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The Fuzzy Delphi Techniques in the Design and Development of Health Education Assessment Module Constructs for the Implementation of Classroom Based Assessment

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Abstract
The researchers have identified a shortage in assessment methods for Health Education for lower primary students in the classroom. This puts pressure on teachers who teach Health Education. To ease the burden on teachers and save time, the researchers have developed a Health Education assessment module for classroom use. The module was designed using the Fuzzy Delphi method, where experts from various fields were consulted through a questionnaire (FDM 1) to reach a consensus on the construct of the module. The results showed that all the constructs and items met the criteria set by the Fuzzy Delphi method, including a threshold value less than 0.2, a consensus percentage greater than 75%, and an Alpha cut value greater than 0.5. These results indicate that the Health Education assessment module is acceptable and suitable for use in the classroom.
Keywords: Fuzzy Delphi Technique, Classroom Assessment, Health Education, Assessment Module

Introduction

Education has undergone various developments and changes according to the currents of the world as well as the development of technology and science (Alsubaie, 2016). In the

meantime, assessment becomes the basis for determining the effectiveness of learning (Guerriero, 2017). In Malaysia, there are two types of tests, i.e., exam-oriented evaluation and school-based evaluation. The Malaysian Exams Board administered an exam-oriented assessment and the school carried out a school-based assessment. The application of the evaluation is consistent with the definition made by Shepard (2000), whereby the exam-oriented evaluation is classified as a summative external evaluation, whereas the school-based evaluation is also known as a formative internal evaluation. Focusing too much on academic performance, according to the Malaysian Examination Board (2011), will infuse tension on students, parents, and pupils. In finishing the syllabus, pressure on the teacher allows the examination to be neglected and less successful in teaching and learning. Efforts should also be made to strengthen the teaching career and increase the standards of teaching and learning. In addition, the Malaysian Examinations Board (2011) has reported that their education assessment system has been updated by developing countries. There is also a claim that our national education system depends very heavily on exam-oriented exams. As part of the Curriculum Transformation Policy dated 17 December 2010, the Cabinet of Ministers decided that school-based evaluations should be carried out in schools. School-based appraisal commonly referred to as Scholl Based Assessment refers to an effort to holistically improve an individual by prominence towards intelligence mastery, academic model, progressive attitude as a habit of teaching moral values, ethics and morals as illustrated in the Malaysian Education Roadmap, the national honesty strategy that aspired to be our national mission. In 2011, the Scholl Based Assessment was launched in primary school and was introduced in 2012 at high school level. It was carried out on the basis of Circular Letter No. 3/2011 from the Review Board. According to the letter, School Based Evaluation is an assessment method used without being measured strictly on review to ensure the success of the student. Scholl Based Assessment also provides systematic (holistic) progress assessment and academic growth of pupils across four elements, including school evaluation, physical activity evaluation, athletics and co-curriculum, psychometric evaluation, and exam-oriented evaluation. In 2014, as in Examination Board Circular Letter No. 1/2014, the Ministry of Education (MOE) had to stabilise School Based Assessment implementation by further revision to become more welcoming students. One of the elements of School Based Assessment, namely school-based assessment, was modified to classroom-based assessment in 2016. According to the Division of Curriculum Development (2018), school-based appraisal maintains all principles of school evaluation and requires the extent of determination of pupil control in each subject. Teacher plays a crucial role in the execution of School Based Assessment with a series of learning priorities aimed at enhancing the learning of pupils by formative appraisal known as learning evaluation, evaluation as learning and learning evaluation. The Division of Curriculum Development (2018) clarified that learning appraisal is known as formative assessment. Evaluation as learning emerges as the student reflects and reviews the learning progress in question. This helps them to appreciate their learning intent and know what they can do to meet learning goals. The measurement of learning, on the other hand, was carried out at the end of a given period, subject or field of education. Evaluation typically takes place in the summary form of the (Division of Curriculum Development, 2018). As the former Minister of Education, Dr. Maszlee Malik, declared the test to be withdrawn for pupils on 31 October 2018, classroom appraisal became more relevant and obligatory for all residents. According to the Malaysian Education Ministry, his declaration was imposed by Circular Letter No. 14/2018 (Abolition of Intermediate and End of Year Examination Practices for lower primary Students).

