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Research Article

The Development of Circle Kit for Form 2 Circle Topic

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ABSTRACT

The aim of this study is to develop and evaluate the validity and usability of Circle Kit for the Form 2 Circles topic. The study employs the Design and Development Research (DDR) approach, focusing on the Analysis Phase and the Design and Development Phase guided by the ADDIE model. Five experts consisting of four Mathematics lecturers from a public university and one secondary school Mathematics teacher, assessed the kit's validity. To determine usability, 35 Mathematics trainee teachers from Universiti Pendidikan Sultan Idris (UPSI) were selected through simple random sampling and responded to a usability questionnaire. Data from expert evaluation were analysed using descriptive analysis, employing the Content Validity Index (CVI), while usability was determined using the mean score. The results of the study found that the validity of the content of daily lesson plan (RPH), kit face and kit content is satisfactory with a value of CVI 1.00. The results also show that the kit's usability scored a mean of 3.83, indicating high usability. In conclusion, the RPH aligns with the learning standards and supports the kit's use during Teaching and Facilating (PdPc) sessions. The implication is that the developed kit effectively addresses the Circles topic, making it suitable as a teaching aid (BBM). This study provides valuable guidelines and innovative ideas for Form 2 Mathematics teachers to enhance their teaching through the application of this educational tool.

Keywords: validity, usability, teaching aid, integer multiplication, form 2

1. INTRODUCTION

The Secondary School Standard Curriculum (KSSM) was initially implemented in the national education system in 2017. The High School Integrated Curriculum has undergone continual implementation to enhance its effectiveness. As a result, notable modifications have

been observed across all subject syllabuses, including Mathematics. The current syllabus, which emphasises a high level of learning, is a significant challenge for all teachers. The Mathematics topics included in the KSSM curriculum demonstrate a heightened difficulty level, as evidenced by the use of circles. Before implementing the KSSM, the topic of Circles was exclusively taught to students beginning in Form 3. However, under the current curriculum, students begin studying this topic in Form 2. Form 2 students must acquire knowledge of three Content Standards of Circles. These standards include understanding the Properties of Circles, comprehending the Properties of Cross-Symmetry, and mastering the concepts of Circumference and Area of Circles. The issue warrants attention due to its significance and relevance to the upcoming study of the Circle topic in Form 4.

The subject of Circle in Form 2 is regarded as a crucial component of the mathematics education curriculum, as stated by Siang and Hui (2022). Mathematically, it signifies one of the deficiencies that students possess. Hence, it is imperative for individuals involved in educational settings, particularly educators, to prioritise the exploration of innovative and organised teaching methods and practices. Consequently, this has a beneficial influence on students since it enables the implementation of well-structured and efficient teaching and learning activities. In contemporary educational practice, teachers assume a more facilitative role in conducting teaching and learning sessions, both within and outside the classroom. Consequently, the proficiency of teachers in selecting appropriate approaches facilitates both students and educators in carrying out learning activities (Yaakob et al., 2019). In addition to the factor of the teacher, the selection of teaching and learning strategies or methods is also necessary to achieve success (Ramli & Mohd Tajudin, 2021).

Consequently, this can result in the creation of a learning environment characterised by more harmony. In order to uphold the standard of instruction and facilitate effective student learning, it is imperative for educators to consistently demonstrate preparedness in devising, cultivating, overseeing, and implementing a range of pedagogical approaches. One successful approach educators can employ to enhance the engagement and efficacy PdPc sessions is the creation of manipulative Teaching Aids (TAB). A study conducted by Popov et al. (2021) found that the use of teaching aids can facilitate the learning process by making it interesting and less time consuming. Hence, the selection was made to construct the Circle Kit within the PdPc framework, specifically targeting the topic of the Form 2 Circle. The primary emphasis of this endeavour will be on assessing the validity and usability of this kit.

