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The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool: Validity and Reliability

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ABSTRACT

This study was conducted to determine the validity and reliability of instrument The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool based on expert approval. This study is in the form of a survey conducted using an instrument to obtain expert validity and reliability is instrument The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool. The study employed the item content validity Indexes (I-CVI) analysis method to assess content validity. The method comprised item clarity, language appropriateness and score scale using five-point Likert scale to analyze expert evaluations of items using an instrument form. An instrument is accepted and has a good level of content validity when it exceeds the take off value of > 0.8. The average results scale content validity index (S-CVI) of each expert review on the items ranged from 0.8 to 0.9, suggesting that no questions required repetition. Overall 25 items were refined by fitting the items to the implementation of teaching aids in early mathematics. The finding revealed that the instrument was acceptable and relevant. A pilot study was conducted involving 21 respondents of Kuala Lipis District preschool teachers for reliability testing. The study found that the built instruments had achieved a high level of reliability (Cronbach's Alpha value = 0.831), all 25 items were suitable for use and no items needed to be repaired. In conclusion, instrument of The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool has high validity and reliability and coincides to measure each domain in the instrument.

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1. INTRODUCTION

One of the important aspects of the effectiveness of the teaching and learning process is using interesting and fun teaching aids. According to Abdullah et al. (2021), using teaching aids plays a significant role in ensuring that the teaching and learning process can be carried out effectively. The effectiveness of the teaching and learning process can improve children's understanding of a topic. Using teaching aids allows students to have a positive response in learning (Bakar & Alias, 2021).

The importance of using teaching aids can be seen in the content of the National Preschool Standard Curriculum (NPSC) version 2017 which encourages teachers to use teaching aids. There are several learning strands in the NPSC including Communication, Science and Technology, Spirituality, Attitudes and Values, Humanities, Self-Development, and Physical and Aesthetics Development. Science and Technology (Early Mathematics) is one of the learning strands that really needs teaching aids to facilitate children to understand the concepts in mathematics.

Early mathematics provides early experience, including pre-number experiences, number concepts, number operations, money, concept of time, and shape and space to preschool students. This shows the importance of children understanding mathematical concepts to facilitate their mastery of Early Mathematics. In addition, according to the theory of cognitive development by Jean Piaget (1952), children who are two to seven years old are at a preoperational stage which at that stage is not yet able to think abstractly at the preschool stage. Therefore, the use of teaching aids is very important to help children in the process of thinking. In teaching and learning Early Mathematics, children need to have a high imagination to help children understand certain concepts. Therefore, the use of teaching aids in teaching and learning Early Mathematics is very helpful for children.

Teaching aids that are often used in early math in preschool classes such as lego, blocks, beads and so on. According to Maulana & Wahyudi (2024)), teaching aids are classified as electronic or non-electronic. Electronic materials such as televisions, projectors, slides; while examples of non-electronic teaching materials such as flashcards, magazines, notebooks. For example, teachers want to teach children about the concept of comparison. In this context, teachers can use existing teaching aids such as red beans to make comparisons of quantity (many or few). Through teaching aids, the concept of comparison can be clearly conveyed. So, teachers should be creative in diversifying the use of teaching aids in the teaching and learning process so that children enjoy learning early mathematics. Thus, children's understanding of the content that has been conveyed can be enhanced.

Referring to NPSC (2017), there are several teaching strategies such as child-centred learning, learning through play, inquiry-based learning, integrated approach, thematic approach, project-based learning, mastery learning, contextual learning, and multiple intelligences. These strategies require the use of teaching aids to create a fun learning environment. According to the findings of Kero & Wewe (2024), teachers who use contextual learning make teaching and learning more understandable and pleasant. They can connect the teaching and learning process with real-life examples and materials in the environment. The approaches outlined in NPSC strongly rely on teaching aids. For instance, activities that can be carried out include buying and selling simulations, block games, and bead activities. This is in line with the opinion of the National Association for the Education of Young Children (NAEYC) where mathematics begins with the exploration of materials such as building blocks, sand and water.

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However, there are various problems that occur today in the teaching and learning process, especially the constraints and challenges faced in the use of teaching aids. According to Bakar and Alias (2021), teachers face problems such as lack of knowledge and self-confidence in using teaching aids. According to Ahmad & Md-Ali (2019) there are also several constraints that arise in the development of teaching aids, including insufficient time, a shortage of resource materials, impracticality, heavy teaching workload, limited financial resources, and a lack of skills in creating teaching aids. In short, teachers' understanding of how to use teaching aids is critical for overcoming all of the challenges and constraints connected with using teaching aids throughout the teaching and learning process.

