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Content Validity of STEMTIP Using CVR Method

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Abstract
This study aims to examine the content validity of STEM Teachers' Instructional Preparedness (STEMTIP) for Malaysian science teachers using Content Validity Ratio (CVR). Fifteen experts selected via purposive sampling evaluated the content. Eight professional university experts in science, psychometrics, curriculum & instructional, and linguistics, and seven science teachers were consulted. The instrument involved 51 items with five main constructs. The results showed that the instrument has a good content validity and proved that STEMTIP has a great potential to be promoted as a good instrument to measure teachers' STEM instructional preparedness. More sophisticated statistical analysis, such as Rasch Model, will be implemented to obtain more information from the newly developed instrument.
Keywords: Content Validity Ratio, Experts, Stem, Preparedness, Instrument

Introduction
Measurement of content validity in the instrument is one crucial facet in instrument development. Content validity ensures that the instrument is measuring what it wants to measure. Even if the instrument is reported as having good unidimensionality and reliability, poor content validity will jeopardize the instrument's psychometric utility (DeVellis, 2003; Furr, 2011). Furthermore, content validation process will guarantee the instrument to have defensible, accurate, appropriate,

meaningful, and useful properties (Furr, 2011; Ghazali Darusalam & Sufean Hussin, 2016). Thus, the validation process should be done rigorously to develop a valid instrument.

Content validation is the first step in instrument development validation, apart from construct and criterion validation (Bond & Fox, 2015; DeVellis, 2003). It refers to the evaluation for each item so that the item is suitable with the instrument's development purpose. Two elements that are focused in content validation process are the item's representativeness and suitability in measuring what the researcher intends to measure (Mohammad Rahim Kamaluddin & Rohany Nasir, 2017). This study emphasized on one of the important steps in instrument development, which is assessing content validity using Content Validity Ratio (CVR).

Literature Review

STEMTIP uses CVR as the approach to measure content validation. CVR is a quantitative approach developed by Charles Lawshe. It is a method for measuring mutual agreements among the raters or judges regarding how essential a particular item is. Compared to other alternative methods in quantifying content validity such as Cohen's kappa; Tinsley–Weiss T index; and James, Demaree, and Wolf's index; CVR method is more straightforward, user-friendly, and simple. It also provides a table for determining the critical cut-off value (Wilson, Wei Pan, & Schumsky, 2012). Based on these reasons, CVR has been widely used by local and foreign researchers as the initial step in the instrument development process (Doustmohammadian et al., 2017; Kim, 2011; Mohd Effendi Mohd Matore & Ahmad Zamri Khairani, 2015; Norashady, Muhammad Aziz Shah, Eftah, & Haniza, 2016).

Lawshe (1975) proposed that each rater should respond to each item with (1) Essential, (2) Useful but not essential, and (3) Not necessary. For each item, the number of the raters who choose "essential" is calculated. Then, a formula is used to calculate the CVR:

$$CVR = \frac{n_e - (N/2)}{(N/2)}$$

where CVR = content validity ratio, n_e = number of panelists indicating "essential", and N = total number of panelists.

CVR value ranges from −1 to +1, where a value inclining toward +1 shows the mutual agreement of the experts on the respective item. On the other hand, a negative CVR value may be obtained when less than half of the experts indicate the item as "essential" (Cohen, Swerdlik, & Sturman, 2010). Lawshe also created the accepted CVR value table as the reference to get the CVR critical value (Lawshe, 1975), which then was revised and improved by Wilson et al. (2012). Based on the table, with the total number of 15 experts, the minimum CVR critical value for each item is .506 at $\alpha = .05$. So, if the items obtain less than the value, they need to be refined or considered for deletion from the instrument.

Methodology

Experts are persons who possess the expertise and skills in a particular field. Their function is to seriously review each of the items before making any decision whether to retain or the remove the items that have been proposed (Kaseh Abu Bakar & Siti Aishah Hassan, 2009). There are two types of experts who are normally consulted in content validation: professional experts and lay experts (Rubio, Berg-Weger, Tebb, Lee, & Rauch, 2003; Zamanzadeh et al., 2015). Professional experts are

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experts who have published or worked in the field while lay experts are people who are skilled in the topic studied (Rubio et al., 2003). Among the selection criteria for the experts are having background in the research area, possessing related working experience, being diverse in giving opinion, and having up-to-date knowledge (Powell, 2003). Rubio et al. (2003) also suggested considering the number of recent publications as one of the criteria for expert selection.
In this research, eight professional experts from four universities in Malaysia were selected based on the aforementioned criteria. All of them are still active in research and publication in their respective fields and are the consultants in Malaysia's education system. Table 1 summarizes the professional experts' information.

