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ICT-BASED TEACHING OF MECHANICAL AND MANUFACTURING PROGRAM TEACHERS FROM VOCATIONAL COLLEGES USING FUZZY DELPHI IN NORTHERN ZONE

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ABSTRACT
ICT-based learning environment has been identified as a new and interesting method and able to change the way people learn. ICT-based learning can take place beyond the boundaries of the classroom walls, place and time. Thus, this study aims to identify ICT-based teaching techniques among mechanical and manufacturing program teachers in Vocational Colleges. In this study, Delphi Fuzzy Method using 7 fuzzy scales was used to collect the responses of 15 expert lecturers in various areas of expertise. The collected data were analysed using fuzzy triangular numbering and the ranking of each variable was determined using a 'defuzification' process. Expert consensus found that problem solving and teacher guidance items (scaffolding) came first with a defuzification score value of 10.2. Lecture items are in the last position which is eighth with a defuzification score value of 7.8. The results of this study provide input on the factors that need to be given attention to realise the concept of ICT-based learning in Vocational Colleges.
Key words: Fuzzy Delphi, Expert Consensus, Triangular Fuzzy Number, Scaffolding

Introduction
In Malaysia, rapid development in information and communication technology (ICT) in the last two decades has had a huge impact on millions of people. Education is the driving force for the development and advancement of ICT that will be used in various sectors for the formation of a knowledgeable generation to meet the demands and desires of the modern world (Alazam, 2012). Teachers need to make a shift, so that they have skills in the field of information communication technology (ICT) and given exposure to the latest technology in order to produce capable and qualified educators to develop the country (Ali, S. N, 2012).

The Malaysian Ministry of Education has also specified that teachers should have at least a minimal ICT knowledge in order to be able to guide students in their efforts to bring positive and sustainable development to countries around the world (Alazzam, A.O, Bakar, A.R, Hamzah, R., & Asimiran, S., 2012). ICT is now considered as a powerful tool to promote social and economic development. Therefore, education has become the main focus in the development of Information and Communication Technology for the development of a country's society, especially in developed countries. Among the factors that have been proposed by UNESCO in the third International Congress (2012) is to make TVET relevant to the current situation by promoting the integration of ICT in education.

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Background of the Study

Malaysia desperately needs skilled workers in technical fields in order to boost the country's economy to a better level. TVET will hopefully prepare the students towards the preparation of knowledgeable and skilled employees. This suggestion is further strengthened by the statement of the former Director of BPTV, Ahmad Tajudin Jab (2012) who stated that the changes in Technical and Vocational education will change with the passage of time where the transformation involves a huge change in the provision of knowledge to students. Abdul Rahim (2005) stated that the vast and global world of education has challenged teachers to adapt the curriculum, teaching and learning processes and exploration of information through ICT so that the role of teachers is more effective in advancing the world of education. To realise this desire, the Ministry of Education generally needs to look at the readiness of the technical teachers so that they are given exposure to ICT knowledge and skills first so that the ICT-based teaching process can be implemented to students.

The results of the study showed that the overall level of skills and knowledge of vocational teachers in Malaysia in the field of ICT is at a moderate level (Alazam, 2012).These findings clearly explain that these teachers already have the knowledge and skills and are able to use ICT during the teaching process in the workshop. However, these teachers need to be given exposure and guidance in advance on how this ICT-based teaching process can be implemented, provided that each need must be in line with the requiment of the Ministry (Nasir, S. B. 2012).

Problem Statement

In Malaysia, the development of digital technology is moving in line with the development of the Technical and Vocational Education system. The role of teachers is to develop teaching methods from conventional to new digitalisation pedagogy as the main catalyst for disseminating and storing information in turn helping students to build new knowledge (Lechner & Boli, 2000). The fast changes of information technology are undergoing this very rapid technological revolution making technology as a media medium to convey information and communication, especially in teaching and learning in this cyber era (Livingstone, 2012).