OBJECTIVE STUDY

This study has two objectives as follows:

I. To determine the validity of the instrument for The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool based on expert approval.

II. To determine the reliability of the instrument for The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool based on expert approval.

THEORY

The following illustration presents the stages of cognitive development according to Piaget's theory in **Figure 1**.

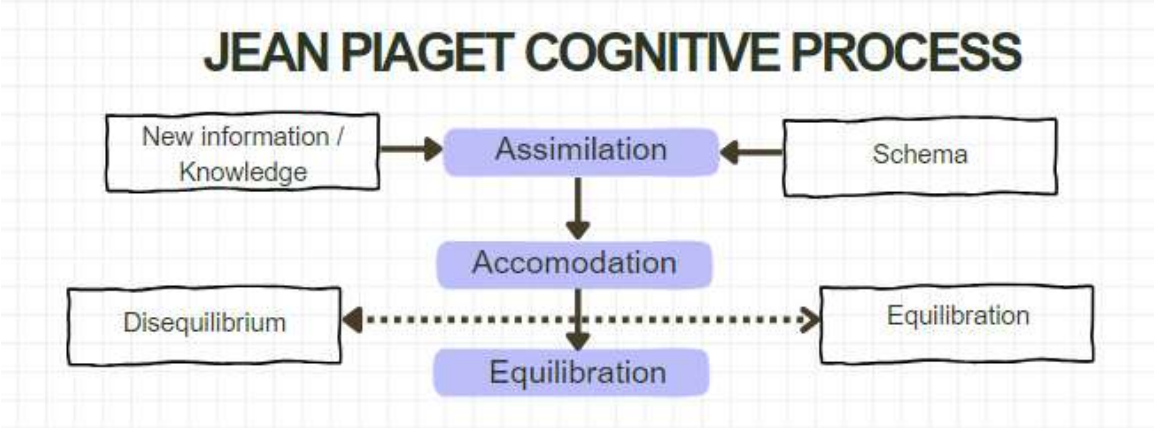

Figure 1. The Theory of Cognitive Development by Jean Piaget (1952)

Jean Piaget believed that every child is born with reflex behaviours (crying, sucking, reaching) to interact and assess the environment. In this cognitive theory, he argues that children learn mathematics through three main concepts: schema, assimilation, and accommodation. This means that each child will construct their own schema through their environment and then adapt all new information gained to the existing experiences to form new knowledge and organize it in the mind. that is organized in the mind.

Jean Piaget argued that every infant is born with reflex behaviours (crying, sucking, reaching) that allow them to interact with and assess their surroundings. According to this cognitive theory, children learn mathematics through three major concepts: schema, assimilation, and accommodation. This means that each child will create their own schema from their environment and then adapt any new information obtained to previous experiences to generate new knowledge and organise it in the mind. In this context, teaching aids are critical in assisting youngsters in developing new schemas and connecting them to current ones. Therefore, continuous interactions among existing schemas, assimilation, accommodation create a strongly interconnected cognitive system for new learning.

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In addition, Jean Piaget in his book 'To Understand is to Invent: The Future Education' also said that knowledge is developed from an individual's construction of knowledge when that individual understands the knowledge (Hasanuddin, 2020). In this aspect, the environment has a considerable impact on children's comprehension. According to Almigo & Sonda (2025), children primarily learn by observation and will copy anything in their environment. As a result, teachers should foster a favourable learning atmosphere for their children. Teachers should use strategies that align with students' interests such as material-centered strategies. Ibrahim et al. (2020) revealed that the use of storybooks, physical materials, music, and technology considerably aids children's understanding in mathematics teaching. As a result, the teacher's role is critical in providing a fun learning environment.

Not only that, Jean Piaget believed that a child's growth happens in stages. Jean Piaget's theory of cognitive development, the thinking of preschool children is at the preoperation stage. They grasp the world at this level through firsthand encounters. This stage involves more symbolic thinking than the sensorimotor stage (Sansena, 2022). At this stage, children begin to represent or display objects using words, symbols or pictures. Preschool teachers should create opportunity for children to apply their learning in this environment. For example, teachers can conduct activities such as nature walk. In this activity, children can count the materials they collect, determine how many insects they encounter, and so on. In the context of mathematics, children can understand numerical concepts and calculations in a concrete and manipulative form. Through this activity, children not only experience concrete learning but also learn about mathematics in their natural environment. Implementing engaging activities and games can provide a more effective understanding of mathematics to regular children (Tasripin et al., 2021).

