

Application of Fuzzy Delphi Methods in Developing of Green Skills Elements in Secondary Schools

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Abstract

The purpose of this study is to get an expert agreement on the elements of Green Skills that need to be incorporated into the curriculum of the designated subjects as well as to create the individual who will be the workforce in the care of the environment. The objective of this study is to obtain expert opinion and consensus on Green Skills elements. This is a quantitative study using the questionnaire given to the expert. All data collected were analyzed using Fuzzy Delphi Method. The findings showed that all elements of Green Skills are in line with the conditions, the threshold value is less than 0.2, the group of experts is over 75% and the Fuzzy Score exceeds 0.5. This suggests that the Green Skills element is indispensable among students based on expert agreements.

Keywords: Green skills, fuzzy delphi, competency, environmental awareness

Abstrak

Kajian ini bertujuan untuk mendapatkan kesepakatan pakar berkenaan elemen Kemahiran Hijau yang perlu digabungkan dalam kurikulum mata pelajaran Reka Cipta sekaligus melahirkan individu yang bakal menjadi tenaga kerja dalam keperihatinan menjaga alam sekitar. Objektif kajian ini adalah untuk mendapatkan pandangan dan konsensus pakar terhadap komponen elemen Kemahiran Hijau. Kajian ini berbentuk kuantitatif menggunakan kaedah soal selidik yang diberikan kepada pakar. Segala data yang dikumpulkan dianalisis menggunakan Kaedah Fuzzy Delphi. Hasil dapatan kajian menunjukkan kesemua elemen Kemahiran Hijau menepati syarat, iaitu nilai threshold (dkonstruk) adalah kurang daripada 0.2, peratusan kumpulan pakar adalah melebihi 75% dan Skor Fuzzy melebihi 0.5. Hal ini menunjukkan bahawa elemen Kemahiran Hijau amat diperlukan dalam kalangan pelajar berdasarkan kesepakatan pakar.

Kata Kunci: Kemahiran hijau, fuzzy delphi, kompetensi, kesedaran alam sekitar

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1.0 INTRODUCTION

Green Skill is the necessary skill in every human group that underlies all areas of work in an organization that existed this century. This is in line with Buntat and Othman (2012) statement that Green Skills, also known as "Green Soft Skill", are complementary to Green Jobs and Green Careers). MERIC (2009) also mentioned in a report known as the Missouri Green Jobs Report that has successfully identified the competence of Personnel Effectiveness Competencies as one of the elements in Green Skills. He further added that the competency is the basis of the right way of life for all types of work within any organization across all labor and industrial boundaries. However, the Green Skills context in this study refers to a skill that can be applied in everyday life, the value of skills that value the environment in terms of attitudes, desires and behaviors

2.0 PROBLEM STATEMENT

Indirectly, the younger generation can be instilled in the first place, forming a positive habit for the importance of environmental conservation and preventing nature from being contaminated (CEDEFOP, 2010). Some aspects of the Green Skills that can be implemented at schools will be able to nourish the values of inculcating green technology and also to create a society with Green Skills to drive the economy towards sustainable development and have 50 percent skilled manpower by 2020 (Siti Nor Syazwani et al., 2012).

■3.0 PURPOSE OF THE STUDY

The need for knowledge about the element of Green Skills towards students taking the design subject is very much needed as they are the potential of a workforce who will become skilled workers in the production of a product that is dedicated to the preservation of nature. Thus, this study aims to fulfill the research objective of identifying the element of Green Skills required by the students and their priorities based on expert agreement.

■4.0 RESEARCH DESIGN

This quantitative design uses the Fuzzy Delphi Method which is a widely used and widely accepted approach in collecting data for a study based on the agreement of a group of experts in an issue reviewed (Hsu & Sandford, 2007). The strength of this method has also resulted in the diversification of techniques in obtaining empirical data such as the FDM method. Speaking of the FDM methodology, it is a method of measurement performed by modifications based on the Delphi method (Muhd Ridhuan, 2016).

This method was introduced by Kaufman and Gupta in 1988. This FDM method is a combination of the fuzzy numbering set and the Delphi method itself (Murray, Pipino & Vangigch, 1985). This means that it is not a new approach because it is also based on the classic Delphi method in which the respondents involved must be among the wise experts in a field appropriate to the context of the study. This improvement indirectly creates the FDM method as a more effective measurement approach in which it is able to solve problems with uncertainties and uncertainties for an issue being studied.