A literature review was conducted prior to the development of the BBM Circle Kit. Based on a study conducted by Ganesan and Leong (2020), a computer-assisted learning software was developed for the topic of Form 2 Circle. According to this study, it was found that the researchers developed software to assist students in mastering this topic. However, the developed software is limited due to not all students having access to ICT equipment such as computers, mobile phones, and tablets to access this software. In accordance with the findings of a study conducted by Siang and Hui (2022), a GeoGebra-based module has been developed for the Topic of Form 2 Circle. This GeoGebra-based module is designed as a learning medium to facilitate students in mastering understanding of abstract mathematical concepts. However, it was found that the developed module has broad targets and scopes and may not be wholly appropriate for all proficiency levels of students. The results of the literature review indicate that an existing BBM needs to be developed and enhanced to improve students' understanding of the topic of Circle, thereby enhancing the quality of teaching and learning.

Therefore, this study was conducted to develop a tangible and easily constructible BBM with low cost, while maintaining satisfactory levels of validity and usability.

2. MATERIALS AND METHODS

2.1. Research Design

The research design is the primary planning and strategic on how a concept developed will guide the design and execution of this study (Md. Aris et al., 2024). Comprehensively, it encompasses various elements like the study's title, the population, the sample under investigation, and the employed methodology or procedure. The present study employs the Design and Development Research (DDR) strategy in its design. According to Richey and Klien (2014), the methodology employed in the study entails utilising empirical research within the domain of DDR where it comprises of four comprehensive phases. However, Che Noh and Abdul Karim (2021) and Saedah et al. (2020), divided the DDR research into three stages. This technique demonstrates a high level of systematicity, as it is underpinned by a well-defined design and development process and an evaluation procedure. According to them, the DDR approach consists of three main phases: the initial phase, known as Requirements Analysis (Phase I), is followed by the subsequent phase of Design and Development (Phase II), and ultimately culminates in the phase of Evaluation and Testing (Phase III). This study exclusively concentrates on Phase I and Phase II. Phase I of the study encompassed a comprehensive literature examination, wherein the researcher diligently examined and determined all the necessary prerequisites associated with the assembly of the kit, with particular emphasis on the kit's development. Subsequently, utilising the ADDIE model served as a framework for Phase II, encompassing DDR implementation. Musa et al. (2022) posits that the ADDIE model, which encompasses five interrelated phases, was chosen because it is highly systematic and thorough, making it well-suited for creating effective instructional design. Put simply, it is possible to have repetition, namely in the form of iterative instructional design, when evaluating generated materials or kits. Additionally, it was elucidated that the evaluation occurs continuously, with each formative assessment consistently evaluated to determine the necessity for repetition. Consequently, due to its comprehensive and thorough framework, the researchers have opted to utilise the ADDIE model to develop the kit.

2.2. Study Sample

The sample utilised in the study constitutes a subset of the overall population. The sample for this study included trainee teachers specialising in Mathematics from UPSI, namely those who enrolled in the September 2020 intake (A201) and February 2021 intake (A202), resulting in a total of 244 individuals. Hence, the study cohort included 35 trainee educators from intake A201 and A202, who were chosen using a simple random sampling method. According to Bhardwaj (2019), this sampling technique is justified due to its ability to ensure equal opportunity for every member of the population to be chosen as a sample for the study.

2.3. Research Instrument

This study employed two instruments. Two forms are utilised in the context of teaching aid (BBM) evaluation. The first form is the BBM Content Validity Form (BKKB), while the second form is the BBM Usability Questionnaire Form (BSKB), similar as stated in the study by Jamaludin et al. (2023) and Arbin et al. (2022). The BKKB assessment consists of a total of 20 question items, which have been categorised into three distinct parts: (a) RPH content, (b) kit face, and (c) kit content. In the context of BSKB, it is categorised based on three key dimensions: usefulness, ease of use, and satisfaction. A four-point Likert scale was employed for the assessment of BKKB and BSKB. The researcher gave a link with a video demonstrating

the proper utilisation of the kit, RPH and BKKB. Researchers utilise the connection to collect data disseminated to a group of specifically chosen experts for validation. A panel of five experts was chosen, consisting of four lecturers from public universities specialising in Mathematics and one Mathematics teacher from a secondary school. The study sample was provided with a specific link, consisting of BSKB, to evaluate usability.

