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Content Validity of Matriculation Entrepreneurial Thinking Scale Using Fuzzy Delphi Method

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ABSTRACT

This study aims to test the content validity of the Matriculation Student Entrepreneurial Thinking Scale (METS) using the Fuzzy Delphi method, expanding this scale by making it more relevant to a matriculation student context in Malaysia. Using a questionnaire, this study surveys 15 experts' opinions to assess the suitability of content within the measured dimensions. 55 out of 71 items met the three Fuzzy Delphi criteria. This study found that the items in the measured dimensions are suitable for evaluating entrepreneurial thinking among matriculation students in Malaysia. Dropped items are due to inappropriate use of words and outside the context of matriculation students. Our use of the Fuzzy Delphi method to obtain experts' judgment on an instrument's content validity is a relevant and practical quantitative method that can be applied by researchers. We suggest that a pilot study be conducted on the METS using the Rasch Model to statistically analyze items' suitability, unidimensionality, and polarity to produce a truly robust instrument. This study extends the METS scale by using the Fuzzy Delphi method to analyze its content validity. It also addresses the fact that entrepreneurial scales such as this one are deemed unsuitable for the context of students in Malaysia.

Keywords
entrepreneurial thinking, content validity, matriculation, fuzzy delphi

Introduction

Recently, acknowledging the rise of technology globally that seems to undermine individual human capital, the Ministry of Education in Malaysia has initiated improvements in curriculum quality according to current needs, paying equal attention to aspects of student academic development and the development of transferable skills (Ministry of Education, 2013). Here, transferable skills are critical thinking skills, creativity, innovation, perseverance in facing challenges, and working collaboratively (Succi & Canovi, 2020). These characteristics correspond with the conception of the individual in entrepreneurial thinking.

In general, entrepreneurial thinking is not just a skill enabling someone to be an entrepreneur, rather it needs to be mastered by individuals so that they can survive in this digital-era job market (Bacigalupo et al., 2016). Entrepreneurial thinking is very important because it can produce individuals who are resilient, competitive, intelligent, efficient in solving problems, and can manage existing resources optimally (Edwards-Schachter et al., 2015). This indicates that entrepreneurial thinking can transform an individual into a creative and successful person (Orr & Kukner, 2015).

The importance of entrepreneurial skills has raised the call to cultivate entrepreneurial thinking among students. This effort has been implemented through education policy structuring to embed entrepreneurial characteristics in education (Buang et al., 2009). Buang et al. (2009) propose a combination of science process skills and entrepreneurial thinking: entrepreneurial science thinking. This integrates problem-solving concepts and entrepreneurial elements, training students to comprehensively and creatively solve problems (Syukri et al., 2013). Entrepreneurial thinking is also implemented at the educational management level. Othman et al. (2006) mention that educational institutions have taken steps to encourage entrepreneurial thinking among teachers and administrators. Thus, high entrepreneurial thinking among individuals should reflect personal and organizational excellence.

Because entrepreneurial thinking points to personal and organizational excellence, various scholars attempt to measure entrepreneurial thinking. Ishak (2014) developed an instrument to measure science teachers' readiness to integrate entrepreneurial thinking while Syukri et al. (2013) developed an instrument to measure teachers' pedagogical knowledge in teaching entrepreneurial science thinking. Furthermore,

Ahmad and Abdullah (2020) developed the Entrepreneurship Science Thinking Test for primary school students. However, we found that the existing instruments are not robust enough to be adapted to measure entrepreneurial thinking, especially in the matriculation context.

A commonly raised issue in psychological measurement is that there are numerous instruments with non-uniformity in their measurement dimensions (Leue & Beauducel, 2020). Subsequently, validity and reliability are significant concerns (Antonak & Larrivee, 1995). Wasserman and Bracken (2003) argue that the instruments commonly used by Malaysian researchers are rarely measured for their content validity compared to their reliability; this issue should not be underestimated as content validity must be followed to produce accurate measurements.

Additionally, an instrument's content validity is rarely reported as the adapted instrument is usually certified by only two experts due to the difficulty of obtaining experts' advice. This contradicts the concept of valid measurement asserted by Polit and Beck (2006) where the minimum number of experts to measure the validity of psychological instruments is three. Researchers such as Effendi et al. (2020) argue that instruments with no content validity, despite having high reliability, do not produce accurate measurements compared to instruments with high content validity. Thus, content validity can ensure that an instrument truly measures what it should (Lawshe, 1975).

