently in their own phase at any place and any time they prefer. Besides, V-math also provide list of keywords in this topic in dual language (Figure 1(e)) as well as sets of quizzes and exercises (Figure 1(f) and (g)) as assessment activities.

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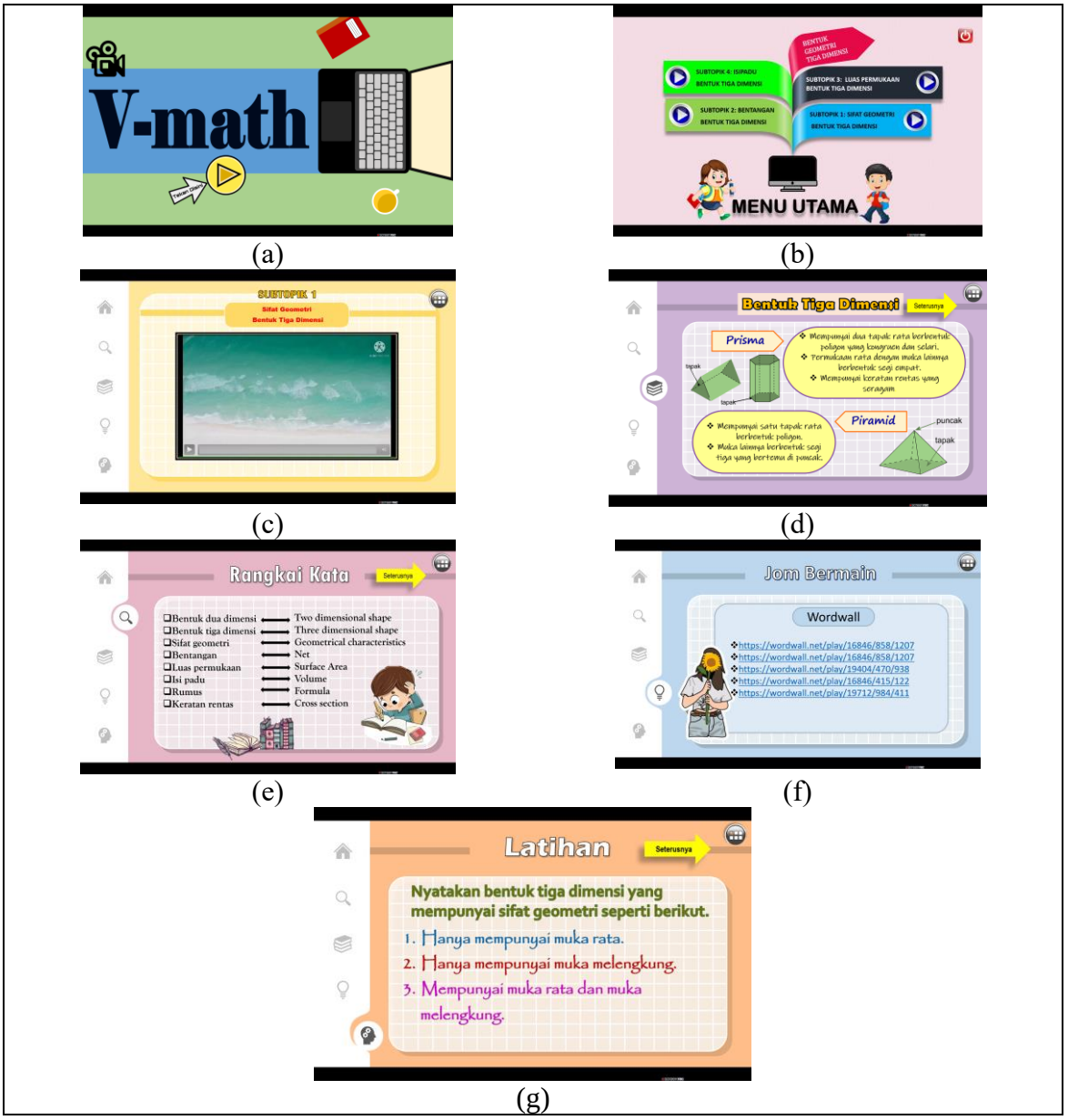

Figure 1. The features of V-math

3.2. The validation of V-math as the teaching aid for the topic of Three-Dimensional Geometrical Shapes

The data obtained from the questionnaire the validation of V-math then analysed using Lynn (1986). In determining the CVI, the Likert scales of 1 and 2 were denoted by 0 and the scales for 3 and 4 were denoted by 1. The responses from all three experts and the CVI for the validation of V-math shown in Table 3. From Table 3, the CVI value is 1.00 and thus according to Lynn (1986), this value portrays a reasonable validation. Hence, V-math has a reasonable validation as a teaching aid for the topic of Three-Dimensional Geometrical Shapes. Thus, V-math can be used and implemented in the next phase.