Literature Review

Researchers have designed and developed the assessment module using due to several important factors such as according to Norazilawati et. al (2015), 66.7 percent of teachers do not produce assessment materials due to time constraints and excessive workload. In addition, teacher assessment skills enable students to achieve the learning objectives and skills required in the curriculum (Ahmad & Mahamod, 2016) but there are statements that state that Health Education teachers are not skilled in constructing assessment materials and do not understand the assessment (Kumaran & Azali, 2019). This statement is further strengthened by the study of Othman et. al (2013) who stated that most teachers who teach the subject of health education are still unskilled in constructing assessment items, lack understanding and lack of clarity related to the meaning of assessment. trusted and valid and lack the skills to assess and evaluate the results of the assessment. It is in line with the statement of Norazilawati et. al (2015), who stated that teachers in schools face problems and competencies in constructing question items as well as the implementation of health education assessment. Therefore, researchers have designed and developed an assessment module for Health Education subjects using Fuzzy Delphi technique.

Wan Omar's study (2019) also concludes that there are many challenges faced by teachers in implementing PBD so as to cause problems for teachers in carrying out classroom based assessment effectively. By implementing classroom based assessment, teachers can assess students comprehensively in terms of cognitive, psychomotor and affective, in line with the goals of FPK which emphasizes the aspects of JERI (Ministry of Education Malaysia, 2018). The implementation of assessment in the classroom can also help improve the weaknesses of students in lessons (Moktar et. al., 2018). Therefore, Ahmad and Mahamod (2016) suggested that studies related to classroom based assessment be multiplied as School Based Assessment is a new transformation in Malaysia. Therefore, researchers have planned to design and develop the Health Education assessment module for lower primary student with use of Fuzzy Delphi Technique.

Methodology

The methodology used in this research is the Fuzzy Delphi technique proposed by (Murray et al., 1985). and improved by (Kaufman & Gupta, 1998). It's a mix of a fuzzy set theory and a Delphi strategy. Its Ridhuan et al (2013) said It reveals that the Fuzzy Delphi technique is not new, but that it is an instrument that 'improves' the current Delphi technique. This Fuzzy Delphi is a quantitative study, which involving 20 experts from various of field as proposed by (Adler & Zigler, 1996). The research instrument used in this research is a set of questionnaires which contain 6 constructs. To implement the Fuzzy Delphi technique in this study, the researcher first determined and arranged the modified constructs from the needs analysis and the content been validate by three expert panel. After that, the researcher also determines a group of experts who agree to contribute their expertise in expressing ideas, criticizing and improving the content of the construct that has been determined by the researcher. In this research, researchers have used a total of 20 experts from several of field such as Schools, Universities and Teacher Education Institutes. Researchers have distributed questionnaire instruments containing constructs obtained through needs analysis. Experts are asked to state the level of agreement on each item whether Strongly Agree, Strongly Agree, Agree, Moderately Agree, Disagree, Strongly Disagree and Strongly Disagree. After all the experts indicate their level of agreement, the experts are also asked to give their views on each construct in the questionnaire. Data from the Likert Scale obtained later translated

into Fuzzy number data form and analysed using Microsoft Excel software. This data analysis technique is known as Fuzzy Delphi technique or Fuzzy Delphi Method (FDM). Table 1 shows the profiles of the experts involved:

Table 1
Experts' Profile Summary

Information	Detail	Frequency (*N*)	Percentage
Field	Public University Lecturer.	1	5
	Teacher's Training collge letrucers.	4	20
	Health Education subject head coaches.	3	15
	Health Education Textbook writers.	2	10
	School administrators (Curriculum).	3	15
	Health Education Teachers.	4	20
	Classroom based Assessment Coordinator	3	15
Working Experience	5 to 10 years	3	15
	11 to 15 years	3	15
	16 to 20 years	4	20
	More than 21 years	10	50
Expertise	Curriculum	3	15
	Health Education	11	55
	Assessment	3	15
	Module Creaters	3	15
Total		20	100 %

