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EMPLOYING FUZZY DELPHI TECHNIQUE TO VALIDATE MULTIPLE INTELLIGENCE BASED INSTRUCTIONAL TEACHING MODULE FOR PRESCHOOL CHILDREN

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ABSTRACT

Delphi method which is a technique and structured approach used to review and collect opinions of a group of experts, has its own weaknesses. The Fuzzy Delphi Method (FDM), derived from modifications of Delphi Method introduced by Kaufman and Gupta in 1988, is considered by many researchers as more superior in providing evidence of human linguistic system (which is the signature of Delphi Technique). In this paper, FDM was used to assess the key components and contents of an instructional module based on multiple intelligences (MI-Based Instructional Module). This development phase is part of a project to develop a MI-Based Instructional Module for 4 years old preschool children in Malaysia. This phase involves the views of 10 experts who are experienced in teaching preschool children and have deep knowledge in early childhood education. It is a rigorous statistical analysis to validate the validity of abstract concept of the MI-Based Instructional Module. Experts are required to validate the key components and contents of the MI-Based Instructional Module which include themes, sub-themes based on Bloom's taxonomy, learning objectives, learning activities based on higher order thinking skills, multiple intelligence component and assessment for learning using seven-point linguistic before converting into triangular fuzzy numbers (TFNs). The validity of these key components and contents to make up the instructional module for 4 years old preschool children is very crucial to provide good learning experiences for learners that could enhance their innate potential; thus, FDM was used to provide evidence of validity of the instructional module. This article presents the results of the experts' views and the appropriateness of FDM as a tool to provide information about the validity of a MIBased Instructional Module.

Keywords: fuzzy delphi method, validation, instructional module, preschool children, multiple intelligences

INTRODUCTION

The Delphi Method (DM) proposed by Chang et al., (2000) is an approach that has been used and accepted worldwide in collecting data based on the judgments of experts (Hsu & Sandford, 2007). However, research found out that DM has its own weaknesses. According to Bojadziev and Bojadziev (2007) and Ho and Wang (2008), some of DM weaknesses includes long and repeating cycle process which allows leakage and loss of data, thus leading to inaccurate and incomplete data collection (Hair et al., 2006). According to experts, the repeating cycles contribute to inappropriate of data collection, which also increased the cost

of processing. In DM, experts' opinion will not be assessed in depth, which then led to misinterpretation amongst experts' views. The weaknesses in the analysis process on the other hand, disallow some of the experts' opinion to be considered as experts' consensus. Jamil et al., (2013) added on the weaknesses of Delphi technique that cause doubtfulness in data reliability if the researcher failed to select appropriate experts (Mohd Yusoff & Yaakob, 2016). Due to that, most of the researcher reduces the number of experts; however, lower number of experts will not help to solve the problem if the issue studied is huge (DeWitt & Saedah, 2008).

Due to a numbers of weaknesses with DM (Ho & Wang, 2008; Rau et al., 2014), the FDM was developed and introduced (Kaufman & Gupta, 1988). FDM which is adapted from DM is a combination between a set of fuzzy numbering sets and the Delhi method itself (Murray et al., 1985). Therefore, FDM is not to be considered as a new approach in research since it is based on the classic Delphi method where knowledgeable experts came from each context of the study. The advantages of FDM reduces the cycle process to avoid data losses, allow experts to express their opinions and maintain the original opinion of experts (Zaini et al., 2019). FDM can also clarify invertible fuzziness in interviews process to predict more reasonable and proper responses on respondents' information, as well as explain participant characteristics (Chang et al., 2000). FDM allows the achievement of higher economic effectiveness in time and costs required to conduct surveys and the simplicity in calculation to process (Tahriri et al., 2014). Clearly, FDM is a method of measurement used to obtain agreement of experts who act as respondents using quantitative methods.

Literature Review

FDM is a combination between Delphi classic method and f*uzzy* set theory. The method was introduced by Lotfi Zadeh in 1965, an expert in mathematics (Zadeh, 1965). The *Fuzzy* set theory mechanism act as a leeway of the classic set theory in which each element in a set is evaluated based on the binary set of "Yes" or "No". According to Bodjanova (2006) the values for numbering f*uzzy* are between 0 to 1 or if in the unit interval of (0, 1). It has been proven in previous literature review that FDM has been used as a method in various areas, such as in education and many other professional fields. According to Wu, (2011), FDM has been adopted to quantify experts' attitudes toward regional road safety, urban road safety, and road safety. FDM also has been used to analyse the selection of materials in engineering sector (Chang et al., 2011; Kazemi et al., 2015), selection of technology for lubricants (Hsu et al., 2010) and problem strategy selection in communication sector (Jafari et al., 2008). As in the educational sectors, FDM has been used to evaluate the effectiveness of teaching based on students' perspective (Tarmudi et al., 2016) development of a sexuality education module for children with learning disabilities (Shariza Said et al., 2014), designing home-schooling education for early childhood Islamic education (Rahman et al., 2017), determining phases for multicultural-based model of peace education curriculum for preschool children (Yusof et al., 2018) and the development of Malay poetry module in secondary schools **(**Mohd et al., 2018)**.**

