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Determining the Content Validity of a Linear Pattern Test

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Abstract Determining the content validity of a measure a very important process. It ensures that the test constructed is able to represent the content domain to be assessed accurately and meaningfully. In this study, there are three key aspects in determining the content validity of a linear pattern test, namely (a) table of specification, (b) item relevance, and (3) content coverage. The linear pattern test consists of eight interview tasks covering four content domains of linear equation topic based on Malaysian Form Two, Form Three, and Form Four syllabus namely, linear pattern (pictorial), direct variation, concepts of function and arithmetic sequence. Two tasks were constructed for each content domain assessed. The mean value of panel judgment will also be discussed in detail.Based on the responses given by the three panels in reviewing aspects of the item relevance and the content coverage, the measurement tool of this study has been found to possess an acceptable degree of content validity.

Keywords: content validity, linear pattern test, item relevance, content coverage

Introduction

Determining the validity is a very important process for all types of achievement test. Without this process, the test results may fail to outline the right conclusion. As a result, the test can be considered invalid. Gay and Airasian (2009) stated that content validity is the degree to which a test measures an intended content area. It is important to ensure that the test is able to represent the content domain to be assessed accurately and meaningfully. According to Popham (1999), content validity demonstrates the degree to which the sample of items or questions on a test representative of some defined universe or domain of content. He claimed that there are three key aspects in determining the validity of content, namely: (a) table of specification (b) item relevance, and (c) content coverage. Each of this aspect will be discussed in detail. In this study, content validity of linear pattern test had been determined based on Popham's three key aspects, to ensure that the eight interview tasks constructed were covering four content domains of linear equation topic based on Malaysian Form Two, Form Three and Form Four syllabus.

Table of Specifications

Table of Specifications (TOS) is an important 'tool' to clarify the content domain of a test. Normally, the Table of Specification is built in the form of tables consisting of two main dimensions. The first dimension is the topics or subtopics to be assessed. The second dimension describes the mental processes to be assessed for each of the subtopic or topics. Table 1 shows a Table of Specification for a linear pattern test, which is one of the algebra topics in Mathematics. It was developed based on the Mathematics Curriculum Specifications of Form Two, Form Three and Form Four (Ministry of Education, 2003). Eight interview tasks were constructed to assess the linear equation solving ability among Form Four students. The content of the table had been divided into four domains, namely linear pattern (pictorial), direct variation, concepts of function and arithmetic sequence. Two tasks were constructed for each content domain to be assessed (see an example of task in Appendix A). A total of 101 questions were prepared to evaluate the four content domains of this topic. Each content domain was measured by three categories of skills or three cognitive complexity (Kubiszyn and Borich, 2003), namely investigating the patterns, generalizing of patterns and applying linear equations. The descriptions of each content domain are as follows:

a) Linear pattern (pictorial)
In mathematical definition, linear pattern is said to exist when the coordinates of two variables (dependent variable and independent variable) have the same relationship and connected by a certain rule. For example, a relationship between variables x and y is called linear if the graph of related (x, y) value is a straight line. This graph pattern occurs when there is a constant different between successive y values as x values change uniformly. In this study, linear pattern is expected to be a pivotal component which would drive student's solving ability in algebra, initially in recognizing the pattern and later forming and applying the algebraic expression and linear equation to solve the related and new problem situation. Based on the syllabus, the important formulas exist for working the linear pattern (pictorial) are $y = x + a$, and $y = mx + a$ where x and y are variables and a and m are constant.

b) Direct variation
Direct variation is a situation in which two quantities such as hours and pay, distance and time, increase or decrease at the same rate. It means the ratio between the quantities is constant; as one quantity doubles, the other quantity also doubles. In mathematical definition, direct variation means two variables quantities have a constant (unchanged) ratio. It is said that one quantity is directly proportional to another when the ratio of the two quantities is constant. The constant is the constant of proportionally and the ratio is a direct proportion (Lee, 2003; Key Curriculum Press, 2003; The Annenberg/CPB, 2005). In this study, direct variation is described by an equation of the form: $y=kx$ where x and y are variables and k is called the constant of variation. Student's cognitive ability in direct variation tasks had been studied (e.g. Swafford and Langrall, 2000; Lee, 2003). Swafford and Langrall observed that, although majority of 6^{th} grade students were often able to write equation to represent the direct variation situation but they tended to use mental mathematics strategies to solve the problem. In other words, most of students showed

a remarkable ability to generalize the direct variation situation but they rarely to apply it in solving the related problem. In constructing the tasks with respect to direct variation, the findings of previous studies were recognized by establishing linear equation solving ability expectations involving with representation and application of direct variation equation.