Table 1. Interpretation of the Mean Score of the Four-Point Likert Scale

Mean Score	Mean Interpretation
1.00 - 1.50	Less Related
1.51 - 2.50	Low
2.51 - 3.50	Moderate
3.51 - 4.00	High

The data analysis involved examining the input provided by each expert via the BKKB, which was subsequently evaluated using the Content Validity Index (CVI). The experts who give feedback on scale 3 and scale 4 are categorised as the agree group, corresponding to ordinal scale 1. Conversely, the disagree group, denoted by ordinal scale 0, pertains to expert feedback on scale 1 and scale 2. The CVI calculation involves the utilisation of a formula, specifically n / N, where n represents the count of experts within the consensus group, and N denotes the overall number of experts involved. According to Zaipul and Saleh (2023), the acceptable CVI value for a panel of experts consisting of five or fewer experts is 1.00. Subsequently, the data acquired from BSKB is analysed using the mean score value whereby the scale and interpretation of the mean score that being used were referring to Pimentel (2019) and Che Lah et. al (2023) as shown in Table 1.

3. RESULTS AND DISCUSSION

3.1. Circle Kit Development

During Phase II of the DDR, the ADDIE model paradigm guided the Circle Kit's design and development. The ADDIE model encompasses five phases: Analysis, Design, Development, Implementation, and Evaluation. The construction of the Circle Kit commences with the Analysis phase, during which researchers examine the pertinent aspects of the kit that are appropriate for its development. This analysis is based on information about the topic of the Circle and the utilisation of BBM in PdPc in relation to this subject matter. In the subsequent phase, known as the Design phase, the kit is meticulously strategized based on its appropriateness and specific requisites. Furthermore, the researcher is responsible for identifying the desired learning outcomes and selecting pertinent teaching methodologies. Simultaneously, the design approach of the kit is informed by the principles of Constructivism Theory, to facilitate a PdPc for 21st Century Education (PAK21). The subsequent step in the research process is called the Development phase. During this stage, researchers apply the BBM construction process, which entails the utilisation of kits, RPH, and the development of research instruments. The Circle Kit comprises four primary elements: a white cork board, coloured triangular cards, ball head push nails, and string, as depicted in Figure 1.

Upon the conclusion of this phase, the validity of the Circle Kit is evaluated by experts in the field. During the Implementation phase, pilot studies and actual studies are carried out to assess the reliability and usability level of the Circle Kit. Finally, the Evaluation phase is formative, encompassing a continuous evaluation that includes a validation procedure, pilot study, and actual study.

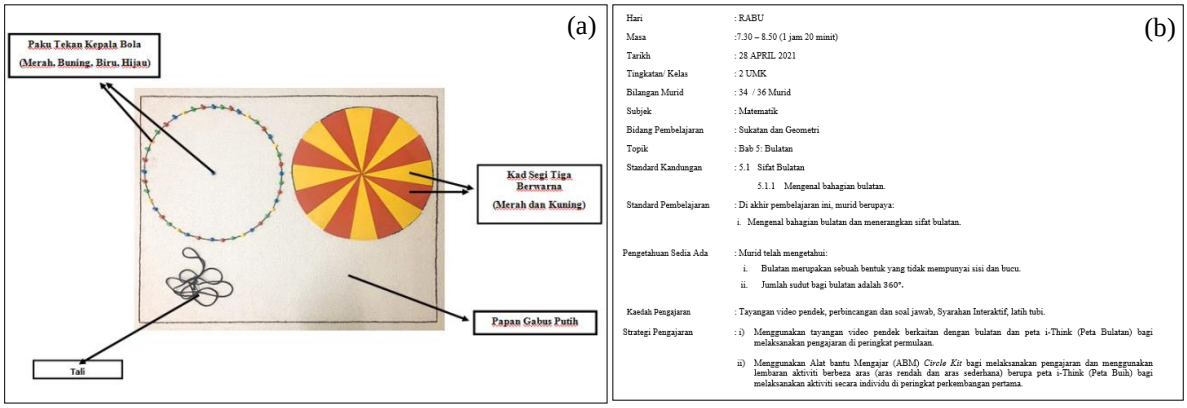

Figure 1. (a) *Circle Kit* Component and (b) RPH

3.2. RPH Content Validity

The Daily Lesson Plan (RPH) CVI was determined to be 1.00. The RPH purposes as a guide and reference for utilising the developed kit. The findings of this study demonstrate a strong and acceptable level of validity for the developed RPH content. The results additionally indicate that the ordinal scale of 1 was assigned to all the items assessed by the five experts. The attainment of a CVI value of 1.00 proves that the RPH's design and substance are precise and aligned with the study context and established learning requirements. The content validity of the RPH is presented in Table 2.

