Development and Evaluation of the Bvee Kit for Teaching Circle Topics: A Validity and Usability Study in Form 2 Mathematics

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***Abstract*—In the 21st century, the success of a country depends on ideas and the ability to build a scientific and innovative society. Essentially, the enhancement of teaching aids is as important as the development and innovation in the education field. Therefore, this study aims to build a Bvee Kit for Form 2 mathematics circle topics that exhibits satisfactory validity and usability. Through the combination of the first letter of the circle and the researcher's nickname, the name Kit Bvee was born. This study uses a Developmental Research Design (DRD) involving the use of the ADDIE instruction model. The instrument used is a validity questionnaire instrument evaluated by 4 experts consisting of lecturers and mathematics teachers with experience in the mathematics field for more than five years, as well as a usability questionnaire instrument using a four-point Likert scale. The sample for the usability of the kit consists of 81 UPSIBatchA202 mathematics trainee teachers. The analyzed data used is the Content Validity Index (CVI) to assess validity, reliability using Cronbach's alpha value, and usability analyzed using SPSS Version 29 software in a descriptive analysis to obtain the mean value and standard deviation. The findings of the study revealed a kit validity with an average CVI value of 1.00, an acceptable reliability value of 0.914, and a high level of usability based on a value mean of 3.773 and a standard deviation of 0.3753. This shows that the developed Bvee Kit has a satisfactory level of validity and usability. In conclusion, this study is able to help students to remember the various parts and properties of a circle in an easier way.**

***Keywords*—teaching kit, circle topic, content validity index**

I. Introduction

The goal of mathematics is to be a driving force for the advancement and development of science and technology. Therefore, it is important for teachers and schools to improve students' achievements in mathematics. Conventional teaching does not provide adequate opportunities for students to engage in classroom activities because the concept presented leans towards theoretical learning. When students learn mathematics, they tend to rely on written and traditional methods. According to Hanim [1], teachers need to use more innovative and dynamic methods that relate to the content of teaching in line with current educational developments. Therefore, the use of kits is a method that can help the teaching and learning process to be extra effective and interesting.

The learning chapters have been structured and systematically designed, guided by the Curriculum and Assessment Standard Document (DSKP) of the Ministry of Education of Malaysia (MOE) for Form 2 Mathematics. This study is related to the topics of mathematics Form 2 circle. The topic of the circle is included in Chapter 5, and this chapter can be applied in architecture, philosophy, design, and astronomy. In this study, the researcher took the initiative of using teaching aids (BBM) to help in the PdP for circular topics. According to Fauzi and Abdullah [2], the use of BBM in mathematics teaching and learning may attract students' interest in understanding abstract mathematical concepts better. A BBM, like a kit, can help students improve their mathematical knowledge. Thus, the researchers have focused this study on building a reinforcement training kit for a Form 2 circle topic named Kit Bvee.

According to Othman and Arshad [3], a creative and quality BBM can make PdP sessions more relevant for students learning in the current education system. Utilizing the kit as a BBM is one of the most effective methods in adapting highly creative and innovative teaching, which is in line with the transformation of education through the 21st Century Learning (PAK21). In this study, the kit was opted as the BBM to help students understand the concepts of circles more readily. It is a form of learning material that boosts the students' grasp of the concepts of mathematics.

Based on previous studies, an arising problem is that students consider mathematics as something abstract and difficult and believe that someone mastering mathematics means that the person is mathematically gifted (Li *et al*. [4]). According to Ling and Mahmud [5], achievements for students in Malaysia in the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) are still below anticipated averages. It proves that students are weak in mathematical mastery. Hence, a BBM is required to support mathematics learning.

Additionally, the circle topic of Form 2 mathematics is a key topic in the field of mathematics and geometry. The traditional approach to teaching geometry is hardly effective when depicting the concepts to students (Ibili *et al*. [6]). This situation proves that the use of BBM is significant in the PdP process. According to Bakar and Sulaiman [7], the PdP for circle topics requires special attention in secondary school education because its concepts are the basis for understanding geometry. However, according to Subramaniam and Rosli [8], the teaching of circle topics at the secondary school level reveals that it is a difficult topic to understand because of its abstract nature, complex principles, and difficulty to be described. Based on Reza and Mahmud's [9] studies, students still face challenges in comprehending circle topics, including understanding the properties of circles and applying related

concepts in problem solving. Circle topics related to spaces, perimeter, angles, and concepts of geometry are similarly challenging for teachers without any assistance from BBM. By developing kits for this topic, students could better memorize related mathematical concepts. Thus, this study will introduce and produce Kit Bvee as an essential aid.

