Journal of
Creative Practices in Language Learning and Teaching (CPLT) Special Issue: *Generating New Knowledge through Best Practices in Computing and Mathematical Sciences*
Volume 7, Number 1, 2019

Evaluation of Students' Satisfaction on Learning Calculus using Fuzzy Conjoint Model

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Received: 22 May 2018. Accepted: 15 Feb 2019/Published online: 28 Feb 2019

ABSTRACT
Learning Calculus is one of the challenges that must be faced by engineering students in a university. In this study, students' satisfaction of using PowerPoint in learning Calculus was evaluated. There are several ways in analyzing effectiveness in learning Calculus. So far, not much attention has been given to analyzing evaluation of students' satisfaction from the fuzzy theory perspective. This paper employed the Fuzzy Conjoint Model to evaluate student's satisfaction in learning the topic 'integration' using PowerPoint application. The fuzzy conjoint model presents the linguistic terms in five-point Likert scale. In this model, three main attributes of learning were evaluated: anxiety, learning enjoyment and mobility. The sample of the study consisted of undergraduate students randomly selected from computer science and applied sciences program in the Universiti Teknologi MARA (UiTM) Pahang, Malaysia. The results of the study support the use of fuzzy conjoint model in the evaluation of student's satisfaction in learning Calculus.

Keywords: Calculus. Fuzzy Conjoint Model . PowerPoint

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1 INTRODUCTION

In the era of excellence in science and technology, applying the right technique in learning and teaching is crucial in the subject of Calculus. The learning and teaching of Calculus are both active process that very complex. Now, an understanding of Calculus learning has always been a challenging criterion for mathematic students. So, a committed lecturer will try to produce an outstanding student of excellence in the study of Calculus. Application of learning and teaching techniques in lectures such as the use of whiteboard and power point has been implemented. However, the evaluation students' satisfaction of using PowerPoint will be discussed whether PowerPoint usage is more effective in ensuring students are easy to understand Calculus learning. Previously, a studied by Othman et al. [1] stated that student's satisfaction using statistical model but most of the results obtained were unreliable. Therefore, there something needs to be upgrades with these results. This paper is proposed the use of fuzzy conjoint model to represent linguistic terms in five-point Likert scale and employ it into the analysis learning satisfaction by students.

The conjoint fuzzy model set is solely based on the fuzzy set priority model. Each characteristic measurement was presented in the form of a membership level that is believed to reflect the level of perception. Within this model, there are three main attributes; anxiety, learning enjoyment and mobility and their sub-criteria are defined. This paper divided into five sections. The paper is organized as follows. Section 2 gives description of the related topics in PowerPoint analysis using statistical model and fuzzy approach. It also includes some descriptions of fuzzy conjoint model used by other researchers to evaluate customer satisfaction. Section 3 proposes a computational framework and gives description of the fuzzy set and fuzzy conjoint model. Section 4 describes the experimental results of existing model and discussion. Finally, in Section 5 the conclusions are presented.

2 PRELIMINARIES

PowerPoint is an application that is widely used for the presentation. It is a product of Microsoft which is a part of Microsoft Office. As one of the famous technology tool being used in many areas especially the education, some researches have proved that PowerPoint gives some positive effect on its application. For example, Erdemir [2] stated that PowerPoint helps in increasing the student's successfulness. Experiment which has been done on physic course proved that, PowerPoint help student to under-stand and interpret terms, principle and concept better. Besides, it also improved student concentration and stay focus through colored graphic and symbol. Cheng [3] said that PowerPoint helps in improving the interaction between teacher and student and it developed the spoken ability, logic and synthetical qualities of a student. Different models have been developed by researchers to evaluate the effectiveness of PowerPoint in learning compared to the traditional model of teaching. One of the models is by calculating the mean and standard deviation score of the student post-test mark [2, 4]. The result of the calculation shows the experimental group using PowerPoint as a tool of learning has a better performance. On the other hand, Shigli et. al [5] applied t-test and McNamara test to evaluate the

different of overall score and to find the improvement of questionnaire's correct answer. The combination of mean estimation and cluster analysis is used to measure the result of every questionnaire item [3]. Meanwhile another research used percentage in evaluate the questionnaire result [6]. Both research show that PowerPoint has an outstanding effect of effectiveness and give a better way to organize the information in learning process.