The FDM method is a combination of traditional (classical) Delphi and fuzzy set theory. This fuzzy set theory was introduced by a mathematician in 1965, Zadeh (Zadeh, 1965) and it serves as an extension of the classic set theory in which each element in a set is based on the binary set (Yes or No). The fuzzy set theory also allows gradual assessment of each element being studied. Ragin (2007) states that the value for the fuzzy number is composed of 0 to 1 or within the unit interval (0, 1).

■5.0 RESEARCH FINDINGS AND DISCUSSION

There are four steps that the researcher uses to explore the main elements and items in the elements of Green Skills. Table 1 shows each step conducted to answer each question. Given this writing is only to get the element of green skills from the expert's perspective, then steps 3 and 4 will not be discussed in this paper.

Table 1 Summary of activities in fuzzy delphi techniques

Step	Activity
Step 1	The development of elements in the Green Skills model is based on the analysis of documents, reports and literature review
Step 2	The element validation in the Green Skills model is based on expert agreement using Fuzzy Delphi (FDM) method.
Step 3	Development of items for each element in the Green Skills model based on data from interviews and document analysis.
Step 4	Verify item of each element in Green Skills model based on expert agreement using Fuzzy Delphi (FDM) analysis method.

5.1 Step 1: Development Of Element In The Green Skill Model

In this step, the researcher developed the key elements derived from document analysis such as reports, DSKP, blue print, related research on Green Skills. Given the Green Skills study is still new to Green Technology studies in Malaysia, researchers study literature reviewed from outside the country to get these elements.

5.2 Step 2: The Validation Of The Main Elements Of The Model Based On Expert Agreement Using The Fuzzy Delphi (FDM)

In determining the key elements of the Green Skills model, researchers have conducted literature studies as discussed in the findings in step 1 shown earlier. Hence, the findings of this step 2 are aimed at assessing and validating on the basis of a group of experts on key elements that have been selected. The expert group involved in verifying this element is very important as these experts are composed of those who are directly involved in the context of the study.

The analysis of the study data for the Fuzzy Delphi (FDM) method is based on the conditions contained in the triangular fuzzy number and defuzzification process. The condition for the triangular fuzzy number involves the threshold value (d) and the percentage of the expert agreement in which the threshold value (d) of each item (component and element) measured must be less or equal to 0.2 (Cheng & Lin, 2002) experts must exceed or equal to 75.0% (Chu & Hwang, 2008; Murry & Hammons, 1995). The threshold value (d) will be analyzed using Microsoft Excel based on the following formula: -

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

For the defuzzification process, there is only one condition, the value of the fuzzy score (A) must be greater than or equal to the value of α -cut of 0.5. (Tang & Wu, 2010; Bodjanova, 2006) The score of this fuzzy score is equally analyzed using Microsoft Excel using the following formula:

$$A = 1/3 * (m^1 + m^2 + m^3)$$

For this second step, there are 11 experts who have been identified for viewing, discussing, evaluating and validating key elements required by the Green Skills Model. All of these key elements are very important to discuss whether they are accepted or rejected and confirmed on the basis of agreement from a group of experienced experts in the context of the study. For analysis using FDM method, the researcher uses the terms contained in the triangular fuzzy number and defuzzification process: -

- i. Threshold value (d)
- ii. Percent of specialist deals > 75%
- iii. Fuzzy A score = α -cut > 0.5

Table 2 shows the findings based on the analysis of FDM method for green skill elements based on expert agreement using Fuzzy Delphi (FDM) analysis. The findings show threshold value (d) and percentage of expert group. There are 10 elements that include the elements.

Table 3 shows the final findings of the key element in Green Skills that have been negotiated by experts' panel. Referring to the element, the element (i) environmental awareness skills is the most important element followed by (ii) green practice; (iii) learning skills; (iv) career development skills; (v) STEM skills; (vi) entrepreneurial skills; (vii) the communication skills; (viii) interpersonal skills; (ix) self-employed skills and the last element is (x) intellectual skills.