An extensive literature review was conducted to address the problems presented in this study. It is done by focusing on the impacts and effectiveness of teaching aids for the purpose of improving students' understanding and participation in mathematics learning, especially involving geometry. Studies by Fauzi and Abdullah *et al*. [2, 6], for instance, have shown various findings where interactive aids greatly increase students' grasp of abstract mathematical concepts. Thus, it affirms the purpose of this research. To further strengthen the research design, this study employs a constructivist theoretical framework, which supports active and participatory learning through direct engagement with educational materials. This framework underpins the Bvee Kit's design and guides the analysis of results, as it is predicated on the idea that students learn more effectively when they can interact with and manipulate physical representations of mathematical concepts. Using this framework, the utilization of practical and interactive teaching aids, as intended with the Bvee Kit, allows improvement of the learning outcomes of students. Therefore, the research design and analysis process are more justified. The objective of this study is to build a Bvee Kit for a Form 2 circle topic that has satisfactory validity and reliability. The outcome of this study will be a benchmark for other studies so that innovations can be made to generate educational transformation in the future.

From existing literature, there is a notable gap around teaching aids designed for the circle topic in Form 2 mathematics. Previous research has frequently emphasized the general benefits of teaching tools across various topics; however, few studies have focused on curriculum-aligned kits that address students' difficulties in mastering geometric concepts like circles. This study seeks to fill this research gap by developing and validating the Bvee Kit, an innovative teaching aid specifically designed for the circle topic that meets the requirements of the Malaysian mathematics curriculum for secondary education. By introducing a resource that directly addresses these specific challenges, this study presents a novel contribution to educational tools, providing a teaching aid that allows students to interact with and better understand the properties and applications of circles in a structured, engaging way. Thus, the Bvee Kit not only responds to a practical need in secondary mathematics education but also represents a new model for content-specific teaching tools that enhances both accessibility and comprehension for students.

II. Method

A. Study Design

The research carried out was to develop a kit that has satisfactory effectiveness and usability for a circular topic. According to Richey and Klein [10], there are two types of design and development studies: (i) product and tool studies and (ii) model studies. In this study, the researcher uses a design and development study based on a product and tool study. The product intended in this study is the Bvee Kit. Principally, this design and development study refers to the entire design and construction process, including documented analysis, design, construction, implementation, and evaluation. This process specifically involves product development [10].

In this study, the researcher conducted an analysis based on a literature review related to the problems faced by students in Form 2. In learning circle topics context, among the difficulties are low achievement in tests, students' interests, and low understanding and remembering of concepts. Therefore, after the issues were identified, the objectives and research questions were outlined to develop this kit. In this study, the design of the Bvee Kit was constructed based on the Constructivism Theory. In this phase, the kit will be developed by referring to the Curriculum and Assessment Standard Document (DSKP) for the Secondary School Standard Curriculum (KSSM) for the mathematics subject of Form 2. In this regard, the essential learnings are knowing the parts of a circle and explaining the nature of circles. The construction of the Bvee Kit includes essential product components, which are the Bvee Kit box, the Mini Bvee box containing questions and kit activity materials, as well as the kit's user manual.

In the development phase, the researcher will build the kit based on the findings from the needs analysis and the kit construction framework. An important component of the Bvee Kit is the Bvee Kit box. Additionally, the Bvee Mini Box is another essential element, as it contains the activity materials. The researcher also prepared a user manual of the Bvee Kit for teachers and students as a guide, which is a reinforcement training kit for the Form 2 circle topic. After the Bvee Kit was completed, the validity of the kit was tested from the aspects of face validity and content validity. In the evaluation phase, the researcher used SPSS software version 29.0 to analyze the mean score and standard deviation to determine the usability of the constructed Bvee Kit.

B. Population, Samples, and Sampling Techniques

In this study, the effectiveness and usability of the Bvee Kit were selected from different sampling techniques. The selection of effective samples was conducted using a targeted sampling technique, while the usability sampler selection was made through simple random sampling. Furthermore, the study sample for reliability used a convenience sampling technique.

A sample study of the effectiveness of Kit Bvee involved four experts. The research team consists of four experts: two mathematics lecturers of higher education institutions (IPT) and two mathematics teachers around Malaysia. The team was selected based on their expertise in mathematics with over five years of experience in this field.