Table 2. RPH Content Validity Results

Item	Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	CVI
		Ordinal Scale	Ordinal Scale	Ordinal Scale	Ordinal Scale	Ordinal Scale	
1.	The introductory phase aligns with the established learning standards.	1	1	1	1	1	1
2.	The teaching development phase adheres to the learning standard.	1	1	1	1	1	1
3.	The ending phase aligns with the learning standards.	1	1	1	1	1	1
4.	The learning content aligns with learning standards.	1	1	1	1	1	1
5.	The planned teaching activities are organized.	1	1	1	1	1	1
6.	The planned teaching activities coincide with the learning standards.	1	1	1	1	1	1
7.	The allocated time is sufficient for the planned activities.	1	1	1	1	1	1
8.	The RPH provided follows the correct format.	1	1	1	1	1	1
	Relevant rate	1	1	1	1	1	
				Item average that 5 experts agreed on (CVI)			1

3.3. Circle Kit Face Validity

The face validity of Circle Kit is deemed satisfactory, as evidenced by its CVI value of 1.00. Five experts assigned all evaluated items an ordinal scale of 1. This demonstrates that the constructed items obtained satisfactory endorsement from all the experts. Hence, the findings suggest that the face attributes, encompassing the design, colour, size, and materials that

enhance the use of this kit, are suitable for BBM. The face validity results of the Circle Kit are presented in Table 3.

Table 3. Circle Kit's Face Validity Results

Item	Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	CVI
		Ordinal Scale	Ordinal Scale	Ordinal Scale	Ordinal Scale	Ordinal Scale	
1.	Circle Kit is easy to use.	1	1	1	1	1	1
2.	The Circle Kit has an attractive design.	1	1	1	1	1	1
3.	The Circle Kit's colour scheme is appropriate.	1	1	1	1	1	1
4.	The Circle Kit's size is appropriate.	1	1	1	1	1	1
5.	Circle Kit is safe to use.	1	1	1	1	1	1
	Relevant rate	1	1	1	1	1	
	Item average that 5 experts agreed on (CVI)						1

3.4. Circle Kit Content Validity

The Circle Kit's content generally demonstrates satisfactory validity, as indicated by a CVI rating 1.00. Che Lah et al. (2023) assert that assessing a measuring instrument's accuracy in a research study is accomplished by assessing its validity. Additionally, they asserted that if the entirety of the content can be measured with accuracy and effectiveness, then the content validity is deemed satisfactory. This implies that the prepared kit's material is suitable and aligns with the concept topic of the Circle. The content validity results of the Circle Kit are presented in Table 4.

Table 4. Circle Kit's Content Validity Results

Item	Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	CVI
		Ordinal Scale	Ordinal Scale	Ordinal Scale	Ordinal Scale	Ordinal Scale	
1.	The construction of Circle Kit is based on learning standards.	1	1	1	1	1	1
2.	The Circle Kit is utilised within the allotted time frame.	1	1	1	1	1	1
3.	The use of the Circle Kit is appropriate for comprehending the Circle concept.	1	1	1	1	1	1
4.	The constructed Circle Kit is appropriate for Form 2 students' experience.	1	1	1	1	1	1
5.	The constructed Circle Kit is appropriate to the skill level of Form 2 students.	1	1	1	1	1	1
6.	The Circle Kit that is constructed is appropriate for the planned activities.	1	1	1	1	1	1
7.	This built Circle Kit is suitable for BBM.	1	1	1	1	1	1
	Relevant rate	1	1	1	1	1	
	Item average that 5 experts agreed on (CVI)						1

3.5. Usability of Circle Kit

The evaluation of Circle Kit's level of usability is conducted by considering three fundamental constructs: usefulness, user convenience, and user satisfaction. Concerning the construct of usefulness, the study's results reveal that all respondents provided feedback only in the form of "agree" or "strongly agree" for the five items under consideration. Among all the items, item 4, which pertains to the utilisation of the Circle Kit as a means to offer students a comprehensive understanding of the Circle topic, obtained the highest average score of 3.89. In general, the mean score for this part is 3.73, suggesting a high level of usefulness for this kit. The usability construct findings of Circle Kit are shown in Table 5.