Another model that is being chosen by researcher because of its precise evaluation is fuzzy analysis. Fuzzy analysis has been used by some of the researcher in evaluating the effectiveness of learning process. Owusu-Agyaman et. al [7] applied fuzzy analytic hierarchy process to evaluate data which was gathered from a survey. On the other hand, a study in fuzzy evaluation model has a potential to be an efficient measurement for subjective performance. In this paper, fuzzy set theory was proposed to evaluate the quality of teaching in science course. The result from the evaluation can be used to rank the quality of teaching [8]. Evaluation of student performance is done by using fuzzy logic. As one of the mathematical tool, fuzzy model was developed in performance evaluation, test it and compared the performance result with traditional evaluating performance model. This study proved that evaluation using fuzzy logic is better than the traditional model. Fuzzy logic system is being compared with the classical evaluating model in evaluating the student's performance [9]. The use of fuzzy logic gives advantage as it is flexible and provides an evaluation option. The rule in fuzzy logic membership can be changed to get the different performance. This is complement to classical evaluating model where it follows strictly to a constant mathematical rule.

In the evaluation process with fuzzy conjoint approach, Lazim and Wahab [10] used and paired comparison of the criteria made by the system to evaluate the ferry service quality. Then, it required processes completed on the weight of each criterion and the conclusion was reached. The results facilitated the ferry operator to upgrades their service and meet their customer needs. In 2011 the study extends re-search to evaluate students' satisfaction on learning computer algebra system (CAS) using the same approach. The result shows that the fuzzy approach was successfully implemented in evaluate student's satisfaction towards learning CAS [11].

Besides, there is another study using the same model to evaluate the level of satisfaction of employers on graduate's performance [12]. The finding shows that the useful information for decision making made by the employers and to be enhance by engineering students to get employ. Chang et. al [13] employed fuzzy multi-criteria analysis model to evaluate the quality service of domestic airlines and the model was solved using effective algorithm which integrate the predilection of customer's assessment on criteria weights and performance ratings.
Until recently, there is study in the integration of fuzzy logic and fuzzy conjoint model to measure the job satisfaction. The results obtained by fuzzy conjoint was the best results and been recommended to be used in analyzing the satisfaction in job performance [14, 15].

3 METHODOLOGY

The sample of this study was conducted on 48 undergraduate students randomly selected from applied and computer sciences program in UiTM Pahang Branch, Malaysia [1]. After two hours lectured using PowerPoint application in learning Calculus, questionnaire was distributed. Students were asked to fill the questionnaire in the form of five-Likert scale that representing the different levels of satisfactory (very disagree, disagree, undecided, agree, very agree). There are three main attributes; anxiety, learning enjoyment and mobility and their sub-criteria are defined. The code name of each criterion is presented in Table 1. Finally, the collected data was analysed using fuzzy conjoint analysis.

Table 1. Main/sub criteria in the evaluation process

Criteria	Code Name	Sub-criteria	Code Name
Self-Confidence (Anxiety)	C_1	I'm still afraid of integration	C_{11}
		Integration still makes me nervous	C_{12}
		I'm still not able to solve integration by myself	C_{13}
		I'm still not confident in solving integration problems	C_{14}
		I'm more confident in solving integration problems if my friends are around	C_{15}
		I have a better understanding of integration now	C_{16}
Affective (Learning Enjoyment)	C_2	I like learning integration using PPT	C_{21}
		I enjoy learning integration using PPT more than the traditional 'chalk-board'	C_{22}
		I'm still bored with integration topics	C_{23}
		I'm excited learning integration with the use of technology	C_{24}
		Historical facts about integration in PPT presentation is so interesting	C_{25}
		The video attached to the PPT presentation helps in learning integration	C_{26}
		Now I know the historical figures behind the models of integration	C_{27}
		I'm more interested in learning integration by the use of colourful graphics in PPT	C_{28}
		Learning integration is now enjoyable	C_{29}
Affective (Mobility)	C_3	It is easy to obtain and carry around PPT notes on integration	C_{31}
		Internet connection is not needed to watch the PPT presentation on integration	C_{32}
		I am able to repeat watching the PPT presentation to enhance my understanding whenever I want	C_{33}

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3.1 Fuzzy Set

Fuzzy set is typically defined as a collection of elements (normally termed as crisp set in the literature) [15] or a class of objects with a continuum of grades of member-ship. It had been

developed to solve problems in which the explanation of activities are imprecise, vague and uncertainty [16, 17].