N = 20 Experts

Data Analysis

In the Fuzzy Delphi technique there are two terms that need to be understood namely the Triangular Fuzzy Number and the Defuzzification process. Triangular Fuzzy Number represents the values of m1, m2 and m3 and it written like this (m1, m2, m3). The value of m1 represents the minimum value, the value of m2 represents the value reasonable while the value of m3 represents the maximum value. While Triangular Fuzzy Number
used to produce the Fuzzy scale (the same as the Likert scale) for the purpose translate linguistic variables to fuzzy numbers. Number of levels for the scale Fuzzy is in odd numbers. The higher the Fuzzy scale, the more accurate the data obtained. The higher the Fuzzy scale, the more accurate the data obtained (Ridhuan, 2013). Figure 1 shows the fuzzy scale agreement level:

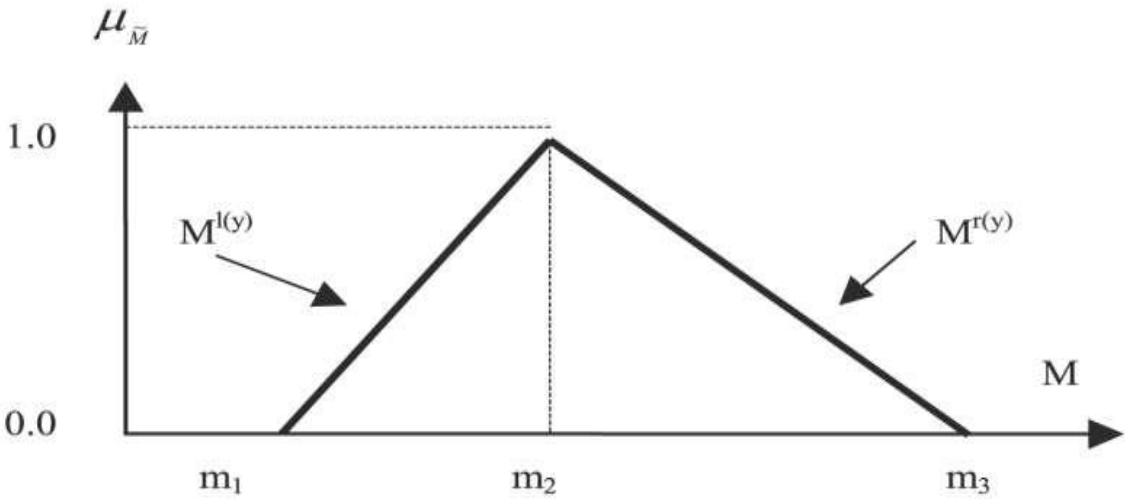

Figure 1: Fuzzy Scale Consensus Level

In this research, the process of collection and analysis of Fuzzy Delphi techniques was implemented when an expert is given an item and each instrument is represented by a Likert scale as well as a column blank for expert comments and suggestions. The Likert scale data obtained will be analysed by using the Excel program. All data is converted to Triangular form Fuzzy Number. The seven-point Fuzzy scale was used in this study. It can be seen in the table 2:

Table 2
Linguistic Variable Scale - 7 points

Consensus Level (7 points)	**Fuzzy Numbers**		
	m1	**m2**	**m3**
1- Extremely Disagree	0.0	0.0	0.1
2- Strongly Disagree	0.0	0.1	0.3
3- Disagree	0.1	0.3	0.5
4- Moderately Agree	0.3	0.5	0.7
5- Agree	0.5	0.7	0.9
6- Strongly Agree	0.7	0.9	1.0
7- Extremely Agree	0.9	1.0	1.0