Table 3. Content validity for each item (I-CVI) and validity content for the overall scale (CVI) of V-math

Item	Expert 1	Expert 2	Expert 3	I-CVI
The introduction of V-math is suitable and clear.	1	1	1	1
V-math fulfils the concepts in Three-Dimensional Geometrical Shapes.	1	1	1	1
The use of V-math may achieve learning outcomes for Three-Dimensional Geometrical Shapes.	1	1	1	1
The use of V-math may spark fun in learning.	1	1	1	1
The user manual is complete and easily understood.	1	1	1	1
Contents in V-math is appropriate for the learning of Form Two students.	1	1	1	1
The use of V-math can clarify the topic easily since it provides videos and realistic animation rather than solely on explanation.	1	1	1	1
Exercises and quizzes can be solved easily with V-math.	1	1	1	1
The design of V-math suits its use.	1	1	1	1
The design of V-math is interesting.	1	1	1	1
V-Math can reinforce students' concept understanding.	1	1	1	1
The use of V-math in teaching and learning is in line with Standard-based Curriculum and Assessment Documents (DSKP)	1	1	1	1
			CVI	1

3.3. The usability of V-math as the teaching aid for the topic of Three-Dimensional Geometrical Shapes

The set of questionnaires on the usability of V-math being distributed to 80 mathematics trainee teachers at a public university in a West Coast of Malaysia as samples of this study. The usability of V-Math is assessed through four different aspects namely assessment of the achievement of learning objectives, comprehension, user-friendliness and interest. The data then analysed descriptively by looking at the mean score, percentage and its standard deviation. Tables 4, 5, 6 and 7 show the results of the usability of V-math in the aspects of achievement of learning objectives, comprehension, user-friendliness and interest, respectively.

Table 4. Mean, percentage and standard deviation for the usability of V-math in the aspect of achievement of learning objectives

Item	1	2	3	4	Mean	Standard deviation (SD)
Learning by using V-Math can help to achieve the learning outcome for the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	1 (1.25%)	19 (23.75%)	60 (75.0%)	3.74	0.470
V-Math is suitable to be used in teaching and learning activity for the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	0 (0%)	24 (30.0%)	56 (70.0%)	3.70	0.461
The use of V-Math can help students in following/completing assignments given by the teacher.	0 (0%)	0 (0%)	23 (28.75%)	57 (71.25%)	3.71	0.455
The use of V-Math can make exercises and quizzes easy.	0 (0%)	0 (0%)	19 (23.75%)	61 (76.25%)	3.76	0.428
			Overall mean/ standard deviation		3.73	0.336

From Table 4, it shows that 100% of the respondents where is 61 out of 80 respondents strongly agreed while others are agreed that the use of V-math can make exercises and quizzes

are easy to do with the mean for this item is 3.76 (SD=0.428). Besides, respondents also agree with 30% of them agreed and 70% of the strongly agreed that V-math is suitable to be used for the topic of Three-Dimensional Geometrical Shapes and it can help students in doing their assignments with mean values are 3.70 (SD=0.461) and 3.71 (SD=0.455), respectively. However, one of the respondents not agreed that learning using V-math can help in achieving the learning outcome for this topic. This study obtained the overall mean for this construct is 3.73 (SD=0.336). By referring to Table 4 and Table 2, all the means obtained for the items and this construct portray the usability of V-math in the construct of achievement of learning objectives are very good.

Table 5. Mean, percentage and standard deviation for the usability of V-math in the aspect of comprehension

Item	1	2	3	4	Mean	Standard deviation (SD)
The use of V-Math is very important to increase students' understanding of concepts related to the topic Three-Dimensional Geometrical Shapes.	0 (0%)	1 (1.25%)	27 (33.75%)	52 (65.0%)	3.64	0.509
The use of V-Math is appropriately used to review learning for the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	0 (0%)	23 (28.75%)	57 (71.25%)	3.70	0.461
The use of V-Math can help students in easily understanding the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	0 (0%)	24 (30.0%)	56 (70.0%)	3.70	0.461
The use of V-Math can help students to add knowledge.	0 (0%)	0 (0%)	19 (23.75%)	61 (76.25%)	3.76	0.428
			Overall mean/ standard deviation		3.70	0.331

From Table 5, it shows that 100% of the respondents where is 61 out of 80 respondents strongly agreed while others are agreed that the use of V-math can help students to add knowledge with the mean for this item is 3.76 (SD=0.428). Besides, respondents also agree with 33.75% of them agreed and 65% of the strongly agreed that V-math is very important to increase students' understanding of concepts related to the topic Three-Dimensional Geometrical Shapes and it can help students in easily understanding the topic with mean values are 3.64 (SD=0.509) and 3.70 (SD=0.461), respectively. However, one of the respondents not agreed that the use of V-Math is very important to increase students' understanding of concepts related to the topic. This study obtained the overall mean for this construct is 3.70 (SD=0.331). By referring to Table 5 and Table 2, all the means obtained for the items and this construct portray the usability of V-math in the construct of achievement of learning objectives are very good.