c) Concept of function

Function is the relationship of two variables whichare associated with each other according to some given condition or rule. For instance, *y* is a function of *x*; represents that for each value of *x,* there is only one value of *y*. (ThinkQuest, 1998). Function is also defined as a process that receives input and returns a unique value of output. In general, function is a rule of correspondence connecting the element of one set (the domain of the function) with the element of another set (the range of the function). For example, the perimeter of a square is completely determined by the length of its side (Cathcart, Pothier, Vance & Bezuk, 2000). According to Edwards (2000), Sheffield and Cruikshank (2000), understanding of functional concept can be investigated through the function machine and guess my rule method. It is the excellent method that focuses on the input-output nature of functions, which is the most important property of functions. Thus, In this study, the formulas exist for working the concept of function is $y = mx + a$ where x is the input value, y is the output value, a and m are constant.

d) Arithmetic sequence

An arithmetic sequence is a sequence of numbers in which the difference of any two consecutive terms is constant. This difference is called common difference. For example, 3, 6, 9, 12 is an arithmetic sequence because to progress from one term to the next, like 6 to 9, it must be added a constant number 3 to the previous term. In this example, 3 is called common difference. Common difference is denoted by *d*. If the difference in consecutive terms is not constant, then the sequence is not arithmetic. To produce the next term *d*, may be positive or negative; so, a sequence can increase or decrease. An important formula exists for working with an arithmetic sequence... $a_n = a_1 + (n-1)d$, where a_n represents the n^{th} term, a_1 represents the first term, n represents the total numbers, and d represents the common difference.

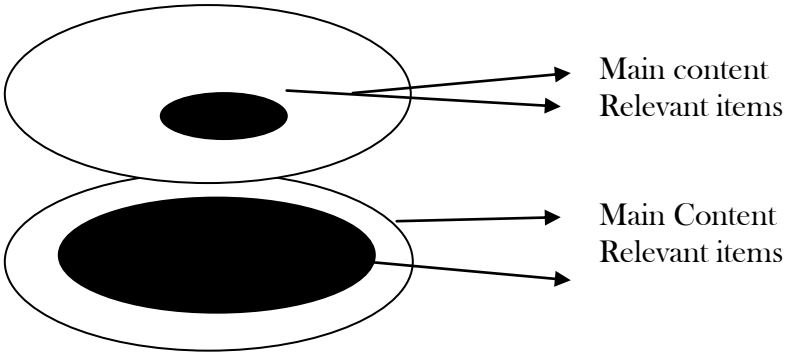
Some story problems of this study were adapted from previous studies and mathematics projects in order to suit the Malaysian Secondary School Mathematics Syllabus and objectives of this study. For example, a story problem for a second, fifth and sixth interview have been adapted from MathPARTNERS Project (Education Development Center, 2004). Story problems for third and seventh interview were adapted from the study of Langrall & Swafford (2000) concerning the use of equations to describe and represent problem situations. Construction of the questions in each interview was made according to table of specification that represents the the relevance of the item and content coverage which have been specified. Thus, content validity can be proved. The next sections discuss the specification of the interview tasks in terms of item relevance and content coverage.

Item Relevance

Item relevance is to ensure that all the questions of each task are relevant or closely related to the content domain of a topic to be assessed. Nitko (1996) and McMillan (2001) stated that the key measure in determining the item relevance is built by the construction of the Table of Specifications.

Content Coverage

Content coverage is to ensure that all the tasks are able to represent the main content of each topic to be assessed. The following diagram describes the relationship between the item relevance and the content coverage of a topic assessed. Based on Figure A, although all of the questions or tasks that are relevant to the main content of the topic to be assessed, but it only covers a small part of the main content. While Figure B shows the questions or tasks cover the main content more representatively and thoroughly.



Process of Determining Item Relevance and Content Coverage of Linear Pattern Test

In our study, the process of determining item relevance and content coverage of linear pattern test had been done systematically. Three panels who are knowledgeable regarding the topic of algebra for secondary school level had been asked to review independently the relevance of each question in the eight tasks and the content coverage based on a given scale. Thus, there are two aspects of judgment determined by the panels. The first is the relevant of items for each task. The second is the coverage of the main content of the linear equation topic that has been represented by all the tasks. The second question is important to identify whether all the tasks are able to represent the overall main content or only a small part of the main content.

