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Content Validation Procedure: Development of Problem-solving Skills Test (PSST)

Prosedur Pengesahan Kandungan: Pembangunan Ujian Kemahiran Penyelesaian Masalah (PSST)

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ABSTRACT

This research aimed at developing a test instrument, the Problem-solving Skills Test (PSST) for Year Four students. The researcher has carried out content validity procedures on the PSST instrument. The content validity of the test involved six content validation experts. There were ten items for the test instrument. The items on the test have been evaluated quantitatively using the Content Validity Index (CVI) to determine whether they should be retained or discarded. According to the findings, the item content validity index, I-CVI, came in at a value of 1.00 for all items. This resulted in the scale content validity index, for both S-CVI/Ave and S-CVI/UA, equal to 1.00. Therefore, the Problem-solving Skills Test (PSST) has attained a very high degree of content validity and may be administered in actual research to determine students' problem-solving skills.

Keywords: Content Validity, Content Validity Index (CVI), Problem-solving Skills, Mathematics Education, Validity of Instrument

ABSTRAK

Kajian ini bertujuan membangunkan instrumen kajian, iaitu Ujian Kemahiran Penyelesaian Masalah (PSST) bagi murid Tahun Empat. Penyelidik telah menjalankan prosedur kesahan kandungan pada instrumen PSST. Kesahan kandungan ujian melibatkan enam orang pakar kesahan kandungan. Terdapat sepuluh item dalam ujian tersebut. Item-item pada ujian telah dinilai secara kuantitatif menggunakan Indeks Kesahan Kandungan (CVI) untuk menentukan sama ada item-item tersebut harus dikekalkan atau dibuang. Menurut dapatan kajian, nilai Indeks Kesahan Kandungan Item (I-CVI) adalah 1.00 bagi kesemua item. Ini menjadikan Indeks Kesahan Kandungan Skala, untuk kedua-dua S-CVI/Ave dan S-CVI/UA, bersamaan dengan 1.00. Oleh itu, Ujian Kemahiran Penyelesaian Masalah (PSST) telah mencapai tahap kesahan kandungan yang sangat tinggi dan boleh ditadbir dalam kajian sebenar untuk menentukan kemahiran penyelesaian masalah murid.

Kata Kunci: *Kesahan Kandungan, Indeks Kesahan Kandungan (CVI), Kemahiran Penyelesaian Masalah, Pendidikan Matematik, Kesahan Instrumen*

INTRODUCTION

Content validity is a crucial aspect of instrument development and evaluation. Content validity denotes the degree to which a research instrument measures what it is intended to measure (Ary et al., 2013; Lynn, 1986). In other words, the process of evaluating content validity involves an in-depth analysis of the test items and their relevance to the construct being measured. There are various statistical methods of evaluating content validity, including the CVI, which stands for Content Validity Index. The index of content validity (CVI) is the most popular and extensively used method for quantifying the instrument's validity (Lynn, 1986). The procedure of evaluating content validity should be thorough and systematic, with a panel of field experts reviewing and rating the test items. Each item is evaluated and rated using the rating scale by several experts to determine the validity of the instrument. The rating scales of four points are frequently used by researchers (Polit et al., 2007), and Lynn (1986) also favoured four-point rating scales over three-point or five-point rating scales. Davis (1992) developed the most widely used version of the four-point rating scale, which goes as follows: (i) a score of one indicates that the item is not relevant, (ii) a score of two indicates that it is somewhat relevant, (iii) a score of three indicates that it is quite relevant, and (iv) a score of four indicates that the item is highly relevant. An item is considered relevant if it receives a score of three or four. Meanwhile, the item is irrelevant if it receives a score of one or two. The Content Validity Index (CVI) is calculated by giving a zero to an irrelevant item and a one to a relevant item. A score of one indicates perfect content validity of the item, and a score of zero indicates poor content validity. CVI is derived by dividing the number of experts who believe each item in the instrument is relevant by the total number of experts who participated in the evaluation. This ratio is then averaged across all items to create a single score for the entire instrument. In this research, the developed Problem-Solving Skills Test (PSST) went through the content validity procedure using the analysis of content validity index (CVI) to ensure this test is able to measure the problem-solving skills of Year Four students.