In this study, the diverse dimensions used for entrepreneurial thinking measurement encouraged us to build a new instrument that considers matriculation students. The issue of content validity shows there is still a gap in the measurement of entrepreneurial thinking in Malaysia. Thus, this article discusses the content validity of METS using Fuzzy Delphi technique.

Literature Review

Content Validity of Instruments

A good psychometric instrument must have high validity and reliability to determine its suitability and usability. Instrument validity ensures that measurements are accurate. It guarantees defensible answers to research questions, appropriateness for the study, meaning to data through scores, and usefulness by showing that results can be based on the study findings (Tseng et al., 2017).

Content validity is an essential research validity as it ensures that the instrument can measure the concept it is trying to measure (Kaplan & Saccuzo, 2017). It refers to the suitability of an item in a construct (Machleit, 2019; Nunnally & Bernstein, 1967). Generally, content validity can be improved through subjective review by experts based on test specifications and operational definitions of a construct (Antonak & Larrivee, 1995). The experts evaluate whether the generated items cover all the contents being tested.

There are several methods to quantitatively evaluate content validity, such as Tinsley-Weiss T index (Tinsley & Weiss, 1975), Content Validity Ratio (CVR) (Lawshe, 1975), and Fuzzy Delphi (Zadeh, 1996). We chose the Fuzzy Delphi technique to measure the items' validity as it is more practical, user-friendly, and cost-effective. Here, the CVR method limits evaluators' choice, providing only three options: important; useful but unimportant; and unnecessary. Contrastingly, the Fuzzy Delphi technique provides five to seven scale options regarding the items' suitability and significance (Habibi et al., 2015). A Likert scale value chosen by the respondent is converted to a Fuzzy scale set that has three numbers making the evaluation process far from biased (Habibi et al., 2015). To ensure the quality of selected items, items are screened based on three main criteria: threshold value (d) ≤ 0.2 (Chu & Hwang 2008); each item's expert consensus percentage ≥ 75 percent, and α-Cut defuzzification value (average of fuzzy response) exceeding 0.5 (Chu & Hwang 2008).

The Fuzzy Delphi Method (FDM) aims to obtain expert consensus on certain aspects. The FDM is a modification of the Delphi technique that gives researchers more benefits. It combines Delphi techniques with fuzzy set theory. Scholars have used the FDM to measure the content validity of Distributive Leadership Instruments (Yaakub et al., 2020), Philippine Tourism Sustainability

Instruments (Ocampo et al., 2018) and Science Process Skills Instruments (Karim et al., 2017).

The FDM has several strengths. Most prominently, it can reduce cost and time compared to the Delphi technique (Yaakub et al., 2020). Moreover, a researcher only needs to do one round of the FDM to gain expert consensus. This method can reduce experts' fatigue and, therefore, produce accurate results (Karim et al., 2017). The FDM can also avoid bias, intervention, and stress when making decisions due to its anonymity (Yaakub et al., 2020). Subsequently, experts cannot identify each other, therefore their decisions are independent and uninfluenced. Lastly, experts' feedback through the FDM will help researchers improve the instrument and experts' consensus is analyzed statistically to assess the suitability of each item.

Entrepreneurial Thinking

Entrepreneurial thinking refers to cognitive aspects that help individuals identify opportunities, think creatively and innovatively, solve complex problems, and be sensitive to the environment (Mohamad et al., 2019). Ishak (2013) states that individuals' entrepreneurial thinking enables them to use important life information beneficially. Based on the previous researchers' conceptions of entrepreneurial thinking characteristics, entrepreneurial thinking is the ability to think critically and creatively toward solving problems and then create opportunities to generate profits. Individuals with entrepreneurial thinking make decisions (De Winnaar & Scholtz, 2019) and are willing to take risks (Lumpkin & Dess, 1996).