However, in the context of ICT in education, most developing countries, including Malaysia are still far behind (Ibieta, Hinostroza, Labbé, & Claro, 2017). This can be seen based on the statistics of very low ICT use among teachers (Cheok, Wong, & Ahmad Fauzi Ayub, 2017). Among the issues that are often cited as contributing to the rejection of ICT by teachers are such as lack in terms of facilities, support, readiness and excessive workload (Cheok & Wong, 2016; Copriady, 2015; Kihoza, Zlotnikova, Bada, & Kalegele, 2016).

However, government policies have always been consistent in using technology as a teaching tool. This step is a paradigm shift and opens up opportunities for teachers to maximise the use of resources provided by the government in the implementation of the teaching and learning process (Mohamad Sani, 2002).

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However, there are some issues that arise from previous studies that highlighted the weaknesses of teachers in using ICT as a teaching medium stem from the lack of skills and knowledge in the field (Shau, 2008). The findings of Liaw and Muzafar's (2011) study also showed a lack of technical instructors to apply or apply ICT during the teaching process. Therefore, vocational education institutions in Malaysia need to implement changes more rapidly so that the teaching and learning process will be more relevant in line with the latest developments (Ruhizan & Norazah, 2014).

Teachers need to find interesting teaching ideas and teaching aids to motivate interest and create attraction in the learning process of the educational curriculum (Sharifah Nor, 2010). Therefore, the challenge that needs to be faced by technical teachers in the education system in Malaysia is to change teaching methods using ICT facilities as an alternative.

Based on the issues that have been explained in the background of this study, there is a justification to conduct a study in developing an ICT-based teaching model for technical teachers in Vocational Colleges to be used as a reference for the implementation of a more effective teaching process.

Research Objective

1.Identify ICT-based teachers teaching techniques among teachers of mechanical programs and vocational college manufacturing based on experts' consensus.

Research Question

1. What are the teaching techniques of ICT-based teachers of mechanical programs and the manufacture of vocational colleges based on experts' consensus?

RESEARCH METHODOGY

This is a quantitative as well as qualitative study involving 15 field experts (Adler & Zigler, 1996). The research instrument used is a set of questionnaires containing 10 items distributed to experts. To implement the Fuzzy Delphi technique in this study, the researchers first defined and arranged the modified items from the needs analysis in a more neat and orderly form to be scrutinized by expert panels.

Subsequently, the researchers determined a group of experts who agreed to contribute their expertise in expressing ideas, critiquing and improving the content of the items that had been determined by the researchers. The researchers distributed a set of questionnaires containing the items obtained through needs analysis. Experts are asked to state the level of agreement on each item whether Strongly Agree, Agree, Moderately Agree, Disagree and Strongly Disagree. After all the experts indicated their level of agreement, the experts then were also asked to provide their views on each item in the questionnaire. The data from the Likert Scale obtained were then translated into Fuzzy numerical data form and analysed using Microsoft Excel

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software.

This data analysis technique is known as Fuzzy Delphi technique or Fuzzy Delphi Method (FDM). Expert comments and suggestions are also taken into account to improve the items. This study also takes into account the views of 8 students and 2 lecturers. Data were obtained through semi-structured interviews based on the TUP Model (Roman Bednarik, 2002).

DISCUSSION

Data Collection and Analysis of *Fuzzy Delphi* Techniques

In the Fuzzy Delphi technique, there are two terms that need to be understood namely Triangular Fuzzy Number and Defuzzification process. The Triangular Fuzzy Number represents the values of m1, m2 and m3 and it is written like this (m1, m2, m3). The value of m1 represents the minimum value, the value of m2 represents the reasonable value while the value of m3 represents the maximum value. While the Triangular Fuzzy Number is used to produce a Fuzzy scale (similar to the Likert scale) for the purpose of translating linguistic variables into fuzzy numbers.

The levels for the Fuzzy scale are 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. It can be explained in Figure 1.