MI-Based Instructional Module

In 1983, Gardner through his theory of multiple intelligence theory (MI) has stirred and make known several research-based projects to be tested at preschool level (Torff, 1997). Gardner's Multiple Intelligence theory (MIT) is a useful model for developing a systematic approach to nurture and promotes children's development in nine different avenues. MIT provides a framework on how to individualize children's learning based on their needs, strengths and ability within a classroom setting (Armstrong, 2017; Abdullahi, 2020). It has been proven that, applying MI approach in the classroom as part of the educational method increased preschool children's cognitive development (Syed Chear et al., 2019) and enhance children's multiple intelligences through their potential learning styles (Armstrong, 2017; Şener & Çokçalışkan, 2018). MI-Based Instructional Module provides choices of nine intelligences that are developmentally appropriate specifically for 4 years old preschool children in Malaysia.

Objectives

The objectives of this study are to;

i) Validate components for the development of MI-Based Instructional Module based on experts' agreement.
ii) Identify component rankings for the development of MI-Based Instructional Module based on experts' agreement.

METHODOLOGY

The purpose of this study is to validate the components and content of MI-Based Instructional Module for 4 years old preschool children in Malaysia using FDM via experts' feedback. Ten experts (Ciptono et al., 2019; Yusoff et al., 2021) who are experienced in teaching preschool children and have deep knowledge in early childhood education were involved in this study. *Fuzzy* Delphi Method Procedure was selected to validate the components and contents of the MI-Based Instructional Module. *Fuzzy* Delphi Method (FDM) is used to identify, evaluate and confirm all the key components and contents of the MI-Based Instructional Module according to three terms of the experts' agreement which are threshold *(d)* value, percentage of expert agreement and the value of *Fuzzy* Score (A). Data analysis uses average of *fuzzy* numbers (defuzzification process). In this analysis we aimed to get the score of *fuzzy* score (A) to ensure the third condition is observed, the value of the *fuzzy* score (A) must be greater than or equal to the median value (α - cut value) of 0.5 (Bodjanova, 2006; Tang & Wu, 2010). This indicates that the element is accepted by an expert agreement. Among other functions, the value of *fuzzy* scores (A) can be used as a determinant and priority of an element according to expert opinion views.

RESULTS

The MI-Based Instructional Module includes key components of the monthly themes, weekly subthemes based on Bloom's taxonomy, learning objectives, learning activities based on higher order thinking skills, multiple intelligence strategy and assessment for learning, and contents of a one-year plan beginning from January until December. For the purposes of this study, three months in January, June and December were selected to show the different key components findings based on the weekly subthemes contents of week 1-4. Experts are given a seven likert scale linguistic variables to validate the module's key components and contents of each weekly subthemes, which later was converted into triangular fuzzy numbering.

Based on the results of Table 1, there are threshold values highlighted in red that has passed over the threshold value of 0.2 (> 0.2). This means that there is an uneven expert opinion, and it did not reach a consensus on certain items. However, the average value of all subjects of subjective norm constructs the threshold value *(d)* < 0.2 which is 0.0598 (0.05975). If the average value of threshold *(d)* is less than 0.2, the item has reached a good expert agreement (Cheng & Lin, 2002, Chang et al., 2011). While this percentage of the overall agreement is at a value of 94.2% of the agreement above 75% means meeting the terms of the expert agreement on this item. The highest value of defuzzication evaluation is 0.967 and the lowest is 0.913. In addition, all Alpha-Cut defuzzication (average of fuzzy response) exceeds α-cut ≥ 0.5. According to Mamat et al., (2018) and Hashim et al., (2020) the cut-off value should exceed 0.5. If the value is less than 0.5, the item should be dropped. This shows that the subjects of subjective norms have got good experts' agreement on item assessed.