In addition, the study population for the usability of Kit Bvee comprises 105 students of UPSI's BatchA202 mathematics trainee teachers, consisting of students of AT14 Bachelor of Mathematical Education and AT48 Bachelors of Science (Mathematics) with Education semester 7. The selected study sample is 81 students of Batch A202 mathematics trainee teachers, referring to the Krenjcie and Morgan tables. For the pilot study, the reliability sample

consisted of 20 Batch A202 mathematics trainee teachers.

C. Research Instruments

Study data was collected through the questionnaire instrument as it is tailored to facilitate the collection of data for analytical purposes. In this study, the researcher used two types of study instruments, which are the efficiency survey instrument and the usability survey instrument. Efficiency ratings will be carried out in two stages, namely, the effectiveness of the instrument for the efficacy survey and the tool for the usability survey.

In the questionnaire instrument, the examiner used a four-point Likert scale for each item: strongly disagree (STS), disagree (ST), agree (S), and strongly agree (SS). Respondents need to mark the approval scale to determine the level of approval for each item in the questionnaire based on a scale of one to four as in the following Table 1.

Table 1. Four-point Likert scale

Agreement Level	Summary	Score
Strongly Disagree	STS	1
Disagree	ST	2
Agree	S	3
Strongly Agree	SS	4

D. Data Analysis

Data analysis for this study involves instrumental effectiveness and usability. Efficiency involved is the face and content accuracy analyzed using the Index of Content Validity Index (CVI). The instrument for usability is also analyzed using SPSS version 29.0, which involves calculating mean scores and standard deviation.

1) Face validity and content validity

Content Validity Index (CVI) was calculated to assess the kit's content relevance and adequacy. The study used four expert reviewers, each evaluating the kit on specific criteria. The CVI was computed at both the item level (I-CVI) and the scale level (S-CVI), as recommended by Polit *et al.* [11]. The Content Validity Index (CVI) is used to analyze data related to both face and content validity obtained. This is due to the fact that, as stated by Yusoff *et al.* [12], CVI takes into account the average rating and level of suitability given by experts. According to Yusoff *et al.* [13], there are two types of CVI: CVI for items (I-CVI) and CVI for scales (S-CVI). Yusoff *et al.* [13] also said that before calculating the CVI, the appropriateness assessment must be coded as 1, that is, by setting scales 3 and 4 as relevant and 0 for scales 1 and 2. For this Bvee Kit study, CVI was analyzed using the [11] formula, which is:

$$Content\ Validity\ Index\ (CVI) = \frac{Total\ score\ of\ each\ expert}{Total\ actual\ score}$$

$$Average\ Content\ Validity\ Index\ (CVI) = \frac{Total\ CVI}{Total\ expert}$$

Table 2. Number of experts and received CVI values

Number of experts	Value of CVI
2–4	1
5	> 0.92
6	> 0.86
7-10	> 0.78

Table 2 shows acceptable CVI values according to the number of experts determined by the researcher [14]. Therefore, based on the table, the number of validity experts in this study is 4 people, so a satisfactory CVI value should be 1.00.

2) Reliability analysis

Reliability for all items was analyzed using Cronbach's Alpha analysis using SPSS software version 29.0. Cronbach's Alpha internal consistency method is used in the questionnaire instrument that will be used in the actual study. In this study, a pilot study was conducted on 20 Batch A202 Mathematics trainee teachers through Google Forms. Here are the ranges of coefficients for Cronbach's Alpha:

Table 3. Cronbach's alpha value scale range

Scale Range	Level
0.90 and above	Excellent
0.80 to 0.89	Very good
0.70 to 0.79	Good
0.60 to 0.69	Moderate
Less than 0.60	Weak

Based on Table 3, the Cronbach alpha value is on a scale of 0.90 and above, indicating that the survey question instrument has an excellent level of reliability. If the Cronbach alpha is on a scale of 0.80 to 0.89, the survey question instrument is at an excellent level of reliability. If the Cronbach alpha scale is in the range of 0.70 to 0.79, the survey question instrument is at a good level of reliability, while the range of 0.60 to 0.69 is at the moderate level. The truth is, if the Alfa Cronbach value is in the scale of 0.60 and less, this means that the survey question instrument is weak and questionable.

3) Usability analysis

The data obtained from the kit usability questionnaire will be collected in quantitative form. The data for each item of the Bvee Kit usability questionnaire will be analyzed statistically and descriptively by involving the calculation of the mean score and standard deviation. All the data collected in this questionnaire will be analyzed using the Statistical Package for the Social Sciences Version 29.0 software. Table 4 displays the value of the mean score and the interpretation of the mean score to determine the level of usability of the constructed Bvee Kit.