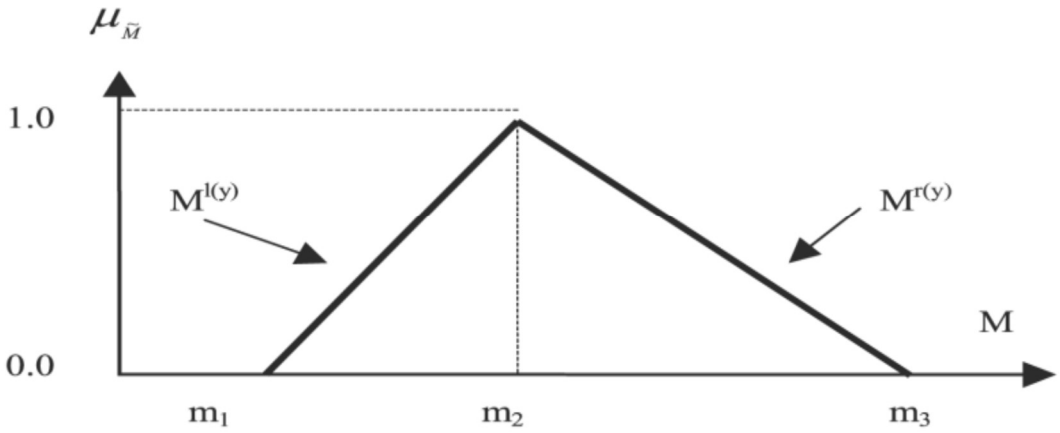

Figure 1. Fuzzy Scale Consent Level. Adapted from "Fuzzy Delphi in design research," by Mohd. Ridhuan Mohd. Jamil, Saedah Siraj, Zaharah Hussin, Nurul Rabihah Mat Noh & Ahmad Arifin Sapar, 2014. Kuala Lumpur: Intellectual Mind.

In this study, the Fuzzy Delphi technique collection and analysis process was implemented when experts were assigned items and each instrument was represented by a Likert scale as well as blank spaces for expert comments and suggestions. The Likert scale data obtained will be analysed using Excel program. All data is converted into Triangular Fuzzy Number form. A

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seven -point Fuzzy scale was used in this study. It can be seen in Table 1.

Table 1 : Seven Scales

BASIC CONSENSUS	FUZZY SCALES			LIKERT SCALE
7. Extremely Very Important	0.9	1	1	7
6. Very Important	0.7	0.9	1	6
5. Important	0.5	0.7	0.9	5
4. Quite Important	0.3	0.5	0.7	4
3. Unimportant	0.1	0.3	0.5	3
2. Very Unimportant	0	0.1	0.3	2
1. Extremely Unimportant	0	0	0.1	1

The data were then tabulated to obtain Fuzzy values (n1, n2, n3) as well as Fuzzy average values (m1, m2, m3) to obtain threshold values, expert consensus percentage, defuzzication and item ranking. For the purpose of obtaining expert agreement for each item, the threshold value does not exceed 0.2. The percentage of expert agreement should exceed the value of 75% while the defuzzication value for each item should exceed the value of α-cut = 0.5.

To obtain the threshold value, the distance between two Fuzzy numbers is determined using the following formula:

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

Figure 2 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 $d \leq 0.2$, it means that all experts reached agreement on the item. If otherwise, a second round should be made to see whether the item is needed or vice versa (Chen, 2000 and Cheng & Lin, 2002). The Fuzzy Delphi technique also involves the process of determining whether expert consensus exceeds or equals 75% for the entire construct or for each item. Each item is assumed to reach experts' consensus if the percentage of experts' agreement for the item is equal to or exceeds 75% (Chu & Hwang, 2008).

The defuzzification process was also performed in the data analysis process of the Fuzzy Delphi technique study. It is the process of determining the position or priority of each item or to determine the position of each variable or sub-variable. In this process, there are three formulas namely:

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

Value α-cut = median value for '0' and '1', where α-cut = (0+1)/2 = 0.5.

If the result of A value is less than the α-cut value = 0.5, the item will be rejected because it indicates experts' consensus in rejecting the item. However if the resulting A value is above the α-cut value = 0.5, then the item will be accepted because it indicates experts' consensus to accept the item in question (Bodjanova, 2006).