LITERATURE REVIEW

Problem-solving is one of the most important elements of mathematics education. It is a skill, a procedure, a learning goal or a method of instruction (van Zanten & van den Heuvel-Panhuizen, 2018). An individual's capacity to solve problems is referred to as problem-solving skills, which means it involves the mental processes used by the individual to get closer to achieving the goal (Martinez, 1998; Mayer & Wittrock, 2006). The ability to solve problems calls for individuals to take action or seek the best possible answer (Sutama et al., 2021). When seen from a mathematical perspective, problem-solving is the act of working through and finding solutions to mathematical problems (National Council of Teachers of Mathematics, 2000). The act of problem-solving is the pinnacle of comprehending every mathematical topic and concept studied, as it assesses one's cognitive ability and other proficiencies, such as mastery of fundamental facts, reasoning through problems, performing operations, arranging data, utilising diverse mathematical concepts, and conducting logical verifications (Tuan Siti Humaira & Mohamad Amir Shah, 2016). Effective problem-solving is the result of a mental process where it involves using knowledge, skills, and experiences to recognise problems, generate viable solutions, and implement them successfully.

Mathematics education in Malaysia places a strong emphasis on problem-solving skills and is integrated across the whole curriculum in the hope that students successfully solve various problems (Curriculum Development Centre, 2018). Developing the ability to solve problems is an important skill for students to cultivate during their time spent studying mathematics. The problem-solving process is designed to act as a guide in finding a solution to a problem. Therefore, Polya's problem-solving strategy may be used for the process of solving problems in addition to improving problem-solving skills. Polya's strategy for solving mathematical problems is emphasised in the mathematics education curriculum in Malaysia, and its steps are incorporated in mathematics textbooks. Polya's problem-solving strategy can assist students in solving mathematical problems with greater structure, deliberate, and conscientious manner, enabling them to have a more comprehensive understanding of the solution process that they are undergoing (Mohd Rusdin & Dollah, 2018). Polya (1945) described the process of problem-solving as a progression from one phase to the next that took place in a step-by-step manner. This allows the individual to follow the problem-solving steps in a manner that is more methodical and sequential, ultimately leading to the discovery of the problem's solution. The following are the steps of Polya's problem-solving strategy: (i) Step 1 - Understand the problem, (ii) Step 2 - Develop a strategy, (iii) Step 3 - Execute the strategy, and (iv) Step 4 - Check the solution. Figure 1 illustrates Polya's problem-solving strategy.