Table 4. Interpretation value determination score min

Mean Value Range	Usability Level
1.00–2.00	Low
2.01–3.00	Moderate
3.01–4.00	High

Based on Table 4, the mean score on the scale of 3.01 and above shows that the built kit has a high level of usability. If the mean score is on a scale of 2.01 to 3.00, the kit is at a moderate level of usability. If the mean score is on a scale of 1.00 to 2.00, the kit is at a low level of usability. If the mean score is on a scale of 1.00 and less, this means that the kit is questionable and unacceptable (Shaari *et al.* [15]).

E. Study Procedures

In order for the study to be carried out smoothly, the researcher needs to follow several processes. Analysis, development, implementation, and evaluation are steps taken to collect data. In the analysis phase, information from previous studies is gathered to determine the needs of the study. For the second phase, which is the design phase, the

kit must be developed using the ADDIE model and constructivism theory. After the design phase, the next phase is development. In the final phase, implementation and evaluation, procedures to obtain content validity are taken into account. At this stage, the researcher will seek validation from experts for the kit to be used. The researcher also applied for a specialist appointment letter from the Department of Mathematics of UPSI. The UPSI Mathematics Department will give permission to build the Bvee Kit and give expert appointment letters to the four experts who have been selected. The Content Validity Index (CVI) will be used to analyze the data obtained. Next, the researcher conducted a pilot study on 20 selected respondents. After obtaining satisfactory reliability for the usability questionnaire, the researcher will use the questionnaire to obtain data related to the usability of the kit. The data obtained will be analyzed using SPSS software version 29.0. Fig. 1 is a flowchart of the study procedure.

Fig. 1. Study flow chart.

III. Results and Discussion

A. Results

1) Validity of Bvee Kit

The Bvee Kit Validity Questionnaire consists of 20 items divided into three parts, namely, Part B: the validity of the kit design, Part C: the content validity of the Bvee Kit, and Part D: the validity of the Bvee Kit manual. Each item is rated using a four-point Likert scale. For validity, the study employed the Content Validity Index (CVI) methodology, calculating both item-level (I-CVI) and scale-level (S-CVI) scores to evaluate the relevance and appropriateness of each item within the Bvee Kit. This approach, based on [11] guidelines, yielded a CVI score of 1.00, indicating an optimal level of content validity.

Table 4. Total average CVI value of Kit Bvee validity

Part	Construct	CVI Value
A	Bvee Kit Design Validity	1.00
B	Bvee Kit Content Validity	1.00
C	Bvee Manual Kit Validity	1.00
	Overal Average Value of CVI	**1.00**

Based on Table 4, through the analysis of this validity, the researcher can conclude that overall, the development of this kit was agreed upon by all four experts and reached a satisfactory level of validity. The average CVI value obtained meets the standard CVI value for validity from four experts, which is 1.00 [14]. Therefore, it clearly proves that the Bvee Kit built by the researcher for the circle subtopic is at a satisfactory level.

2) Realibility of Bvee Kit

Table 5. Total average CVI value of Kit Bvee validity

Number of Items	Cronbach's Alpha Coefficient Value
15	0.871

Based on Table 5, the results of the analysis show that the value of Cronbach's alpha coefficient is 0.871. According to Lim [16], the value of Cronbach's alpha coefficient, which is in the range of 0.8-0.89, is good. Therefore, this developed Bvee Kit usability questionnaire instrument is acceptable and reliable for use in real studies. It sreliability was confirmed through Cronbach's alpha, which produced a score of 0.871, demonstrating strong internal consistency and reinforcing the study's methodological rigor.

The items discussed include face validity and content validity of the kit. There are 3 parts in the item, which are the validity of the kit design, the validity of the kit content, and the validity of the kit manual. Based on the findings of the validity of the kit, all four experts agree that the Bvee Kit is well built because it has an attractive design and use of colors with a suitable and easy-to-carry kit size. In addition, this proves that this kit is built to meet the content standards set by the Ministry of Education, and it can assist teachers in achieving learning objectives related to the subtopic of the circle based on the student's ability level. Next, based on the findings of the validity of the kit, it can be concluded that the Bvee Kit user manual created by the researcher is appropriate in terms of instructions, choice of colors, spelling, grammar, manual size, and font used; the information is also complete.