Furthermore, in this Cognitive Theory, Jean Piaget also emphasizes the use of teaching aids in a real way. This aligns with the viewpoint of (Lee et al., 2023) who state that Piaget places a strong emphasis on hands-on activities in promoting children's development. Therefore, teachers play a role in providing and using existing teaching aids in the teaching and learning process. For example, math toys such as lego numbers, building blocks, duck dice and so on. This can help preschool children develop a better and more enjoyable understanding of mathematics through existing teaching aids. In this way, teaching aids can help improve children's direct experience with mathematical concepts and help them understand concepts more comprehensively.

Finally, the consequences of this cognitive theory for preschool teachers are discussed. Preschool teachers can learn about the importance of teaching aids in early mathematics by using Jean Piaget's Cognitive Theory. A variety of teaching aids, the development of real learning, and engaging teaching strategies, all help to stimulate children's interest in learning and create meaningful learning. According to Voon & Amran (2021), in order to create effective learning, teachers must combine strategies, techniques, and activities in the teaching and learning process that might improve children's cognitive development by producing new concepts or knowledge. Jean Piaget's theory clearly supports the use of early mathematics teaching aids in preschool and emphasises the necessity of direct and manipulative experiences in building the understanding of preschool children in mathematics.

2. METHODS

In this study, the instrument was adapted and modified from an article entitled "Use of Teaching Aids for Primary School Mathematics Teachers" (Omar et al., 2017). The instrument has three sections and 32 questions and uses a Five-Point Likert scale. **Table 1** shows a table of the Five-Point Likert scale.

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Table 1. Five-Point Likert Scale

Score	Statement
1	Strongly disagree
2	Disagree
3	Neutral/Uncertain
4	Agree
5	Strongly agree

Based on **Table 1** above, the representation of score of 1, which is 'Strongly Disagree' means that respondent strongly disagrees with the statement. Meanwhile, the level 'Disagree' with a score of 2 means that the respondent believes that the statement is incorrect. Score 3 represents the 'Neutral/Uncertain' meaning respondent are not very much in agreement with the statement. Furthermore, the representation of score 4 is 'Agree' which means that the respondent believes the statement is true. The last score 5, represents the 'Strongly Agree ' level, meaning respondents are very confident in the validity of the statement. Thus, respondents can choose any rating scale based on their own individual judgment (Abdul et al., 2021).

The process of implementing the validity and reliability of instrument The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool consists two phases. The first phase is the validity test of the instrument, and the second phase is the reliability test of the instrument. For the first phase, face validity and content validity of the instrument are conducted to ensure that the instrument can accurately measure the research domains. In the second phase, a pilot study is conducted to determine the study's reliability based on the Cronbach's Alpha value. The flowchart in **Figure 2** shows the process of implementing the validity and reliability of this study:

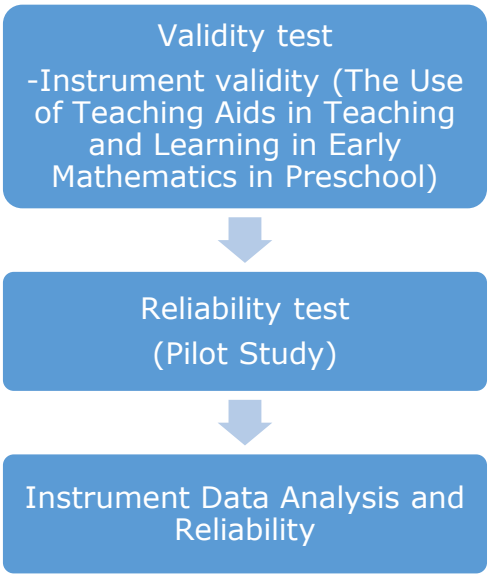

Table 2. Process of implementing the validity and reliability of the study

Face Validity

At this stage, for face validity, the instrument was given to one lay experts on the research topic. The lay expert evaluated the instrument on the clarity of the questions, as in whether the question is easy to understand and less likely to cause misinterpretations or confusion. Subsequently, the expert rated the instrument concerning problem, ambiguity, clarity,

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correct terminology and grammar, and comprehension. The detail of the lay expert is summarized in **Table 2**.