Table 2 shows that the higher the number on the scale, the more accurate the data obtained. In this study, the researcher chose a seven-point linguistic scale as such shown. As a next step, the data are then scheduled to obtain Fuzzy values (n1, n2, n3) as well as average values Fuzzy (m1, m2, m3) for threshold value, expert consensus percentage, defuzzication and item ranking. For the purpose of obtaining expert agreement for each item, threshold value does not exceed 0.2. The percentage of expert consent should exceed 75% while the defuzzication value for each item should exceed the α-cut value = 0.5. To get the threshold value, the distance between two Fuzzy numbers is determined by using the following formula:

$$d\left(\tilde{m},\tilde{n}\right)=\sqrt{\frac{1}{3}\left[\left(m_1-n_1\right)^2+\left(m_2-n_2\right)^2+\left(m_3-n_3\right)^2\right]}.$$

Figure 2: The formula for determining the distance between two Fuzzy numbers

Based on the formula in Figure 2, the value of d is the threshold value. If the value of d ≤ 0.2, it means that all experts reach an agreement on the item. Otherwise, a second round needs to be made to see if the item is needed or not (Chen, 2000; Cheng & Lin, 2002). The Delphi Fuzzy technique also involves a determining process expert agreement either exceeds or equals 75% of the entire construct or for each item. Each item is assumed to reach an expert agreement if percentage expert agreement for the item is equal to or more than 75% (Chu & Hwang, 2008). The process of defuzzification is also done in the process of data analysis of Fuzzy technique study Delphi. It is the process of determining the position or priority of each item or for determines the position of each variable or sub-variable. In progress here, there are three formulas, namely:

i. A = 1/3 * (m1 + m2 + m3), or;
ii. A = ¼ * (m1 + 2m2 + m3), or;
iii. A = 1/6 * (m1 + 4m2 + m3).

A-cut value = median value for '0' and '1', where α-cut = (0 + 1) / 2 = 0.5. If the value of A resulting in less than α-cut value = 0.5, the item will be rejected because it indicates an agreement expert in rejecting the item however if the resulting A value is above the α-cut value = 0.5, item will be accepted as it indicates expert consensus to accept item concerned (Bodjanova, 2006).

Results

Fuzzy Delphi Expert consensus on main Constructs of Health Education assessment module for the implementation of classroom based assessment. In this study, the main components are as stated in table 3

Table 3
Main constructs of Health Education assessment module

Items	**Main Constructs**
1	Objectives
2	Table of contents
3	Unit titles
4	Domain Mastery
5	Form of instruction
6	Assessment method

Threshold values (d), for the above items are shown in Table 4:

Table 4
Threshold values (d)

Experts	CONSTRUCTS					
	Objectives	**Table of contents**	**Unit titles**	**Domain Mastery**	**Form of instruction**	**Assessment method**
1	0.049	0.034	0.048	0.076	0.082	0.085
2	0.107	0.034	0.111	0.178	0.173	0.171
3	0.107	0.122	0.111	0.076	0.173	0.085
4	0.107	0.034	0.111	0.178	0.173	**0.467**
5	0.288	0.274	0.283	0.076	0.082	0.085
6	0.107	0.122	0.283	0.076	0.082	0.171
7	0.049	0.122	0.111	0.076	0.173	0.085
8	0.107	0.034	0.048	0.178	0.173	0.171
9	0.049	0.034	0.048	0.178	0.173	0.171
10	0.107	0.034	0.048	0.076	0.173	0.171
11	0.049	0.122	0.048	0.178	0.173	0.171
12	0.107	0.122	0.111	0.215	0.220	0.221
13	0.049	0.034	0.111	0.215	0.220	0.085
14	0.049	0.122	0.111	0.215	0.220	0.221
15	0.107	0.034	0.111	0.076	0.220	0.221
16	0.049	0.034	0.283	0.178	0.173	0.171
17	0.049	0.034	0.111	0.076	0.082	0.221
18	0.288	0.274	0.048	0.178	0.082	0.085
19	0.107	0.122	0.111	0.215	0.220	0.221
20	0.049	0.034	0.048	0.178	0.082	0.085
Threshold value (d) of each construct	0.099	0.089	0.114	0.145	0.157	0.168
Overall Threshold value (d) for all the Constructs	0.129	(< 0.2)				