3) Usability of the Bvee Kit

Table 6. Average total output of min values and standard deviation value

Part	Construct	Min Score	Standard Deviation Score
A	Usability Bvee Kit	3.752	0.4014
B	Usability of the Bvee Kit	3.684	0.4276
C	Satisfaction Bvee Kit	3.884	0.2970
	Total Average	**3.773**	**0.3753**

Based on Table 6, the overall average value obtained for the mean score is 3.773, and the standard deviation is 0.3753, based on the constructs of Bvee Kit usefulness, Bvee Kit ease of use, and Bvee Kit satisfaction, which consists of 15 items. Based on the interpretation value of determining the mean score (Shaari *et al.* [15]), the researcher found that all the items on the kit's usability questionnaire instrument were at a high level because they exceeded the mean score of 3.01. The average overall mean score of the study obtained, which is 3.773, shows that the level of usability of the kit is at a high level. Therefore, the findings of this study show that Kit Bvee is suitable to be developed as BBM.

For the analysis of usability, the SPSS Version 29.0 software could calculate mean scores and standard deviations, offering a statistically robust assessment of the Bvee Kit's usability across the sample. Based on the findings of the study, the validity value obtained proves that the developed Kit Bvee is able to have a positive effect on the effectiveness of

the PdP process, student achievement, and increasing the students' mathematical knowledge and interest in the topic of circles in Form 2 mathematics. The construction of the Bvee Kit is agreed to have a good impact on its users. By understanding how to use a simple and effective kit for the circle topic, students can understand related subtopics well. Furthermore, the game-based learning applied in this kit lets the students enjoy learning the topic of circles and, at the same time, encourages them to remember the concepts of circles well. In addition, the findings of the study show that the use of this Bvee Kit is very beneficial and important for teachers.

B. Discussion

The constructivist theory has been selected as a guiding framework for this research because of its suitability for hands-on learning. It describes that students are encouraged to actively construct their understanding by interacting with the educational materials. By applying this theoretical approach to the Bvee Kit, the study aims to enhance engagement and comprehension. This approach is practical, especially in learning geometric concepts that are often abstract and difficult for students to grasp conventionally. This theory, which emphasizes the role of experiential learning in building cognitive understanding, is well-aligned with the study's objectives of making abstract mathematical concepts accessible through a tangible teaching tool. The results of this study resonate with findings from previous research, such as [7, 8], which highlight the value of BBM tools in facilitating mathematics learning and improving students' performance. By discussing the Bvee Kit's findings within the context of these studies, this research not only reinforces the effectiveness of interactive teaching tools but also presents unique contributions to the field by showing how hands-on engagement with geometry topics can result in deeper understanding and retention of mathematical concepts.

The findings of this study affirm the Bvee Kit's high usability and reliability, contributing valuable evidence to both the literature on BBM tools and constructivist educational theory, which emphasizes that students learn more effectively through hands-on, experiential engagement. The usability score, alongside the kit's validated reliability, demonstrates that the Bvee Kit successfully enhances students' comprehension and retention of geometric principles, particularly in understanding the parts and properties of circles, a typically abstract and challenging topic. These results support existing constructivist theory by showing how physical manipulation of mathematical concepts aids in learning retention, as students are able to internalize complex ideas through direct interaction. Additionally, by aligning these findings with prior research, this study offers new insights into the potential for subject-specific teaching aids to reinforce learning outcomes while also expanding on previous studies that have broadly examined BBM without focusing on specific mathematical content. Therefore, while this study confirms the value of interactive tools in mathematics education, it also provides new evidence that demonstrates the significant benefits of content-specific aids, such as the Bvee Kit, in enhancing understanding of complex topics like circles.

IV. Conclusion

Based on the results of the study, this Kit Bvee has a satisfactory effectiveness based on an average CVI value of 1.00. Besides, this Bvee kit also has a high usability based on a min of 3,773 and a standard deviation of 0.3753. Thus, it can be concluded that the Bvee Kit for this Form 2 circle theme has a satisfactory level of validity and usability. This proves that this kit, as a complete kit for the Form 2 Mathematics' circle topic, has been successfully developed.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, V.J. and N.A.H; methodology, V.J.; software, S.M.S; validation, S.M.S and N.A.R.; formal analysis, V.J. and S.M.S; investigation, N.A.R; resources, N.A.H; writing—original draft preparation, M.A.A.B.; writing—review and editing, S.M.S.; visualization, supervision, N.A.H. and S.M.S. All authors have read and agreed to the published version of the manuscript.

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