Rationale for using Fuzzy Delphi Technique

The rationale for applying Fuzzy Delphi technique is done in this study as it saves time and cost in handling the questionnaire compared to the usual Delphi technique. In addition, it also allows experts to fully give their views consistently (Mohd. Ridhuan Mohd. Jamil et al., 2013).

Fuzzy Delphi Experts ' Consensus on e-Tvet Teaching Techniques in Vocational Colleges.

Table 2
Teaching Techniques based on (e-Tvet) Model in Vocational Colleges

ITEM	
A1	Lecture
A2	Questioning
A3	Cooperative learning techniques
A4	Inquiry of findings
A5	Drill
A6	Project
A7	Problem solving
A8	Practical
A9	Teacher Guidance (Scaffolding)

The threshold values (d), percentage of experts' consensus, defuzzification and item ranking for the above items are shown in Table 3.

Table 3
Threshold value (d), percentage of experts' consensus, defuzzification and item ranking for Teaching Techniques.

EXPERT	**ITEMS**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	0.163	0.168	0.167	0.153	0.115	0.154	0.164	0.115	0.134

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2	0.143	0.186	0.147	0.111	0.142	0.138	0.73	0.143	0.165
3	0.167	0.432	0.154	0.163	0.157	0.141	0.421	0.155	0.167
4	0.186	0.134	0.181	0.131	0.132	0.176	0.156	0.113	0.175
5	0.141	0.167	0.131	0.173	0.113	0.118	0.146	0.117	0.164
6	0.123	0.123	0.165	0.132	0.131	0.153	0.155	0.158	0.186
7	0.121	0.196	0.123	0.133	0.126	0.132	0.154	0.133	0.154
8	0.167	0.167	0.161	0.136	0.167	0.165	0.111	0.161	0.192
9	0.105	0.156	0.117	0.111	0.432	0.357	0.157	0.167	0.134
10	0.178	0.168	0.176	0.168	0.156	0.165	0.134	0.465	0.186
11	0.186	0.171	0.178	0.165	0.134	0.144	0.168	0.167	0.128
12	0.152	0.197	0.153	0.152	0.174	0.158	0.161	0.147	0.135
13	0.112	0.156	0.114	0.175	0.142	0.183	0.144	0.154	0.156
14	0.141	0.123	0.131	0.137	0.136	0.133	0.153	0.181	0.153
15	0.132	0.195	0.487	0.146	0.162	0.156	0.187	0.131	0.161

Table 3 (continuation)

EXPERT	**ITEMS**									
	A1	A2	A3	A4	A5	A6	A7	A8	A9	
Experts' Consensus Percentage Based on Each Item	100%	93%	93%	100%	93	93%	93%	93%	93%	100%
Experts' Group Consensus Percentage for Entire Item	Expert Group Consensus Percentage = (129/135) x 100% = 95.5 % 129-total iem d≤0.2 135-15 expert × 9 item									
Defuzzification Value / Item Score Value	0.520	0.547	0.533	0.667	0.542	0.560	0.524	0.680	0.667	0.680
Position (ranking) Item	8	4	6	2	5	3	7	1	2	1

* Method 1: Item A1, A2, A4, A5, A6, A7 and A10 exceeds the threshold value (d) = 0.2
** Method 2: Experts' agreement percentage indicates that all items exceed 75%
*** Method 3: All defuzzification values for each item exceed the value of α-cut = 0.5

Based on Table 3, only items A3 and A5 have a threshold value of (d) ≤ 0.2. According to Cheng and Lin (2002), if the average value and expert rating are less than the threshold value of 0.2, the item has gained experts' consensus. Although the findings showed items A2, A3,

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A6, A7, A8 and A9 and exceeded the threshold value (d) = 0.2, but the percentage of experts' consensus showed that all items were above the value of 75%. All defuzzification values for each item also exceeded the α-cut value = 0.5. This shows that the opportunity items to implement teaching based on the e-Tvet model in Vocational Colleges obtain consensus from experts. Items are sorted by priority as shown in Table 4.