Table 2. List of Face Validity Expert

Expert	Expertise	Experience (years)	Institution	Validity
1	Bahasa Melayu	26	Tengku Ampuan Afzan Teachers' Institute	Face validity

Content Validity

Content validity is defined as "the degree to which items of an assessment instrument are representative and relevant to the target construct" (Nengsih et al., 2019). Content validity provides the preliminary evidence on construct validity of an instrument. If an instrument lacks content validity, it is possible to establish reliability for it. For establishing content validity most researchers used judgment of experts (Subhaktiyasa, 2024; Zayrin et al., 2025).

Identification of content domain and item generation

Content domain is the content area represented through the variables that are intended to be measured. The content domain was determined through literature review, and focused discussion with the expert and the target group. A mixed deductive-inductive method was adopted for conceptualization and item generation. After the item generation, items were refined and organized in a suitable format and sequenced so that the finalized items were in a usable form.

Determining the content validity

Relevance and representativeness are the two key aspects to be fulfilled in content validation (Salwa et al., 2025). The content validity was assessed by computing the content validity index (CVI) to determine the relevancy of the scale. For the present study, 3 experts were approached to determine the validation of content. **Table 3** is the list of content validity experts.

Table 3. List of Content Validity Experts

Experts	Expertise	Experience (years)	Institution	Validity
Expert 1	Early Childhood Education	10	Tengku Ampuan Afzan Teachers' Institute	Content validity
Expert 2	Early Childhood Education	30	Tengku Ampuan Afzan Teachers' Institute	Content validity
Expert 3	Early Childhood Education & Preschool	12	Tengku Ampuan Afzan Teachers' Institute	Content validity

Content validation procedure

Content validity index (CVI) is widely used index in quantitative evaluation. There are 2 types of CVI: I-CVI (item level) and S-CVI (scale level). Prior to the calculation of CVI, the scale is dichotomized by recoding all responses with 3 and 4 as I and all responses with 1 and 2 as zero. Where 1 means 'relevant' and 0 means 'not relevant'.

I-CVI = Experts in Agreement/ Total No. of experts

S-CVI = The average of proportion relevance scores across all experts.

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Pilot Study

Vasileiou et al. (2018) stated that the optimal sample size range in a pilot study is 15 to 30 respondents. Therefore, a total of 21 preschool teachers in Kuala Lipis District, Pahang were selected as a pilot study sample. The **Table 4** below represents the interpretation table for Cronbach's Alpha scores.

Table 4. Interpretation of Cronbach's Alpha Scores

Cronbach's Alpha Score	Reliability
0.9-1.0	Excellent
0.7-0.8	Good
0.6-0.7	Good and Acceptable
<0.6	Acceptable
<0.5	Non acceptable

Source: *Bond and Fox, (2007), in Faizal et al. (2014).*

3. RESULTS AND DISCUSSION

FINDING

Face Validity

Based on expert opinion, the face validity of the instrument for The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool is based on **Table 5**. The table below provides a summary of the expert validity reviews.

Table 5. Face Validity Review

No.	Item	Review
1	The instrument format is suitable and attractive.	Interesting and suitable.
2	Items measure the intended domains.	Suitable.
3	The language used is easily understandable.	Yes.
4	Font size is appropriate and easy to read.	Yes.
5	The meaning of each item is clear.	Clear.
6	Sufficient number of items.	Sufficient items.
7	Clear objectives.	Clear.
8	Clear instructions.	Clear.
9	Correct spelling.	Correct in terms of spelling.
	Overall Review	The proposed items are in line with the action research. Good luck and success.

Content Validity

The following are the findings for the validity of the content of the instrument for The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool based on two parts, Part B (The Importance of Teaching Aids in Early Mathematics in Preschool), Part C (Constraints and Challenges Faced by Teachers in Using Teaching Aids in Preschool). **Table 6**, **Table 7** are the I-CVI and S-CVI tables.

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Table 6. Section B The Importance of Teaching Aids in Early Mathematics in Preschool

Question	Expert 1	Expert 2	Expert 3	i-CVI
Q1	1	0	1	0.67
Q2	1	0	1	0.67
Q3	1	0	1	0.67
Q4	1	1	1	1
Q5	1	1	1	1
Q6	1	1	1	1
Q7	1	1	1	1
Q8	1	1	1	1
Q9	1	1	1	1
Q10	1	0	1	0.67
Q11	1	0	1	0.67
Q12	1	0	1	0.67
Q13	1	0	1	0.67
Q14	1	0	1	0.67
Q15	1	0	1	0.67
		S-CVI / AVE		0.8