Three panels who are experts in the related areas were invited to ensure the content validity of the interview questions, namely a university lecturer who specialized in the field of psychometrics, a university lecturer who specialized in the field of mathematics education, and a secondary school mathematics teacher with teaching experiences in Mathematics over ten years had agreed to determine the content validity in terms of item relevance and content coverage. Two judgment forms were provided to each panel in reviewing the content validity based on a given Likert Scale (Sax, 1997). Judgment Form A had been used to judge the item relevance of the interview questions for each task while Judgment Form B was used to

judge the content coverage of each task for the topic of linear equation (see Appendix B and C).

Table 2 depicts the judgment value for each panel and the mean value of judgment for each interview question. Based on this table, all the judgment values given by the three panels were at least 3 and the mean value of judgment for all the interview questions were more than 3. It can be concluded that all the interview questions are relevant to the content domain assessed. It also reflects the clarity levels of the interview questions are high.

Table 3 demonstrates the mean value of the three appraisal judgments for the aspects of content coverage. The mean value of all the judgments is greater than 3. This means that all the tasks had covered the main content of the linear equations with fairly comprehensive.

Based on the responses given by the three panels in reviewing aspects of the item relevance and the scope of content, it can be concluded that the measurement tool of this study has an acceptable degree of content validity.

Conclusion

Although the key ingredient in securing content validity is human judgment, the judgment procedures to gather the evidence are particularly appealing because such evidence can be gathered quantitatively and systematically. The generally high ratings of item relevance and the content coverage are not only supportive of the content validity of the instrument but also bode well for its broad acceptance when it is implemented (Guba & Lincoln, 1989). As a consequence of the quantitative results of this study, all the questions in each task are: (a) relevant to the content domain assessed; (b) covered the main content of the linear equations with fairly comprehensive. Our investigation suggests that greater clarity about content validity in three key aspects is needed. Future studies will have to address the generalizability of results to determine the universal agreement among experts.

Content validity is an important factor in identifying the content of measuring tests. However, it is not a sufficient indication that the instrument actually measures what is intended to measure. According to Yaghmaie (2003), the finding from content validity could contribute to support the construct validity of an instrument. Thus, a single approach is insufficient and a variety of approaches should be tested.

Table 1
Table of Test Specification

Category Content Domain	Number task	Investigating pattern (finding terms)	Generalizing of pattern		Applying of linear equation	Total number of question
			algebraic expression	linear equation		
Linear pattern (pictorial)	1	5	1	2	7	15
	2	5	1	2	6	14
Direct variation	3	3	1	2	4	10
	4	3	1	2	4	10
Concept of function	5	5	1	2	7	15
	6	5	1	2	5	13
Arithmetic sequence	7	3	1	2	6	12
	8	3	1	2	6	12
Total		32	8	16	45	101

Table 2
Judgment of Item Relevance

Number task	Panel	Number question														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	4	5	4	3	4	4	4	4	5	4	4	3	4	4	3
	2	5	5	4	4	4	3	5	5	4	3	4	4	5	5	5
	3	4	4	5	5	5	4	5	5	4	4	4	5	5	5	4
	mean	4.33	4.67	4.33	4	4.33	3.67	4.67	4.67	4.33	3.67	4	4	4.67	4.67	4
2	1	4	4	3	5	4	4	4	5	4	4	4	4	4	3	
	2	4	4	4	4	4	3	4	5	4	4	4	4	5	5	
	3	5	5	4	5	4	5	5	5	4	4	4	5	5	4	
	mean	4.33	4.33	3.67	4.67	4	4	4.33	5	4	4	4	4.33	4.67	4	
3	1	4	4	5	4	3	4	4	4	3	4					
	2	5	5	5	4	4	4	3	4	4	3					
	3	4	5	5	5	4	4	5	5	4	4					
	mean	4.33	4.67	5	4.33	3.67	4	4	4.33	3.67	3.67					
4	1	4	5	4	3	4	5	4	4	4	4					
	2	5	5	5	4	4	4	3	4	4	3					
	3	5	5	5	4	4	5	5	5	4	4					
	mean	4.67	5	4.67	3.67	4	4.67	4	4.33	4	3.67					
5	1	4	4	5	4	3	5	4	4	5	4	3	5	4	4	5
	2	5	5	5	4	4	3	4	4	5	4	4	5	4	5	4
	3	5	5	4	4	5	5	4	4	4	5	5	5	4	4	4
	mean	4.67	4.67	4.67	4	4	4.33	4	4	4.67	4.33	4	5	4	4.33	4.33
6	1	4	4	4	5	4	4	4	4	5	4	4	5	4		
	2	5	5	4	4	4	3	4	4	5	5	4	5	4		
	3	5	4	4	5	4	5	4	4	4	4	5	4	4		
	mean	4.67	4.33	4	4.67	4	4	4	4	4.67	4.33	4.33	4.67	4		