Table 4
Items of Teaching Techniques in order of priority

Sort by priority	**Items**	**Number Item**
1	Problem solving	**A8**
2	Teacher Guidance (Scaffolding)	**A10**
3	Inquiry of findings	**A4**
4	Practical	**A9**
5	Drill	**A6**
6	Questioning	**A2**
7	Cooperative learning techniques	**A3**
8	Project	**A7**
9	Lecture	**A1**

Table 5 shows the value of defuzification scores for the construct characteristics of ICT-based teaching implementation opportunities in Vocational Colleges. Based on the value of the defuzification score shows the position for each item that should be given priority by experts in implementing ICT-based teaching in Vocational Colleges.

Table 5
Teaching Technique items according to fuzzy evaluation values

Sort by priority	**Items**	***fuzzy evaluation Value***
1	Problem solving	**10.2**
1	Teacher Guidance (Scaffolding)	**10.2**
2	Inquiry of findings	**10.0**
2	Practical	**10.0**
3	Drill	**8.4**
4	Questioning	**8.2**
5	Cooperative learning techniques	**8.0**
6	Project	**7.9**
7	Lecture	**7.8**

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The results of the defuzification score values for each of the teaching technique item characteristics were seen to give an agreed value. Table 5 shows that problem solving items and teacher guidance (scaffolding) in the first place with a defuzification score value of 10.2. Followed by a discovery inquiry item with a defuzification value of 10.0. These two items are in the second rank. Next, the practical item with a defuzification score value of 10.0 is also ranked second.

Next was the drill item with a defuzification score value of 8.4 in the third position. The questioning item was in the fourth position with a defuzification score value of 8.2. For the fifth position of the case study item with a defuzification score value is 8.1. The next item was cooperative learning technique with a defuzification score value of 8.0 in the sixth position. The project item is ranked seventh and the last lecture item is ranked last which is eighth with defuzification score values of 7.9 and 7.8 respectively.

DISCUSSION AND CONCLUSION

The results of the analysis conducted showed that the item in the first position was the item of problem solving and teacher guidance (scaffolding) with a defuzification score value of 10.2. Hamdan and Mohd Yasin (2010) stated that the paradigm shifts of vocational college teachers in making changes to the implementation of the teaching process by using ICT as a teaching medium is a big challenge for teachers who are already well versed in the teaching method of "chalk and talk" which they have practiced for a very long period in their teaching career.

Rossyahida Abd Rahman and Hisyam (2011) argued that the use of technology with teacher guidance and problem-solving techniques in vocational education today seems appropriate in the development of ideas and creativity of students. If it is done in a planned and orderly manner as it will bring a change to the students. The item in the second position was the discovery inquiry item with a defuzification value of 10.0. Next, the practical item with a defuzification score value of 10.0 is also in the second rank.

Wahyudin, Sutikno and Isa, A (2012) in their study of physics students found that the use of websites developed by applying inquiry approach findings not only improved students' knowledge but also helped them to form understanding distinct to the topic being studied. Trianto (2007) stated that discovery inquiry learning technique is one of the methods that can be applied based on the constructivist approach where students develop an understanding with their own ideas. This process has made it easier for teachers to teach students as it has taught them their own strategies for learning. The item in the third position is the drill item with a defuzification score value of 8.4.

Next is the fourth position item, which is on questioning with a defuzification score value of 8.2. According to Chin (2007), the teacher's questioning method is an important and best interaction in the teaching and learning process but it depends on their level of understanding

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and feedback. This will be able to improve the cognitive ability of students. In addition, it can be the core to the construction of concepts, willingness to give statements and express feelings, involvement and self-confidence among students. This technique is implemented by the way the teachers submit questions related to the content of the lesson and students are required to respond accordingly.

The next item was cooperative learning technique with a defuzification score value of 8.0 in the sixth position. The project item is ranked seventh and the last lecture item is ranked last which is eighth with defuzification score values of 7.9 and 7.8 respectively.

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