From Table 6, it shows 100% of respondents where 58 out of 80 respondents strongly agree while others agree for two items which is the use of V-Math helps students learn easily and also V-Math is provided on each display with the mean value of both being the same which is 3.72 (SD=0.449). Next the use of the V-Math can be exited or stopped at any time showing that the respondents agree is 35% and strongly agree is 65% with mean values are 3.65 (SD=0.480). Besides, respondents also agree with 41.25% of them agreed and 47.5% of the strongly agreed that the use of V-Math is easy to control without an internet network with mean values are 3.72 (SD=0.449). However, there are 2 respondents strongly disagree with the use of V-Math is easy to control without an internet network and also respondents do not agree that is one respondents of V-Math can be used anywhere, seven respondents of V-Math easy to control without an internet network and five respondents of V-Math is very easy to use without

help from others. This study obtained the overall mean for this construct is 3.61 (SD=0.355). By referring to Table 6 and Table 2, all the means obtained for the items and this construct portray the usability of V-math in the construct of achievement of learning objectives are very good.

Table 6. Mean, percentage and standard deviation for the usability of V-math in the aspect of user-friendliness

Item	1	2	3	4	Mean	Standard deviation (SD)
V-Math helps students to learn easily.	0 (0%)	0 (0%)	22 (27.5%)	58 (72.5%)	3.72	0.449
V-Math can be used anywhere.	0 (0%)	1 (1.25%)	25 (31.25%)	54 (67.5%)	3.66	0.502
Use of V-Math can be exited or stopped at any time.	0 (0%)	0 (0%)	28 (35.0%)	52 (65.0%)	3.65	0.480
The use of V-Math is easy to control without an internet network.	2 (2.5%)_	7 (8.75%)	33 (41.25%)	38 (47.5%)	3.31	0.756
The main menu button provided in V-Math is provided on each display.	0 (0%)	0 (0%)	22 (27.5%)	58 (72.5%)	3.72	0.449
V-Math is very easy to use without help from others.	0 (0%)	5 (6.25%)	23 (28.75%)	52 (65.0%)	3.59	0.610
			Overall mean/ standard deviation		3.61	0.355

Table 7. Mean, percentage and standard deviation for the usability of V-math in the aspect of interest

Item	1	2	3	4	Mean	Standard deviation (SD)
Students really enjoy learning by using V-Math.	0 (0%)	0 (0%)	22 (27.5%)	58 (72.5%)	3.72	0.449
The use of V-Math can attract students' interest in the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	1 (1.25%)	22 (27.5%)	57 (71.25%)	3.70	0.488
The use of V-Math encourages students' curiosity about the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	0 (0%)	28 (35.0%)	52 (65.0%)	3.65	0.480
The use of V-Math can attract students' interest in doing exercises in the topic of Three-Dimensional Geometrical Shapes.	0 (0%)	0 (0%)	24 (30.0%)	56 (70.0%)	3.70	0.461
			Overall mean/ standard deviation		3.69	0.351

From Table 7, it shows that 100% of the respondents where is 58 out of 80 respondents strongly agreed while others are agreed that the students really enjoy learning by using V-Math with the mean for this item is 3.72 (SD=0.449). Besides, respondents also agree with 35% of them agreed and 65% of the strongly agreed that the use of V-Math encourages students' curiosity about the topic of Three-Dimensional Geometrical Shapes and it can attract students' interest in doing exercises in the topic with mean values are 3.65 (SD=0.480) and 3.70 (SD=0.461), respectively. However, one of the respondents not agreed that the use of V-Math can attract students' interest in the topic. This study obtained the overall mean for this construct is 3.69 (SD=0.351). By referring to Table 7, the mean score obtained in this construct portray that V-Math may attract students' interest to the topic of Three-Dimensional Geometric Shape. This is aligned with the main purpose of V-Math that is to allow students to experience the process of learning Three Dimensional Geometric Shapes more effectively and regularly.

Therefore, V-math may help and give opportunities for teachers to provide a variety options of teaching methods in teaching Three-Dimensional Geometric Shapes.

4. CONCLUSION

From the results, this study found out that the respondents have a positive acceptance on V-Math as the teaching aid for the topic of Three-Dimensional Geometrical Shapes for Mathematics in Form Two. The use of V-Math may help students to achieve their learning objectives for this topic and thus it is suitable to be used in their learning. Besides, the use of V-Math may help students to increase their comprehension towards the concepts and knowledge in this topic. The use of teaching aid in lesson is important in increasing students' understanding on the concepts in mathematics (Mohd Suhaimi et al., 2017) especially with the use of effective and innovative teaching aid (Mohd Amin et al., 2016) whereby the clarity, simplicity and user-friendly become one of the criteria for a teaching tool (Zilinskiene & Demirbilek, 2015). Teaching aid can increase learning motivation of the students whereby the motivation is seen from the students' interest and attention as well as enthusiasm on the learning (Haddar & Azmi, 2020). A good, efficient and practical teaching aid can give benefits to teachers and students, therefore, teaching aid as V-Maths may serve as one of the options or alternatives for teachers and educators in conducting their lesson while students may have this teaching aid as their additional reference to be used independently to help their study.

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