Based on table 4 Threshold value of each main construct of Health Education assessment module does not exceed the threshold value of < 0.2 i.e. objective (0.099), content (0.089), unit title (0.114), domain mastery (0.145), form of instruction (0.157) and assessment method (0.168). There is also a threshold value (d) that exceeds the threshold value (d) 0.2 (> 0.2) in the table. This means that there is an opinion of one of the experts that is uneven and does not reach consensus on the construct. However, the threshold value (d) of the entire main construct is 0.129, This indicates that the expert panel has stated the level of consensus on the six main constructs of the Health Education assessment module. All constructs have complied with the first condition because the value of d for almost 99 % constructs is d < 0.2. This indicates the first condition of the fuzzy assessment has been accepted and the analysis

can proceed. Once the threshold (d) value, is accepted, the researcher evaluates the consensus value of 75% or the consensus of a group of experts called the consensus group. The formula used is as follows:

$\Sigma dd - \Sigma dd1 / \Sigma dd \times 100\%$.

Σdd, represents the total threshold of expert answers, $\Sigma dd1$ is the total threshold that exceeds 0.2. The total value of the deal percentage for each construct is recorded in table 5 as follows:

Table 5
Percentage of expert consensus on constructs of the Health Education Asseesment module

Constructs	Objectives	Table of contents	Unit titles	Domain Mastery	Form of instruction	Assessment method
Number of Experts	20	20	20	20	20	20
Percentage of expert consensus on each constructs	100%	100%	100%	100%	100%	95%
Experts overall consensus percentage on main constructs of the Health Education assessment module	99% (> 75%)					

The total value of the overall percentage of expert consensus is 99% where it exceeds the minimum requirement of 75% of the percentage value of the expert agreement. So this shows that the second condition of Fuzzy Delphi is that the availability of experts should exceed > 75 percent is accepted. This means that the selected experts have reached a consensus value for the entire construction of the Health Education assessment module that will be used for the implementation of classroom assessment. After the equity value of the expert group meets the conditions, the fuzzy evaluation value was determined. Fuzzy evaluation is one of the methods to determine the ranking of an item. Since the process is quite difficult because it involves complex numbering, an alternative method using mathematical formulas is used as a ranking determination method and this method is called defuzzification process. The process of Defuzzification (alpha-cut value) is one the process of determining the ranking for

each construct. The purpose of this process is to see the level of requirements of a variable and the required sub-variables. This ranking process produces data according to needs based on the consensus of experts who act as study respondents. At this step the researcher has been able to determine the score or position according to the expert agreement. Constructions that have gained the expertise of experts are arranged according to priority (ranking) as shown in table 6.

Table 6
Alpha cut value and Constructs ranking

Constructs	**Expert Consensus**	***Fuzzy Evaluation***	**Alpha Cut Value**	***Ranking***
Objectives	Accepted	17.700	0.885	**3**
Table of contents	Accepted	17.900	0.895	**1**
Unit titles	Accepted	17.833	0.892	**2**
Domain Mastery	Accepted	16.400	0.820	**4**
Form of instruction	Accepted	16.333	0.817	**5**
Assessment method	Accepted	16.300	0.815	**6**

All Alpha-Cut defuzzication values (average of fuzzy response) for the Health Education assessment module construct have exceeded α-cut => 0.5. According to Tang & Wu (2010); Bodjanova (2006) alpha cut values should exceed 0.5. The result of the defuzification score value for each item of the main construct of the module is seen to give an agreed value. Table 6 shows that the table of content contract is in the first place with a defuzification score value of 0.895. Followed by the title unit with a defuzificationvalue of 0.892 in second place. In third place are the objective objectives with a score value of 0.885. Next the domain mastery construct with a defuzification score value of 0.820 is in fourth place. Next, the form of instruction constructs the defuzification score value of 0.817 in the fifth position and the last construct which is in the sixth position with the defuzification score value of 0.815 is the assessment method. Overall, all constructs have a threshold value (d) ≤ 0.2. According to Cheng and Lin (2002), if the average value and expert evaluation is less than the valuethreshold 0.2, the construct has reached expert agreement. The percentage of expert consent also indicates that all constructs are above the value of 75%. All defuzzification values for each construct also exceed α-cut = 0.5. This shows that each construct is important as a construct for the design and development of Health Education assessment modules for the implementation of classroom assessment. The process of gaining consensus from a group of experts using the Fuzzy Delphi Method is considered a content validity process (Zulkifli, 2020).