Table 7. Section C Constraits and Challenges Faced by Teachers in Using Teaching Aids in Preschool

Question	Expert 1	Expert 2	Expert 3	i-CVI
Q1	1	1	1	1
Q2	1	1	1	1
Q3	1	1	1	1
Q4	1	1	1	1
Q5	1	1	1	1
Q6	1	0	0	0.33
Q7	1	1	1	1
Q8	1	1	1	1
Q9	1	1	1	1
Q10	1	0	1	0.67
		S-CVI / AVE		0.9

Based on the I-CVI and S-CVI above, the instruments provided indicates a high level of validity. This can be stated by Section B obtaining an I-CVI between 0.67 to 1 and S-CVI is 0.8. For Section C, the I-CVI is between 0.33 to 1 and the S-CVI is 0.9. The following are expert suggestions for improvement and an overall expert reviews of the content validity of the instrument for The Use of Teaching Aids in Teaching and Learning Early Mathematics in Preschool. **Table 8** shows suggestions for improvement and overall expert reviews of content validity.

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Table 8. Suggestions for improvement and overall expert reviews in content validity

Experts	Section B	Section C	Overall Review
1	Write specific question instructions.	Check the use of punctuation marks.	Great, you can provide a commendable research instrument.
2	It has been added as suggested.	The instrument has been improved as suggested.	The overall instrument meets the requirements of the title made.
3	You can further improve the instrument.	Add the phrase 'in Early Mathematics Teaching and Learning' to sections B and C of the instrument.	Some items need to be modified for better understanding.

Overall, the provided instruments showed good content validity and could continue to be used throughout the research study.

A Pilot Study

The constructs discussed in this study consist of three sections: Section A, Section B, and Section C. The Cronbach's Alpha values for the instrument are based on the **Table 9** below;

Table 9. Cronbach's Alpha

Section	Total items	Cronbach's Alpha Score	Interpretation
Section B: The Importance of Teaching Aids in Early Mathematics in Preschool	15	0.881	Good and acceptable.
Section C: Constraints and Challenges Faced by Teachers in Using Teaching Aids in Preschool	10	0.919	Very good and highly consistent and effective.
Overall Cronbach's Alpha Value		0.831	Good and acceptable.

Based on **Table 9**, it shows the Cronbach's Alpha for Section B is 0.881, and Section C is 0.919. This indicates that Section B is good and acceptable, while Section C is very good and highly consistent and effective. The overall Cronbach's Alpha value is 0.831, where all items are good and acceptable.

Discussion

Validity expresses the degree to which a measurement measures what its purpose is to measure. Validity tests are categorized into two broad components namely; internal and external validities. Internal validity refers to how accurately the measures obtained from the research was actually quantifying what it was designed to measure whereas external validity refers to how accurately the measures obtained from the study sample described the reference population from which the study sample was drawn (Zayrin et al., 2025b).

Reliability is the extent to which a measurement of a phenomenon provides stable and consists results, and Cronbach's Alpha is an accurate estimate of reliability (Pasianus & Kana, 2021). According to Amanda et al. (2019), the Cronbach's Alpha coefficient between 0.6 - 0.7 indicates an acceptable level of reliability, and 0.8 or greater a very good level.

The results of the pilot test results in this study showed the reliability value index is between Cronbach's Alpha 0.88 (stability coefficient) to 0.92 (very good reliability/ acceptable

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stan test for inferred consistency) and are still within the range of degrees of positive correlation (Kurniawati et al., 2022).

Analysis of Table 9 found that the average value of Cronbach's Alpha coefficient is above 0.83. This suggests that all items in the study are suitable for use in the instrument and no items need to be modified based on Cronbach's Alpha if item deleted. This ensures that the Cronbach's Alpha reliability coefficient obtained in the actual study will provide even better results. According to Kurniawati et al. (2022), if the Cronbach's Alpha value is 0.8 to 1 then the instrument has a high reliability value and is an acceptable item.

4. CONCLUSION

The result of the study demonstrates that instrument of the use of teaching aids in teaching and learning early mathematics in preschool fulfils the criteria of a reliable (pair acceptable criteria) and valid (good criteria) assessment tool to identify the use of teaching aids in the implementation of early mathematics teaching and learning in preschool. The high internal consistency and construct validity support the application of the use of teaching aids in the teaching and learning early mathematics in preschool as an easy-admitted tool to access the importance of teaching aids in early mathematics in preschool and the constraints and challenges faced by teachers in using teaching aids in preschool.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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