Table 5. Circle Kit usability results for usability constructs

Item	Criteria	Frequency of respondents' agreement				Mean
		1	2	3	4	
1.	Circle Kit assists teachers in teaching and facilitation (PdPc) for Circle topics.	0 (0.0%)	0 (0.0%)	12 (34.3%)	23 (65.7%)	3.66
2.	Circle Kit functions effectively.	0 (0.0%)	0 (0.0%)	13 (37.1%)	22 (61.9%)	3.63
3.	Circle Kit can be utilised to enhance students' comprehension of Circles.	0 (0.0%)	0 (0.0%)	9 (25.7%)	26 (74.3%)	3.74
4.	The Circle Kit can provide an overview of the Circle topic to students.	0 (0.0%)	0 (0.0%)	4 (11.4%)	31 (88.6%)	3.89
5.	Circle Kit can reduce the duration of PdPc sessions.	0 (0.0%)	0 (0.0%)	10 (28.6%)	25 (71.4%)	3.71
	Overall average	0.0%	0.0%	27.4%	72.4%	3.73

Furthermore, regarding usability, the average mean score achieved in this part is significantly high, measuring 3.79. The analysis findings indicate that all items achieved a mean score surpassing 3.70, with item 2 attaining the highest value of 3.86. A significant proportion of respondents expressed a high level of agreement, expressly "strongly agree," across all items. Furthermore, this also had an indirect impact on the elevated mean score. The determination of the mean score's average value in this part further suggests that the level of user-friendliness for the Circle Kit is significantly high. The usability results of the Circle Kit for ease of use are presented in Table 6.

Table 6. Circle Kit usability results for the ease of use construct

Item	Criteria	Frequency of respondents' agreement				Mean
		1	2	3	4	
1.	The Circle Kit size is convenient and portable.	0 (0.0%)	0 (0.0%)	10 (28.6%)	25 (71.4%)	3.71
2.	Circle Kit is simple to use.	0 (0.0%)	0 (0.0%)	5 (14.3%)	30 (85.7%)	3.86
3.	The Circle Kit's instructions are straightforward.	0 (0.0%)	0 (0.0%)	6 (17.1%)	29 (82.9%)	3.83
4.	The design of the Circle Kit is simple to manipulate.	0 (0.0%)	0 (0.0%)	8 (22.9%)	27 (77.1%)	3.77
5.	The Circle Kit can be operated independently by students during the PdPc session.	0 (0.0%)	0 (0.0%)	7 (20.0%)	28 (80.0%)	3.80
	Overall average	0.0%	0.0%	20.6%	79.4%	3.79

The study findings on satisfaction indicate that all respondents provided "agree" or "strongly agree" feedback for all the items inquired. This factor also played a role in achieving a mean score of 3.79, considered high. In general, item 2, "I believe Circle Kit can increase students' interest in studying Circle-related topics" received the highest average rating of 3.86.

Simultaneously, more items exhibited mean score values beyond 3.70. The usability results for the satisfaction construct of the Circle Kit are presented in Table 7.