Among the dimensions of entrepreneurial thinking are creativity, innovativeness (Buang et al., 2009), critical thinking (Hancock et al., 2020), opportunity detector (Clausen 2020; Ishak, 2013), risk-taking (Akbay & Delibalta, 2020), and teamwork (Anwar & Menekse, 2020). Critical thinking includes decision-making skills and problem-solving skills. Individuals partake in decision-making every day. It is a mental activity involving analytic and imaginative thinking, reasoning, resolving internal conflicts while choosing the best solutions among multiple options, and predicting future situations (Othman & Wahid, 2006). Von Helversen et al. (2020) state that decision-making is the process of determining the likelihood of an event, making predictions, and choosing available alternatives especially in financial matters. Othman and Wahid, (2006) emphasizes that the decision-making process concerns reducing doubts about the available alternatives to enable reasonable choices to be made.

As per Kuratko and Hodgetts (2007), an entrepreneur can identify opportunities in situations that others view as disorderly. The ability to identify and seize opportunities cleverly is a unique feature of entrepreneurial thinking, creating success in situations that threaten human habit (Mitchelmore & Rowley, 2013; Hisrich et al., 2007). This study regards intelligent tracking opportunities as the individual's ability to detect opportunities, seize opportunities, and organize strategies, while focusing on students' pursuits of excellence. While entrepreneurial actions are, at times, considered counter-normative, they are also a way of thinking that can produce great benefits that others cannot see.

Here, the scope of risk-taking in METS is focused on academic risks. Korkmaz (2002) defines academic risk-taking behavior as the determination of students' efforts when they face difficulties in learning. Moreover, students who take academic risks have high learning and problem-solving skills (Cetin et al., 2014). Additionally, Akça (2017) reports that students with high anxiety have low risk-taking tendencies. Students with low risk-taking tendencies are more prone to procrastination and perfectionism (Akbay & Delibalta, 2020). Procrastination reflects a low level of motivation while perfectionism is an indication of low self-efficacy (Ackerman & Gross, 2005). A review of the literature shows that procrastination is associated with cognitive, emotional, and personality variables. Meanwhile, from an emotional perspective, procrastination is associated with fear of failure. From a cognitive perspective, procrastinating students find decision-making difficult (Solomon & Rothblum, 1984) and have low self-confidence (Overholser & Dimaggio, 2020).

The next dimensions of entrepreneurial thinking are creativity and innovativeness. Creativity is the effort to produce a new process, product, or service while innovativeness is the modification of ideas for mutual benefit (Messmann & Mulder, 2012). Creative and innovative behavior refers to individuals' actions focused on the production, processing, and application of new ideas including product ideas, technologies, procedures, or work processes toward enhancing the effectiveness and success of the self and institutions. De Jong and Den Hartog (2010) agree that creativity and innovative behavior comprises four main features: opportunity exploration; idea generation; idea promotion; and idea application.

The last dimension is teamwork which involve the ability to work with others from a variety of socio-cultural backgrounds to achieve common goals (Silliman et al., 2020). Britton et al. (2017) list three teamwork skills levels: the ability to build good relationships and interact and work effectively together to achieve the same objectives; the ability to understand and assume alternate roles (i.e., group leaders/group members); and the ability to recognize and respect the attitudes, behaviors, and beliefs of others. The six dimensions: decision-making; problem-solving; risk-taking; creativeness and innovativeness; identifying opportunity; and teamwork, should be taken seriously and embedded in educational systems for an integrated set of life-skills.

Methodology

This study adopts a quantitative approach using questionnaires as research instruments. The researchers used sampling techniques to identify respondents based on set expert criteria. The respondents consisted of professional and lay experts (Rubio et al., 2003; Zamanzadeh et al., 2015). Professional experts are those directly involved in the field of study while lay experts have specific skills or experience in the field (Rubio et al., 2003). So, our experts are involved in the fields of psychometrics and entrepreneurship education. The criteria for professional experts include having a Doctor of Philosophy in the field and being active in writing, publishing, or teaching. Lay specialists must have at least 10 years working experience. All experts were contacted in advance to obtain their consent. We made appointments with the experts via e-mail and explained the study's purpose and procedures. We contacted 30 experts to be on the panel and 15 responded with their approval. The professional specialists consisted of 11 experts working in public universities: six in the field of entrepreneurship education and five psychometric experts. The lay specialists consisted of two form six teachers and two matriculation college lecturers. The number of experts adheres to the minimum number of experts recommended (10–15; Adler & Ziglo, 1996).