Table 1
Threshold Value (d), Percentage of Experts Consensus (%) and Fuzzy Score (A) for the Theme of My Self in January

	Week			
Experts	1	2	3	4
1	0.000	0.015	0.101	0.313
2	0.000	0.015	0.054	0.078
3	0.000	0.015	0.054	0.078
4	0.000	0.015	0.054	0.078
5	0.000	0.015	0.054	0.078
6	0.000	0.015	0.054	0.078
7	0.000	0.015	0.054	0.078
8	0.000	0.015	0.054	0.078
9	0.000	0.015	0.054	0.078
10	0.000	0.137	0.338	0.313
Average of Threshold Value (d)	0.000	0.027	0.087	0.125
Percentage of Experts Consensus (%)	100.0%	100.0%	90.0%	80.0%
Fuzzy Score (A)	0.967	0.957	0.930	0.913

The items agreed by the expert consensus are arranged according to the ranking as shown in Table 2.

Table 2
Result of Experts' Consensus using Fuzzy Delphi Method for the Theme 'My Self' in January

		Triangular Fuzzy Numbers		Defuzzification Process				
Week	Subthemes	*Threshold Value* (d)	Average Percentage of Expert Consensus (%)	m1	m2	m3	*Fuzzy Score (A)*	Experts Consensus Decision
1	Getting to Know "Me"	0.000	100.0%	0.900	1.000	1.000	0.967	Accept
2	Look at Me!	0.027	100.0%	0.880	0.990	1.000	0.957	Accept
3	I Can Do This And That!!!	0.087	90.0%	0.840	0.960	0.990	0.930	Accept
4	When I Grow Up	0.125	80.0%	0.820	0.940	0.980	0.913	Accept

Based on Table 3, there is no threshold values highlighted in red that is passed over the threshold value of 0.2 (> 0.2). However, the average value of all subjects of subjective norm constructs the threshold value (d) < 0.2 which is 0.044. If the average value of threshold (d) is less than 0.2, the item has reached a good expert agreement (Cheng & Lin, 2002, Chang et al., 2011). While this percentage of the overall agreement is at a value of 94.95% of the agreement above 75% means meeting the terms of the expert agreement on this item. The highest value of defuzzication evaluation is 0.957 and the lowest is 0.947. In addition, all Alpha-Cut defuzzication (average of fuzzy response) exceeds α-cut ≥ 0.5. According to Tang & Wu, (2010) and Bodjanova (2006) the value of Alpha Cut should exceed 0.5. If the value is less than 0.5, the item should be dropped. This show the subjects of subjective norms have got good experts' agreement on item assessment.

Table 3
Threshold Value (d), Percentage of Expert Consensus (%) and Fuzzy Score (A) for the Theme of Safety in June

Experts	Week			
	1	2	3	4
1	0.137	0.122	0.122	0.122
2	0.015	0.031	0.031	0.031
3	0.015	0.031	0.031	0.031
4	0.015	0.031	0.031	0.031
5	0.015	0.031	0.031	0.031
6	0.015	0.031	0.031	0.031
7	0.015	0.031	0.031	0.031
8	0.015	0.031	0.031	0.031
9	0.015	0.031	0.031	0.031
10	0.015	0.122	0.122	0.122
Average of Threshold Value (d)	0.027	0.049	0.049	0.049

Percentage of Experts Consensus (%)	100.0%	100.0%	100.0%	100.0%
Fuzzy Score (A)	0.957	0.947	0.947	0.947

The items agreed by the expert consensus are arranged according to the ranking as shown in Table 4.

Table 4
Result of experts' consensus using FDM for the Theme 'Safety' in June

		Triangular Fuzzy Numbers		Defuzzification Process				
Week	Subthemes	*Threshold Value* (d)	Average Percentage of Expert Consensus (%)	m1	m2	m3	*Fuzzy Score (A)*	Experts Consensus Decision
1	Safety at Home	0.027	100.0%	0.880	0.990	1.000	0.957	Accept
2	Safety at School	0.049	100.0%	0.860	0.980	1.000	0.947	Accept
3	Personal Safety Assurance	0.049	100.0%	0.860	0.980	1.000	0.947	Accept
4	On the Road Safety	0.049	100.0%	0.860	0.980	1.000	0.947	Accept

Based on table 5, there is a threshold value highlighted in red that is passed over the threshold value of 0.2 (> 0.2). This means that there is an even expert opinion and does reach a consensus on all items. However, the average value of all subjects of subjective norm constructs the threshold value (d) < 0.2 which is 0.029. If the average value of threshold (d) is less than 0.2, the item has reached a good expert agreement (Cheng & Lin, 2002, Chang et al., 2011). While this percentage of the overall agreement is at a value of 95.52% of the agreement above 75% means meeting the terms of the expert agreement on this item. The highest value of defuzzication evaluation is 0.967 and the lowest is 0.93. In addition, all Alpha-Cut defuzzication (average of fuzzy response) exceeds α-cut ≥ 0.5. According to Tang & Wu, (2010) and Bodjanova (2006) the value of Alpha Cut should exceed 0.5. If the value is less than 0.5, the item should be dropped. This show the subjects of subjective norms have got good experts' agreement on item assessment. The items agreed by the expert consensus are arranged according to the ranking as shown in Table 6.