Table 1. List of professional experts

No	Initial	Expertise		Years of Experience	University
1	Prof A	Content Science Education	Female	21	Universiti Kebangsaan Malaysia, Selangor
2	Dr. B	Content Scientific Creativity, STEM	Female	28	Universiti Malaysia Sabah, Sabah
3	Dr. C	Content Science Education Information Technology	Male	28	Universiti Sains Malaysia, Pulau Pinang
4	Dr. D	Content Science & Chemistry Education	Female	20	Universiti Sains Malaysia, Pulau Pinang
5	Dr. E	Content Physics Education	Male	9	Universiti Teknologi Malaysia, Johor
6	Dr. F	Psychometrics Psychometrics & Measurement	Male	11	Universiti Kebangsaan Malaysia, Selangor
7	Dr. G	Instructional Curriculum & Instruction, TESL	Male	28	Universiti Putra Malaysia, Selangor
8	Dr. H	Linguistics Language & Malay Literature	Female	26	Universiti Putra Malaysia, Selangor

Apart from that, seven science teachers from secondary schools in Malaysia were also selected as the lay experts for this content validation process (Table 2). The lay group will help to address issues such as phrasing and unclear terms and will recommend other important or salient items (Rubio et al., 2003). The selection of these lay experts was based on their expertise in teaching science, years of teaching experience, STEM knowledge, and in-service STEM training that they have attended before. The selection of the panel of experts for both professional and lay experts was based on purposive sampling method. All the experts were contacted by the researcher via telephone or e-mail to get their consensus to take part in this study. Formal letters of appointment for the experts and related documents were sent via e-mail or post. All the experts were given two weeks to evaluate the 51 items in the STEMTIP.

Table 2. List of lay experts

No	Initial	Expertise		Years of Experience	State
1	Mrs. I	Biology, Mathematics	Female	10	Selangor
2	Mrs. J	Science, Chemistry	Female	21	Kelantan
3	Mrs. K	Science	Female	12	Selangor
4	Miss L	Chemistry	Female	12	Labuan
5	Mr. M	Science, Chemistry, Biology	Male	10	Kuala Lumpur
6	Mr. N	Physics	Male	11	Perak
7	Mrs. O	Chemistry	Female	20	Selangor

Overall, 15 experts participated as the content experts in this study. It was more than Lawshe's suggested value, which is four. This study followed the suggestions of Rubio et al. (2003), which is to have at least three experts in each group of experts. The total number of experts in this study was more than that of the previous study (Khazaee-Pool, Pashaei, Koen, Jafari, & Alizadeh, 2017; Maryam Hazrati, Tengku Aizan Hamid, Rahimah Ibrahim, Siti Aishah Hassan, & Zahra Bagheri, 2017; Noor et al., 2016).

Results and Discussion

Fifty-one items were content validated based on the 15 experts' judgement using CVR based on the proposed choice of Lawshe (1975). Six of the experts are male (40%) and nine are female (60%). Only one expert (0.07%) have less than 10 years' experience in the field, followed by six experts who have 10 to 19 years of teaching experience (40%). The panel was dominated with experts who have more than 20 years of practical experience in their respective fields (8, 53.3%). All experts were chosen from almost every state in Malaysia.

In conclusion, the results show that only four items from 51 newly developed items were under the CVR critical value of .506. Based on expert advice, all of these four items need to be refined to clarify their meanings by referring to the instrument conceptualization and experts' comment. Table 3 shows the respective items. The four items are Q28 (I encourage my students to explain their work product using ICT), Q37 (I used gamification as the reinforcement practice for my student), Q42 (I involved stakeholders in problem solving activities), and Q51 (I discussed students' STEM achievement with stakeholders).

Table 3. Items that need to be refined based on experts' judgement

Item Number	Items	The CVR Category Expert Panel			Item status
		Professional (*N*=8)	Lay (*N*=7)	Total (*N*=15)	
		CVRcrit=.693	CVRcrit=.741	CVRcrit=.506	
28	I encourage my students to explain their work product using ICT	.25	.71	.46	Refine
37	I used gamification as the reinforcement practice for my student	.50	.42	.46	Refine
42	I involved stakeholders in problem solving activities	.50	.42	.46	Refine
51	I discussed students' STEM achievement with stakeholders	.25	.71	.46	Refine

Q28 is under explanation construct which is intended to measure teachers' preparedness in facilitating student discussions. Q37 and Q42 are under elaboration construct. This construct is proposed to measure teachers' preparedness in preparing students with enhancement activity based on the new STEM content that has been learnt. The activity is supposed to get cooperation among teachers, peers, and stakeholders. The last question, Q51, is under evaluation construct. In this construct, teachers are assessed on their ability to prepare themselves to evaluate students' STEM work products, students' STEM interest, and its report.

The two standout issues on the four items that did not have full agreement among the experts are the use of ICT and stakeholders' involvement. The experts suggested that ICT is not essential in STEM teaching and learning process. They also had a doubt about the need of stakeholders' involvement in students' STEM learning. The researcher will refine and improve those items with reference to the instrument conceptualization.

The refinement and improvement process are not only for the four items aforementioned. Comments from the experts on each item will be taken into consideration to ensure the quality of the items. The improved items will then be prepared for a pilot test among science teachers.

Conclusion

This study is about the calculation of the CVR value of the newly developed STEMTIP instrument items. Based on calculated CVR value from the thorough judgement of 15 experts, only four out of 51 items are under the set critical value. It shows that STEMTIP has a potential to be a valid and reliable instrument to measure STEM teachers' instructional preparedness. The items will be refined based on experts' advice before being included in the pilot test instrument that will involve science teachers. The results of the test will then be tested using advance measurement model like Rasch Model to ensure the quality of the items based on the information from various tests such as unidimensionality, item fit, item polarity, and differential item functioning.

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