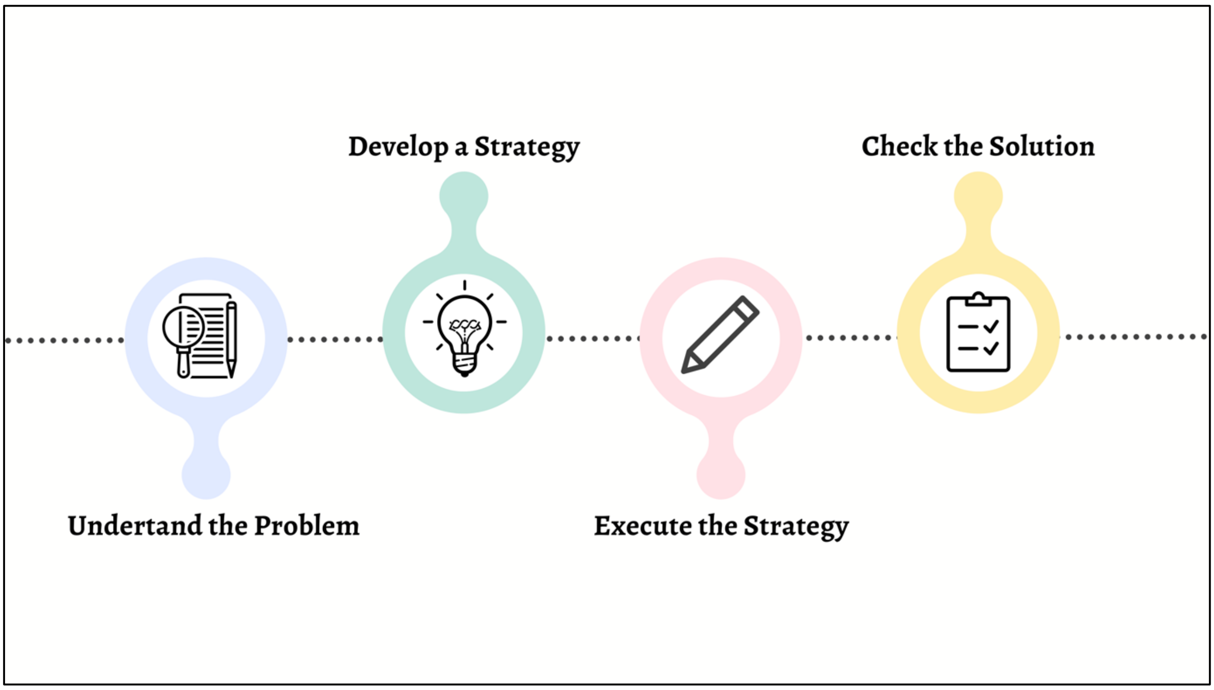

Figure 1: Polya's Problem-solving Strategy

The problem-solving process of Polya's strategy begins with a thorough understanding of the problem at hand. Students should read the problem to have a comprehension of what is known and what has to be done. The students need to be able to differentiate between information that is significant and information that is not significant. In other words, important information is retained while unimportant information is discarded. Developing a strategy is the next step when dealing with a problem. In this stage, students are challenged to think creatively about potential solutions to the problem. The third step in the process of finding solutions to problems is to put the plan into action. Once they have decided on a strategy, they methodically put it into action, ensuring that each step is carried out appropriately. The last step is checking the accuracy of the solution. During this stage, students need to examine their work to make sure the answer is correct. Polya's strategy for solving the problem is summarised in Table 1, which is displayed below.

Table 1: Summary of Polya's Problem-solving Strategy

Step	Explanation
Understand the problem	✓ Read the problem. ✓ Identify important information.
Develop a strategy	✓ Think of possible solutions. ✓ Choose the best solution.
Execute the strategy	✓ Carry out the solution step by using the strategy that was selected. ✓ If the existing solution is unsuccessful, a new strategy should be devised.
Check the solution	✓ Check the answers and make corrections if there are mistakes.

The purpose of this research is to develop an instrument, the Problem-solving Skills Test (PSST), to identify the problem-solving skills of Year Four students in mathematics. Identifying students' problem-solving skills via the development of the instrument may aid in directing their mathematics learning. In addition, the instrument may provide teachers with assistance and insight when they measure the problem-solving skills of their students. Therefore, the act of validating an instrument is an essential step that must be taken after developing the instrument. For a successful PSST instrument development, validating the instrument of PSST must be carried out to ensure that the test can measure what it intends to measure, which is the students' problem-solving skills.

THE PROCEDURE FOR VALIDATING CONTENT

The procedure of validating the content of the instrument was carried out thoroughly and systematically on the basis of the expert group's collective knowledge and experience in order to make a verdict on the validity of the content of the items. For the content to be considered valid, the instrument must demonstrate that it covers the subject area and topic in an objective and comprehensive manner. Validity of the content of the Problem-solving Skills Test (PSST) is essential since the results that are obtained demonstrate the extent to which students have gained problem-solving skills. In this research, five procedural phases for content validation were employed. The phases for content validation are illustrated in Figure 2.