Table 2 Research findings for the main elements of green skills

NO	EXPERT	GREEN SKILLS									
		1	2	3	4	5	6	7	8	9	10
1	Expert 1	0.056	0.083	0.066	0.056	0.028	0.278	0.000	0.000	0.028	0.028
2	Expert 2	0.056	0.222	0.196	0.056	0.028	0.028	0.000	0.000	0.028	0.028
3	Expert 3	0.056	0.083	0.066	0.056	0.028	0.028	0.000	0.000	0.028	0.028
4	Expert 4	0.250	0.528	0.243	0.056	0.028	0.028	0.000	0.000	0.028	0.028
5	Expert 5	0.056	0.083	0.243	0.056	0.028	0.028	0.000	0.000	0.028	0.028
6	Expert 6	0.056	0.083	0.066	0.056	0.028	0.028	0.000	0.000	0.028	0.028
7	Expert 7	0.250	0.083	0.066	0.056	0.028	0.028	0.000	0.000	0.028	0.028
8	Expert 8	0.056	0.083	0.066	0.250	0.278	0.028	0.000	0.000	0.028	0.028
9	Expert	0.056	0.083	0.066	0.056	0.028	0.028	0.000	0.000	0.278	0.278
10	Expert 10	0.056	0.083	0.066	0.056	0.028	0.028	0.000	0.000	0.028	0.028
11	Expert 11	0.056	0.083	0.066	0.250	0.028	0.028	0.000	0.000	0.028	0.028
Value (d) Each Item		1.000	1.500	1.213	1.000	0.555	0.555	0.000	0.000	0.555	0.555
Threshold Value (d) Each Item		0.091	0.136	0.110	0.091	0.050	0.050	0.000	0.000	0.050	0.050
Value (d) Total Items		6.934									
Value (d) Construct		0.063									
Number of items ≤ 0.2		9	9	9	9	10	10	11	11	10	10
% for each item $d \leq 0.2$		82%	82%	82%	82%	91%	91%	100%	100%	91%	91%
Total Items $d \leq 0.2$		98									
% All Items $d \leq 0.2$		89%									
Fuzzy Score (A)		0.764	0.745	0.764	0.764	0.782	0.782	0.800	0.800	0.782	0.782

Table 3 Final analysis for major elements of green skills based on expert agreement through fuzzy delphi method (FDM)

No	Green Skills	Syarat Triangular Fuzzy Numbers		Defuzzification Process Terms				Expert Consensus	Score
		Threshold Value (d)	Expert Consensus (%)	m1	m2	m3	Fuzzy Score (A)		
1	Communication Skills	0.091	82%	0.564	0.764	0.964	0.764	Accept	7
2	Interpersonal Skills	0.136	82%	0.545	0.745	0.945	0.745	Accept	8
3	Intellectual Skills	0.110	82%	0.582	0.745	0.964	0.764	Accept	10
4	Career Development Skills	0.091	82%	0.564	0.764	0.964	0.764	Accept	9
5	Learning Skills	0.050	91%	0.582	0.782	0.982	0.782	Accept	3
6	Self-Employed Skills	0.050	91%	0.582	0.782	0.982	0.782	Accept	4
7	Environmental Awareness Skills	0.000	100%	0.600	0.800	1.000	0.800	Accept	1
8	Green Practices Skills	0.000	100%	0.600	0.800	1.000	0.800	Accept	2
9	STEM Skills	0.050	91%	0.582	0.782	0.982	0.782	Accept	5
10	Entrepreneurial Skills	0.050	91%	0.582	0.782	0.982	0.782	Accept	6

6.0 CONCLUSION

The Green Skills element is indispensable in the context of the design of the subject. It aims to equip pupils with knowledge and skills, creative thinking, critical, innovative, and inventive and potentially engaging with the transformation of current technological developments through the creation of invention designs that can contribute to national development. The findings of this Green Skills element are very important to educate the younger generation now by fostering a loving environment of nature. Through education a goal can be achieved if we want to build a sustainable generation in terms of attitudes, knowledge and values that lead to universal sustainability.

The findings from expert interviews found that the Green Skills element is important and essential to every student. The process of applying this element is important to the students who follow it because students are exposed by interactions not only with their peers but also communities of different layers of workers who need the ability of students to build a good relationship with their learning environment (Mohd Ridhuan, 2016). This is in line with the argument that the process of applying and enhancing the element of Green Skills to students is a thing to be taken seriously as it indirectly helps students improve their self-esteem and develop their identity

The evaluation process has concluded that all experts agree that there are 10 elements in Green Skills that need to be amongst students in high school. Based on the discussion and findings of the study, it is clear that the application of the element of green skills in the curriculum enables one to gain exposure on the concept of sustainability, the greater the awareness they gain in order to change attitudes and behaviors in the workplace that can support green growth.

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