Cont. Table 2

7	1	4	4	5	4	3	5	4	4	4	3	4	4
	2	5	5	4	4	4	3	5	4	4	4	5	5
	3	5	5	5	4	5	4	5	5	5	4	5	5
	mean	4.67	4.67	4.67	4	4	4	4.67	4.33	4.33	3.67	4.67	4.67
8	1	4	4	4	5	3	5	4	4	5	4	5	5
	2	5	5	4	4	4	3	4	5	5	4	5	5
	3	5	5	5	5	5	4	5	5	5	4	4	5
	mean	4.67	4.67	4.33	4.67	4	4	4.33	4.67	5	4	4.67	5

Scales used:
5 – very appropriate
4 – quite appropriate
3 - appropriate
2 – less appropriate
1 - not appropriate

Table 3
Judgment of Content Coverage

Panel	Response (mean)
First panel	3.8
Second panel	4.5
Third panel	4.8

Scales used:
5 - very comprehensive
4 - quite comprehensive
3 - comprehensive
2 - less comprehensive
1 - not comprehensive

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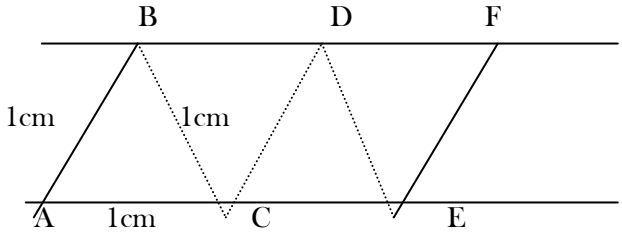
Appendix A
Sample of Interview Task

Task Two: Triangle Train (Linear pattern pictorial)

Look at the triangle train below. The length of triangle train is determined by the number of equilateral triangles with the side 1cm. If the length of the train is 3, the perimeter is 5.



Questions 1.2:

1. What is the perimeterof the triangle train if the length is 4 ? (interior lines don't count as part of perimeter)
2. What is the perimeterof the triangle train if the length is 5 ? (interior lines don't count as part of perimeter)
3. (If subject says the perimeter of triangle train is *a*). Why is that? Can you think of another way to find the perimeter? Why?
4. [Repeat the step (2) and (3) for the length of triangle train is 8, 15 and 120.]
5. [Repeat the step (2) and (3) for the length of triangle train is *h* (state the answer interms of*h*).]
6. (If subject unable to respond to the length of triangle train is *h*, interviewer asks the ***questions 1.2a***).
7. Can you try to write a linear equation to find the perimeter of the triangle train. Let *r* represents the perimeter of the triangle train and*s*represents the length of the train.
8. Why is that? Explain it.
9. If the triangle train has a perimeter of 50 cm, what is the length? Try to apply the linear equation to solve this problem.
10. Try to explain how is the way of solving it.
11. Can you try to draw a new pattern of train?
12. Try to explain the relationship between the length and the perimeter of the new train.
13. Can you try to write a linear equation to find the perimeter of the new train?
14. Why is that? Explain it.

Cont. Appendix A

Questions 1.2a:

(If subject unable to respond to step 6 in questions 1.2, interviewer asks the questions as below).
What is the perimeter if the length of the term is . The shape here represents a certain value.
(If subject successfully responds to interviewer asks again the questions 1.2. If subject unable to respond, interviewer asks questions as below).

1. What is the perimeter if the length of the train is 150?
2. Try to explain how did you find the perimeter for the length of the train is 150?
3. Try to describe the relationship between the length of the triangle train and the perimeter.

Appendix B
Judgment Form A
(Item Relevance)

Number Task:_____

Number question	Judgment scale
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Scales used:
5 – very appropriate
4 – quite appropriate
3 – appropriate
2 – less appropriate
1 - not appropriate

Appendix C
Judgment Form B
(Content Coverage)

Question: Are the tasks have covered the content for the topics of linear equation?

a) Task 1

JudgementScale :____

b) Task 2

Judgement Scale :____

c) Task 3

Judgement Scale :____

d) Task 4

Judgement Scale :____

e) Task 5

Judgement Scale :____

f) Task 6

Judgement Scale :____

g) Task 7

Judgement Scale :____

h) Task 8

Judgement Scale :____

Scales used:

5 - very comprehensive

4 - quite comprehensive

3 - Comprehensive

2 - less comprehensive

1 - not comprehensive