Our questionnaire contained 71 items. Six dimensions measured entrepreneurial thinking: decision-making (10 items); problem-solving (9 items); risk-taking (15 items); opportunity identification (14 items); innovativeness and creativity (10 items); and teamwork (13 items). The experts were required to evaluate the suitability of items using a seven-point Likert type scale, ranging from 1 to 7. A qualitative feedback column was provided for each item and a writing space beneath each dimension so that experts could make corrections or provide suggestions for improvement. At the end of the questionnaire, there was space for experts to review the instrument's usability overall. The expert was given three weeks. The expert evaluation results were calculated using the formula provided in the Microsoft Excel template.

Results

Overall, this study has validated the content of the METS. Of the 15 experts, six were female (40%) and nine were male (60%). The item validity value obtained through the Fuzzy Delphi technique refers to expert consensus. Items received must comply with the three criteria outlined namely, threshold value (d) $\leq$ 0.2 (Chu & Hwang, 2008), the expert consensus percentage for each item should be $\geq$ 75 percent, and

the defuzzification value α- Cut must exceed 0.5 (Chu & Hwang, 2008). Table 1 presents the 10 items under the decision-making dimension. Eight items meet the conditions. Items D8 and D9 did not obtain expert consensus because the threshold values exceeded 0.2 and the percentages of expert consensus were less than 75%. Thus, these were dropped.

Table 1 Fuzzy Delphi method expert approval criteria for decision-making

Item code	Triangular Fuzzy Numbers		Defuzzification Process				Expert consensus
	Threshold value, *d*	Expert consensus (%)	m1	m2	m3	Fuzzy Score(A)	
D1	0.076	100	0.795	0.947	1.000	0.914	Accept
D2	0.087	94.7	0.816	0.953	0.995	0.921	Accept
D3	0.192	84.2	0.711	0.858	0.932	0.833	Accept
D4	0.164	89.47	0.689	0.863	0.953	0.835	Accept
D5	0.177	78.95	0.658	0.816	0.905	0.793	Accept
D6	0.123	94.74	0.784	0.926	0.979	0.896	Accept
D7	0.123	94.74	0.795	0.932	0.979	0.902	Accept
D8	**0.254**	**73.68**	**0.668**	**0.826**	**0.916**	**0.804**	**Reject**
D9	**0.309**	**52.63**	**0.553**	**0.737**	**0.863**	**0.718**	**Reject**
D10	0.198	89.47	0.689	0.853	0.942	0.828	Accept

Table 2 shows the three criteria for the problem-solving . All items meet the criteria except P9 which has a threshold value (d) of 0.305 which exceeds 0.2. Thus, item P9 was dropped.

Table 2 Fuzzy Delphi method expert approval criteria for problem-solving

Item code	Triangular Fuzzy Numbers		Defuzzification Process				Expert consensus
	Threshold value, *d*	Expert consensus (%)	m1	m2	m3	Fuzzy Score(A)	
P1	0.110	100.0	0.753	0.911	0.984	0.882	Accept
P2	0.051	100.0	0.858	0.979	1.000	0.946	Accept
P3	0.107	94.7	0.805	0.942	0.984	0.911	Accept
P4	0.108	94.74	0.795	0.937	0.984	0.905	Accept
P5	0.149	94.74	0.700	0.868	0.963	0.844	Accept
P6	0.071	100.0	0.826	0.963	1.000	0.930	Accept
P7	0.189	89.47	0.711	0.868	0.947	0.842	Accept
P8	0.217	89.47	0.668	0.832	0.932	0.811	Accept
P9	**0.305**	**84.21**	**0.532**	**0.711**	**0.847**	**0.696**	**Reject**

For the risk-taking dimension, six items (R1, R2, R6, R8, R9, and R10) did not obtain expert consensus. These items recorded threshold values of over 0.2 and expert consensus percentages of less than 75%. Therefore, they were dropped.