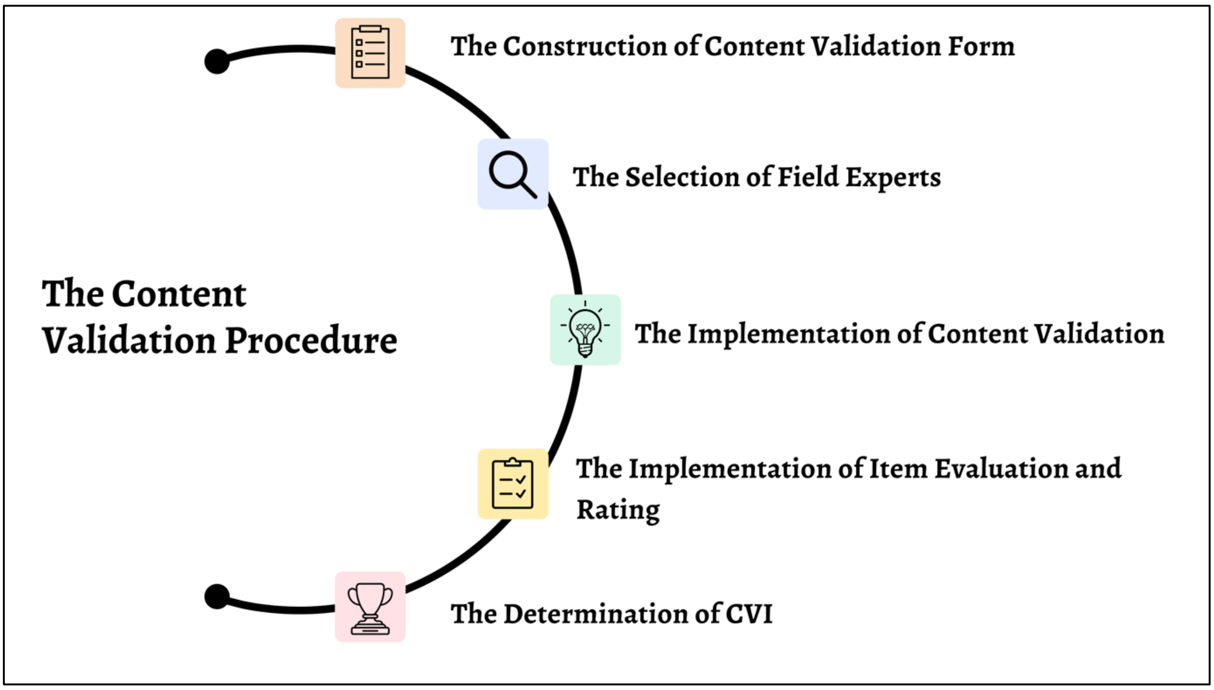

Figure 2: The Content Validation Procedure

Phase 1: The Construction of Content Validation Form

The initial phase in the content validation procedure is constructing a content validation form. In the content validation form that has been provided, the information and description pertaining to the instrument must be presented in a manner that is thorough and understandable. This phase is essential because it ensures that the panel of experts doing the evaluation has a good understanding of the task before the content evaluation can be conducted thoroughly.

Phase 2: The Selection of Field Experts

The procedure of validating the content continues with the selection of a panel of experts who are knowledgeable in the field of study as the second phase. For the purpose of this research, the expert panel of evaluators was chosen on the basis of their knowledge in relation to the subject of mathematics education and problem-solving. The selection of experts was based on the following criteria: (1) possess a Ph.D. degree, (2) have expertise in mathematics education, and (3) have at least ten years of academic experience. When deciding the number of experts to evaluate the content's validity, the bare minimum is three experts, while the ideal quantity is no more than ten experts (Lynn, 1986). Davis (1992) suggested at least six experts are needed. Due to the significance of these recommendations, this research was carried out with the participation of six field experts. The panel of experts' professional backgrounds, as well as their areas of expertise, are outlined in Table 2.