Discussions

The module development process involves the process of content evaluation by experts. Based on the findings, shows that the development of Health Education Assessment module is in line with the needs and requirements of the school curriculum. The findings also show that the content in the development of Health Education Assessment module emphasizes all the main components of curriculum evaluation. The findings of this study are in line with the

study conducted by (Nabila. et. al., 2019). In his study, who also used the same platform in the construction of evaluation modules with the percentage of agreement between experts was 78.35%.

The findings of this study indicate that the measured items obtained a high percentage of consent and at the same time showed that the Health Education Assessment module for this field of health has good validity as well as a high percentage of usability. In addition, the average findings for module reliability are at a high level (alpha Cronbach> 0.800) based on the results obtained from the module user group. Majid (2000) states that if a module obtains a reliability value exceeding 0.60 means that the module produced has a good level of consistency. The process of obtaining this reliability value is in line with what previous researchers have done to the modules developed by them, namely (Fadhila, 2017; Roslaili, 2016). All reliability studies conducted on modules prove that a module must have a high reliability value to ensure the quality and quality of the module. Quality modules can contribute to the effectiveness of module users. Overall, the Health Education Assessment module developed can be considered as a complete module because it has gone through a process of validity and reliability. A quality and complete module can be identified if its validity and reliability have been tested (Sidek & Jamaludin, 2005).

The need for an effective assessment module that can accurately measure students' knowledge and understanding of Health Education is more critical than ever. By providing an effective assessment module, educators can ensure that students have a deep and comprehensive understanding of health-related concepts that can help them make informed decisions about their health.

Not only that, this study also contributes to the development of effective assessment modules for CBA in Health Education by utilizing the Fuzzy Delphi technique. This technique is a reliable and systematic method that enables experts to provide their inputs and opinions, ensuring that the assessment module is comprehensive, accurate, and relevant to the subject matter. The study's approach can be extended to other areas of education, making it a valuable contribution to the field of assessment and evaluation.

In conclusion, it can be concluded that the development of this module meets the requirements of the curriculum and is also based on curriculum design. The contents of this module are expected to be used as an example and guide to all educators to produce more efficient and student-centred teaching and learning activities as facilitators, especially in the aspect of student assessment.

Conclusion

This Health Education Assessment module will give its implications to various parties, especially to the schools and students. Teachers can comfortably and confidently utilize this module towards their students for classroom based assessment. Moreover, the assessment module can be shown as an assessment record for all parents who would want to know their children's development in Health Education subject. Apart from that, the assessment module will also involve students directly in implementing the government’s policy and the aspiration of the State Education Department. In conclusion, results prove that the Health Education assessment module development that design and develop by using Fuzzy Delphi technique is

very trustable, imperative and essential for teachers in conducting classroom based assessment.

Future Studies

The researcher has carefully explained all Fuzzy Delphi technique and how it's been used in this research. Researchers have design and develop a quality assessment module for Health Education which can be used in classroom assessment by using Fuzzy Delphi technique. The steps found in the Fuzzy Delphi technique are very suitable for design and developing any module or models. Researchers can conclude that a very high-quality module can be developed if every step found in the Fuzzy Delphi technique are adequately followed. Researchers who will venture into the field of research can use the Fuzzy Delphi technique if they want to design and develop a quality module. Hope future researchers will develop more modules for elective subjects such as Physical Education and Health Education for upper primary students and elementary school students with this kind effective technique.

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