Table 3 Fuzzy Delphi method expert approval criteria for risk-taking

Item code	Triangular Fuzzy Numbers		Defuzzification Process				Expert consensus
	Threshold value, *d*	Expert consensus (%)	m1	m2	m3	Fuzzy score (A)	
R1	**0.357**	**47.4**	**0.595**	**0.742**	**0.842**	**0.726**	**Reject**

R2	**0.463**	**15.8**	**0.384**	**0.526**	**0.658**	**0.523**	**Reject**
R3	0.228	89.5	0.705	0.853	0.926	0.828	Accept
R4	0.120	100.00	0.784	0.926	0.984	0.898	Accept
R5	0.228	89.47	0.621	0.789	0.911	0.774	Accept
R6	**0.323**	**42.11**	**0.611**	**0.768**	**0.868**	**0.749**	**Reject**
R7	0.132	100.00	0.763	0.911	0.979	0.884	Accept
R8	**0.259**	**84.21**	**0.726**	**0.858**	**0.921**	**0.835**	**Reject**
R9	**0.294**	**73.68**	**0.632**	**0.789**	**0.889**	**0.770**	**Reject**
R10	**0.368**	**42.11**	**0.600**	**0.742**	**0.842**	**0.728**	**Reject**
R11	0.172	94.74	0.711	0.868	0.958	0.846	Accept
R12	0.217	84.21	0.700	0.853	0.937	0.830	Accept
R13	0.157	94.74	0.774	0.911	0.968	0.884	Accept
R14	0.086	100.00	0.774	0.932	0.995	0.900	Accept
R15	0.218	89.47	0.726	0.868	0.932	0.842	Accept

The same analysis was conducted on three more dimensions. Items O4, O5, and O7 for the opportunity identification were dropped. C1, C8, and C10 for the creative and innovative, and T12 under the teamwork were dropped. Items were dropped because their threshold values were over 0.2 and the percentages of expert consensus were below 75%. The items maintained are shown in tables 4, 5, and 6, respectively. Thus, 16 of 71 items did not meet the three criteria; hence 55 items were retained.

Table 4 Fuzzy Delphi method expert approval criteria for opportunity detector

Item code	**Triangular Fuzzy Numbers**		**Defuzzification Process**				**Expert consensus**
	Threshold value, d	**Expert consensus (%)**	**m1**	**m2**	**m3**	**Fuzzy score (A)**	
O1	0.142	89.5	0.763	0.911	0.974	0.882	Accept
O2	0.143	89.5	0.742	0.895	0.968	0.868	Accept
O3	0.204	84.2	0.732	0.879	0.947	0.853	Accept
O4	**0.233**	**73.68**	**0.626**	**0.800**	**0.916**	**0.781**	**Reject**
O5	**0.344**	**36.84**	**0.511**	**0.668**	**0.795**	**0.658**	**Reject**
O6	0.162	84.21	0.721	0.879	0.958	0.853	Accept
O7	**0.276**	**84.21**	**0.674**	**0.821**	**0.905**	**0.800**	**Reject**
O8	0.091	94.74	0.774	0.926	0.989	0.896	Accept
O9	0.206	84.21	0.668	0.837	0.937	0.814	Accept
O10	0.127	89.47	0.784	0.926	0.979	0.896	Accept
O11	0.142	89.47	0.763	0.911	0.974	0.882	Accept
O12	0.119	89.47	0.753	0.911	0.979	0.881	Accept
O13	0.157	89.47	0.732	0.889	0.963	0.861	Accept
O14	0.090	89.47	0.805	0.947	0.995	0.916	Accept

Table 5 Fuzzy Delphi method expert approval criteria for creative innovative

Item code	**Triangular Fuzzy Numbers**		**Defuzzification Process**				**Expert consensus**
	Threshold value, d	**Expert consensus (%)**	**m1**	**m2**	**m3**	**Fuzzy score (A)**	
C1	**0.358**	**57.9**	**0.532**	**0.695**	**0.821**	**0.682**	**Reject**
C2	0.104	89.5	0.795	0.937	0.989	0.907	Accept

C3	0.107	94.7	0.784	0.932	0.984	0.900	Accept
C4	0.213	84.21	0.732	0.874	0.942	0.849	Accept
C5	0.122	94.74	0.774	0.921	0.979	0.891	Accept
C6	0.216	84.21	0.711	0.863	0.937	0.837	Accept
C7	0.192	89.47	0.700	0.858	0.947	0.835	Accept
C8	**0.295**	**78.95**	**0.632**	**0.789**	**0.889**	**0.770**	**Reject**
C9	0.207	84.21	0.742	0.884	0.942	0.856	Accept
C10	**0.285**	**78.95**	**0.679**	**0.826**	**0.905**	**0.804**	**Reject**