Table 2: The Experts' Professional Background and Expertise

Expert	Occupation	Service Period	Service Institution	Field of Expertise
Dr Sy	Lecturer	28 years	IPG Kampus Darulaman	Program Evaluation and Mathematics
Dr Mu	Lecturer	15 years	Universiti Pendidikan Sultan Idris	Mathematics Education
Dr No	Chief Assistant Director	28 years	Kementerian Pendidikan Malaysia	Integrated STEM Education, Mathematics Problem-solving, Mathematics Learning Module Construction, Inquiry-based Learning, Mathematics in Context
Dr Ka	Lecturer	13 years	IPG Kampus Tuanku Bainun	Mathematics Education
Dr La	Assistant Director	11 years	Bahagian Profesionalisme Guru	Mathematics Education
Dr Wi	Lecturer	13 years	Universitas Sarjanawiyata Tamansiwa	Mathematics Education and Problem-solving

Phase 3: The Implementation of Content Validation

The content validation was carried out in a non-face-to-face method. The phase began by obtaining expert approval to be an online content validity assessor via email. After obtaining approval, the researcher sent relevant documents such as an expert appointment letter, content validation evaluation form, and attachment to the instrument to be evaluated. Content validity is determined based on the judgment of a panel of field experts by asking them to rate the level of relevance of the items on the instrument. Experts were given a period of two weeks to evaluate the content validity of the instrument. The researcher has sent a follow-up email to the expert, who has yet to respond within the specified period.

Phase 4: The Implementation of Item Evaluation and Rating

In this phase, the evaluation was done by analysing the item first before giving a rating to the item. In the content validity form that has been given, detailed instructions on how experts should rate the PSST instrument have been included. This research utilised 4-rating scales recommended by Lynn (1986) and Waltz and Bausell (1981). The reason for using a 4-point scale was to get rid of the ambiguous middle point (Lynn, 1986). After going through the instrument, each expert was given a scale with four points and asked to rate each item based on their perceived level of relevance (1 representing not relevant, 2 indicating less relevant, 3 being quite relevant, and 4 being very relevant). Items with ratings of 1 and 2 are regarded as invalid, whereas items with ratings of 3 and 4 are considered valid. Experts must also offer feedback and improvement ideas (if applicable) in the designated section. After finishing the evaluation of the instrument, the experts were required to hand over the completed content validation forms to the researcher via email.

Phase 5: The Determination of CVI

This research employed the Content Validity Index (CVI) to calculate the content validity for the PSST instrument. The CVI is an indicator that measures the level of agreement amongst raters (Polit et al., 2007). Calculations of CVI may be split into two distinct categories. The first category deals with item-level content validity (I-CVI), whereas the second deals with scale-level content validity (S-CVI) (Lynn, 1986). Items with a 1 or 2 rating are deemed irrelevant, whereas those with a 3 or 4 rating are considered relevant. As a result, irrelevant items get a score of 0, while relevant ones receive a value of 1.

The data provided by the I-CVI serves as a guide for the researcher to revise, drop, or replace items (Polit & Beck, 2006). The I-CVI is calculated by taking the number of experts rated 3 or 4 that agree that the item is relevant and dividing that number by the total number of experts involved in the evaluation. In situations with five experts or fewer, the I-CVI will be set at 1.00, indicating that all experts are required to reach a consensus on the evaluation of the instrument. On the other hand, when there are six or more experts, the bar may be decreased, provided that the I-CVI is not lower than 0.83 (Lynn, 1986). The I-CVI value suggested by The I-CVI value suggested by Lyn was agreed by Polit et al. (2007) and Polit and Beck (2006). Meanwhile, according to Davis (1992), a value of ≥ 0.80 for the I-CVI is considered optimal. However, the configuration proposed by Lynn (1986) with the I-CVI value of ≥ 0.83 for the involvement of six field experts was used in this research. The formula for I-CVI is as follows:

$$I - CVI = \frac{Agreed\ Item}{Number\ of\ Expert}$$

The S-CVI may be calculated using either the S-CVI/Ave formula or the S-CVI/UA formula. S-CVI/Ave is the average of the I-CVI scores for all items on the scale. If the SCVI/Ave value is more than or equal to 0.90, the instrument is considered valid (Polit et al., 2007). Meanwhile, S-CVI/UA is the proportion of items on the scale that obtain a rating of 3 or 4 by all experts (Waltz & Bausell, 1981). The score for Universal Agreement (UA) is 1 if all the experts agree on the item. If there isn't unanimous agreement, however, the item gets a score of 0 on the Universal Agreement (UA) scale. The following are the formula to compute S-CVI/Ave and S-CVI/UA, respectively:

$$S - CVI/Ave = \frac{Sum\ of\ I - CVI}{Number\ of\ Items}$$

$$S - CVI/UA = \frac{Sum\ of\ UA\ Scores}{Number\ of\ Items}$$

RESULTS AND DISCUSSIONS

The Problem-solving Skills Test (PSST) was designed to identify problem-solving skills among Year Four students in primary school. This instrument consisted of 10 items. The PSST instrument's content validity was evaluated by a panel of experts consisting of six field experts. The Content Validity Index (CVI) was employed to measure the content validity of the instrument. Table 3 below displays the results of the content validity analysis utilising the CVI approach.

Table 3: The Content Validity Index (CVI) for Problem-solving Skills Test (PSST)

Item	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**		**Experts in Agreement**	**I-CVI**	**UA**
1	1	1	1	1	1	1		6	1	1
2	1	1	1	1	1	1		6	1	1
3	1	1	1	1	1	1		6	1	1
4	1	1	1	1	1	1		6	1	1
5	1	1	1	1	1	1		6	1	1
6	1	1	1	1	1	1		6	1	1
7	1	1	1	1	1	1		6	1	1
8	1	1	1	1	1	1		6	1	1
9	1	1	1	1	1	1		6	1	1
10	1	1	1	1	1	1		6	1	1
								S-CVI/Ave	1	
Proportion Relevance	1	1	1	1	1	1		S-CVI/UA		1
Average proportion of items judged as relevance across the six experts							1			

Based on Table 3, the I-CVI value for all ten items was 1.00. Whenever there are more than six experts participating, the score of CVI must be at least 0.83 in accordance with the guideline made by (Lynn, 1986). Given that the I-CVI result for each item was 1.00, which was ≥ 0.83, it is reasonable to draw the conclusion that the PSST instrument has excellent content validity. In addition, the calculation of S-CVI/Ave produced the same result, which was a value of 1.00, exceeding 0.90 for the instrument that was evaluated. The S-CVI/UA was also 1.00, indicating that every item received relevance ratings of 3 or 4 from all the experts. Given that the S-CVI/UA value for these data was 1.00, it can be deduced that all six experts universally agreed that each one of the ten items has valid content. According to these results, the degree of agreement among experts on all items was extremely high. This demonstrates that the instrument has high content validity. In conclusion, this suggests that the Problem-solving Skills Test (PSST) is capable of being administered and utilised in actual research to determine students' problem-solving skills since it shows that there is a high level of consensus among the experts.

One of the key benefits of high content validity is that it increases the accuracy of test results. A test with high content validity provides a more accurate assessment of the construct being measured. The content validity procedure through CVI analysis carried out by the researcher with the participation of field experts may undoubtedly aid the researcher in carrying out the research so that the research instrument employed can accurately measure the problem-solving skills of Year Four students using the Problem-solving Skills Test (PSST). In addition, while doing validation, experts were given the freedom to evaluate each item in the instrument and provide comments and recommendations to ensure that the constructed items were appropriate to the research objective and respondents.

CONCLUSION

In conclusion, validating the content of test instruments is one of the most significant procedures that must be taken throughout the process of developing and evaluating new test instruments. This is done to make certain that the instruments can be employed appropriately in actual research. The purpose of this research was to evaluate the content validity of the newly constructed instrument, which was the Problem-solving Skills Test (PSST). PSST was designed with the intention of determining the problem-solving skills of Year Four students. The procedure of content validity was carried out to guarantee that the items created accurately measure the students' problem-solving skills. The CVI analysis was employed in the process of evaluating the content validity. The findings of both the I-CVI and the S-CVI indicated that the PSST instrument had attained extremely high expert agreement and was thus validated to have outstanding content validity. Therefore, all items in the instrument were valid and accepted, and ready to be employed in actual research. In the future study, it may be possible to examine the assessment instrument for reliability and other types of validity, such as face validity, construct validity, and criterion validity, to improve the instrument.

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