Table 7. Circle Kit usability results for satisfaction constructs

Item	Criteria	Frequency of respondents' agreement				Mean
		1	2	3	4	
1.	I will recommend Circle Kit in PdPc to my friends.	0 (0.0%)	0 (0.0%)	7 (20.0%)	28 (80.0%)	3.80
2.	I believe Circle Kit can increase students' interest in studying Circle-related topics.	0 (0.0%)	0 (0.0%)	5 (14.3%)	30 (85.7%)	3.86
3.	I believe that Circle Kit prevents students from getting bored.	0 (0.0%)	0 (0.0%)	9 (25.7%)	26 (74.3%)	3.74
4.	I am eager to utilise the Circle Kit.	0 (0.0%)	0 (0.0%)	7 (20.0%)	28 (80.0%)	3.80
5.	The use of Circle Kit encourages students to participate actively during PdPc.	0 (0.0%)	0 (0.0%)	8 (22.9%)	27 (77.1%)	3.77
6.	The Circle Kit is entirely safe to use.	0 (0.0%)	0 (0.0%)	6 (17.1%)	29 (82.9%)	3.83
7.	The use of Circle Kit encourages student interaction.	0 (0.0%)	0 (0.0%)	10 (28.6%)	25 (71.4%)	3.71
	Overall average	0.0%	0.0%	21.2%	78.8%	3.79

The level of usability of the produced Circle Kit was determined using the average overall mean score, encompassing the three constructs of usefulness, ease of use, and satisfaction. The study's findings indicate that the construct of usefulness received an average mean score of 3.73, the construct of ease of use received an average mean score of 3.79, and the construct of satisfaction likewise received an average mean score of 3.79. Upon conducting the computation, the researchers determined that the mean score for the usability of the kit was found to be 3.77 on average. This finding suggests that Circle Kit has a notable degree of usability as perceived by the UPSI Mathematics trainee teachers.

According to Yusoff and Kasdan (2023), usability testing is conducted to assess users' acceptance of a product to meet user satisfaction and aims to identify any issues or weaknesses in the product that were not encountered during the development process. Hence, the study's findings provide evidence that using Circle Kit effectively facilitates the stimulation of PdPc, engendering an enjoyable learning experience that fosters increased student engagement. This indicated that the level of motivation plays a crucial role in influencing students' academic achievement, especially in complex subjects such as Mathematics (Wan Jaafar & Maat, 2020). Hence, utilising manipulative materials significantly contributes to establishing a purposeful, enjoyable, and pertinent educational environment. This approach enables students to engage and assume accountability for their learning actively. The usability findings for the Circle Kit, as indicated in Table 1, are shown in Table 8.

Table 8. Overall results of Circle Kit usability data

Construct	Mean	Interpretation
Usefulness	3.73	High
Ease of use	3.79	High
Satisfaction	3.79	High
Overall average	3.77	High

4. CONCLUSION

The research has effectively achieved its intended aim, as evidenced by the conclusion. The study's findings and analysis, which incorporated feedback from five experts,

unequivocally demonstrate that the RPH content, face, and Circle Kit content possess a high level of validity, as evidenced by a CVI score of 1.00. Hence, this elucidates the alignment between the RPH and the prescribed educational learning standard requirements. Furthermore, the Circle Kit that has been designed successfully fulfills the criteria of the instructed subject matter, which pertains to the fundamental concepts of the Circle. Regarding the usability aspect of the Circle Kit, the findings of this study have also demonstrated that the kit exhibits a high degree of usability, as evidenced by the positive feedback received from the UPSI Mathematics trainee teachers. This demonstrates that the Circle Kit is an appropriate instructional resource for the PdPc, specifically for Circles. Moreover, it could enhance students' engagement and comprehension in acquiring knowledge related to this topic. The implication is that the Circle Kit can be a significant tool for facilitating students' understanding of the concept of Circles and a resource for teachers to create and enhance unique instructional materials.

Conflict of Interest
The authors declare that there is no conflict of interest.

Author Contribution Statement
Amirah Fatihah Mohd Zulkiflee - Investigation, Methodology, Analysis, Writing. Norazman Arbin - Supervision, Writing, Review & Editing. Norsyazana Kamarudin - Conceptualisation, Validation, Writing, Review & Editing. Siti Noor Asyikin Mohd Razali - Validation, Writing, Review & Editing. Riyan Hidayat - Validation, Writing, Review & Editing. Rezi Ariawan - Conceptualisation, Writing, Review & Editing. Firdaus Mohamad Hamzah - Conceptualisation, Writing, Review & Editing.

Data Availability Statement
The authors confirm that the data supporting the findings of this study are available within the article.

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