Table 6 Fuzzy Delphi method expert approval criteria for teamwork dimension

Item code	Triangular Fuzzy Numbers		Defuzzification Process				Expert consensus
	Threshold value, d	Expert consensus (%)	m1	m2	m3	Fuzzy score (A)	
T1	0.316	78.9	0.621	0.779	0.879	0.760	Accept
T2	0.104	89.5	0.795	0.937	0.989	0.907	Accept
T3	0.119	89.5	0.816	0.942	0.979	0.912	Accept
T4	0.066	100.00	0.837	0.968	1.000	0.935	Accept
T5	0.101	89.47	0.816	0.947	0.989	0.918	Accept
T6	0.078	94.74	0.837	0.963	0.995	0.932	Accept
T7	0.123	94.74	0.795	0.932	0.979	0.902	Accept
T8	0.066	100.00	0.837	0.968	1.000	0.935	Accept
T9	0.066	100.00	0.837	0.968	1.000	0.935	Accept
T10	0.128	94.74	0.784	0.926	0.974	0.895	Accept
T11	0.104	94.74	0.816	0.947	0.984	0.916	Accept
T12	**0.316**	**78.9**	**0.621**	**0.779**	**0.879**	**0.760**	**Reject**
T13	0.104	89.5	0.795	0.937	0.989	0.907	Accept

Based on our findings, the experts agree that entrepreneurial thinking can be measured through six dimensions: decision-making; problem-solving; risk-taking; opportunities recognition; creativity and innovativeness; and teamwork. Items that obtained the experts' consensus were repaired and maintained, while items that did not were dropped. The dropped items often had vague sentences such as "I did a reading from an authoritative source" and "I did a reading from the latest source." These are both unclear and carry almost identical meanings. Thus, we rewrote the statement as "I read extensively." Clark and Watson (2016) state that the biggest issue in item generation is the difficulty in producing items that are inclusive for item reservoirs. Thus, we were careful with word choice so that the items were correctly conveyed.

sentences were used for each statement. Researchers should produce simple sentences to ensure cohesion between words in a statement (Eys et al., 2007). Items modified based on expert recommendations are C6, O8, O9, R12, and R15 to fit the context of matriculation students. For example, item C6 "I am always looking for new business ideas" is seen as inappropriate because not all students are interested in doing business. Rather, the identification of opportunities in students' own contexts should be

Items R1 and R2 recorded the lowest percentage of expert consensus. Nine experts disagreed with items R1 "I want to live abroad" and R2 "I prefer to travel rather than sit at home." These items were considered unrelated to risk-taking and matriculation lives. Item R6 "I choose to earn a living instead of running my own businesses" was dropped. While it may describe the thoughts of individuals who are afraid to take risks, the experts thought this item was not suitable for the risks that need to be taken by students toward their academic goals. Typically, students at the age of 18 have not yet chosen entrepreneurial careers as these factors are influenced by peers, attitudes, interests, and teacher guidance (Radin et al., 2020).

Using a "stem" in the items is not recommended by the experts because the number of items is large and respondents might not remember the "stem." Thus, full based on their actions such as finding scholarships or undergraduate courses. This is important to ensure that respondents meaningfully relate to the items. The "proximity" between the respondent and the instrument will affect the reliability of the instrument (Rattray & Jones, 2007).

In the Fuzzy Delphi technique, items are screened quantitatively and qualitatively to ensure that only items that truly measure the dimensions are retained

(Habibi et al., 2015). As per Hsu and Stanford (2007), experts could also suggest new items. In our study, they proposed two items to be added to the dimension of identification of opportunities: "I am looking for information related to career opportunities" and "I am finding study programs recognized by the Malaysian Qualifications Agency"

Conclusion

The METS is expected to contribute to the matriculation programme especially in measuring students' entrepreneurial thinking. The Fuzzy Delphi method is considered a practical method in determining the content validity for the new instrument developed. It relies both on empirical findings and also experts' views. In this regard, content validity should not be ignored because it can be easily implemented by other researchers using the Fuzzy Delphi method.

Limitations and Future Studies

The study of these items should be continued to test the aspects of construct validity and criterion validity. The construct validity aspect and the validity of the criteria should be implemented to meet the psychometric characteristics of a newly built instrument. Additionally, future research should thoroughly analyze the items resulting from this content validity study using statistical analyses, such as the Rasch Model.

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