Table 5
Threshold Value (d), Percentage of Expert Consensus (%) and Fuzzy Score (A) for the Theme Occupation for the Month of December

Experts	Week			
	1	2	3	4
1	0.000	0.000	0.015	0.054
2	0.000	0.000	0.015	0.054
3	0.000	0.000	0.015	0.054
4	0.000	0.000	0.015	0.054
5	0.000	0.000	0.015	0.054
6	0.000	0.000	0.015	0.054

7	0.000	0.000	0.015	0.054
8	0.000	0.000	0.015	0.054
9	0.000	0.000	0.015	0.101
10	0.000	0.000	0.137	0.338
Average of Threshold Value (d)	0.000	0.000	0.027	0.087
Percentage of Experts Consensus (%)	100.0%	100.0%	100.0%	90.0%
Fuzzy Score (A)	0.967	0.967	0.957	0.930

Table 6
Result of Experts' Consensus using Fuzzy Delphi Method (FDM) for the Theme 'Occupation' in December

		Triangular Fuzzy Numbers		Defuzzification Process				
Week	Subthemes	*Threshold Value* (d)	Average Percentage of Expert Consensus (%)	m1	m2	m3	*Fuzzy Score (A)*	Experts Consensus Decision
1	Occupations	0.000	100.0%	0.900	1.000	1.000	0.967	Accept
2	My Ambition	0.000	100.0%	0.900	1.000	1.000	0.967	Accept
3	My Community Occupation	0.027	100.0%	0.880	0.990	1.000	0.957	Accept
4	Career Day	0.087	90.0%	0.840	0.960	0.990	0.930	Accept

DISSCUSSION AND IMPLICATIONS

The uniqueness of this module lies in its local elements, such as cultural values, identity, national aspiration, as well as international best practices in tapping the children's talent and learning capability (Kharuddin et al., 2018). It is important to learn about the culture and identity of our own country before moving globally (Fadzilah Bee Abdul Rahman, 2018). Additionally, the module is based a theory which was studied extensively on its significance in promoting children's multiple ways in learning. MIT was used as a pillar in developing this module. Hence, preschool teachers can use the module confidently with 4 years old preschool children to endorse individual learning uniqueness. MI-Based Instructional Module is evaluated using FDM, to gain experts' agreement in determining the priorities of the module's key components and contents (Kharuddin et al., 2019). Hence, preschool teachers will obtain a "Complete Multiple Intelligences-Based Daily Curriculum" for 4 years old preschool children. The module is designed to help preschool teachers to tailor their teaching methodology based on individual differences amongst preschool children.

CONCLUSION

The findings of this article indicate that there are 12 themes in a year which carried out 48 features of subthemes. Three themes were selected for the months of January, June and December (Table 1 – 6), to show the result of experts' consensus. In order to validate the key components and contents, the process of assessing and validating of the MI-Based Instructional Module was analysed using FDM. Therefore, the most significant contribution

to the methodology involves in this study is the use of the FDM in developing a MI-Based Instructional Module, based on views of a group of experts comprising of academician, management personnel in early childhood education and industrial representatives.

As a result of the used of FDM, the findings show that there is an acceptable expert's agreement on the key components and contents required in the development of the MI-Based Instructional Module. The conclusions from experts' consensus found that the MI-Based Instructional Module is important and essential to every child especially for 4 years old preschool children. The application of the MI-Based Instructional Module is designed to cater for each individual child's needs, strengths, and ability, hence, encourages the children to develop their potential effectively and meaningfully. The evaluation process of the MI-Based Instructional Module concluded that all experts agreed with 48 subthemes derived from 12 themes per year that are required to teach 4 years old preschool children. Based on the discussion and findings of the study, it can be supported that the application of the components and contents of the MI-Based Instructional Module, enables to assist researcher in a more organized and convenient model implementation process named structural equation modelling (SEM) for further analysis. An organized implementation of the components enables the teachers to conduct better evaluation on their teaching and learning.

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