3.1.1 Membership Function

A characteristic of membership function is an interval between zero and one. A value approaching one means true and a value approaching zero means is closer to not true. The membership function of triangular fuzzy number coefficients represented $R=(l,m,u)$ can be defined as follows:

$$\mu_R(x)=\begin{cases}0, & x<l\\ \dfrac{x-l}{m-l}, & l\le x\le m\\ \dfrac{u-x}{u-m}, & m\le x\le u\\ 0, & x>u\end{cases} \qquad (1)$$

3.1.2 Defining Linguistic Variable

The linguistic variable defined as a concept of linguistic variable is valuable in deal-ing with situations which are too complicated or too unclear to be reasonably de-scribed in conventional quantitative expression [17, 18]. The example for this linguistic variable is 'students' satisfaction using PowerPoint in learning integration topics'. It describes to explore students learning experience using PowerPoint presentation in classroom. In this study, the possible values such as 'Very Disagree', 'Disagree', 'Undecided', 'Agree' and 'Very Agree' shown in Table 2 with their membership function for linguistic variables measured using a five-point Likert scale.
For obtaining the value of membership for each criterion (in terms of a linguistic variable), this study used the membership function from Yusoff et. al [12]. The number 0.5/3 is read as 0.5 at level 3.

Table 2. Membership functions for linguistic variables.

Level of satisfaction	Linguistic variables	Membership function
1	Very Disagree (V.D.)	{1/1 0.75/2 0.5/3 0/4 0/5}
2	Disagree (D.)	{0.5/1 1/2 0.75/3 0.25/4 0/5}
3	Undecided (U.)	{0/1 0.5/2 1/3 0.5/4 0/5}
4	Agree (A.)	{0/1 0.25/2 0.75/3 1/4 0.5/5}
5	Very Agree (V.A)	{0/1 0/2 0.5/3 0.75/4 1/5}

3.2 Fuzzy Conjoint Model

In order to evaluate students' satisfaction of using PowerPoint in learning Calculus, fuzzy conjoint method was used. Conjoint model is a model proposed by Tuksen and Willson [19],

used as a model to analyses consumer preferences. The member-ship degree for linguistic label/terms representing item is defined as follows:

(2)

$$\mu_R(y_j, A) = \sum_{i=1}^{n} \left(\frac{w_i}{\sum w_i} \right) \times \mu_{F_i}(x_j, A) \quad (2)$$

Where

w_i = score of linguistic value given by several respondents

$\frac{w_i}{\sum w_i}$ = weight that represent level of satisfaction

$\mu_{F_i}(x_j, A)$ = membership degree for respondent j for item A according linguistic label $x_j = 1,2,...,n$,

n = number of respondent

A = an item/a question

3.2.1 Degree of Similarity

The membership value degree given in Eqn. 2 represent the fuzzy set of response by respondents is then compared to fuzzy set defined by expert. This can be conducted using fuzzy similarity measured proposed by Tuksen and Willson [19] involved the calculation of Euclidean distance between two fuzzy sets calculated as follows:

$$Sim(R_i(y_j, A), F(x_j, l)) = \frac{1}{\left[1 + \sqrt{\sum_{j=1}^{n} \left(\mu_{R_i}(y_j, A) - \mu_F(x_j, l) \right)^2} \right]} \quad (3)$$

Where

$R_i(y_j, A)$ = fuzzy sets determined using the responses of respondents

$F(x_j, l)$ = standard fuzzy sets determined for linguistic label l

$\mu_{R_i}(y_j, A)$ = calculated overall value of membership functions

$\mu_F(x_j, l)$ = fuzzy set defined for linguistic rating

The similarity is computed for every criterion for each level linguistic label/terms. The result of similarity rate is range from 0 to 1. The outcome from this calculation is determined based on maximum similarity value for each level.

4 FINDING AND DISCUSSION

Table 3, 4 and 5 showed the fuzzy similarity values of students' responses on how they perceive regarding the use of PowerPoint in learning integration. The decision made for each sub-criterion is obtained by the highest value on each agreement level.

Table 3. Fuzzy similarity values based on anxiety.

Code Name	Very Disagree	Disagree	Unsure	Agree	Very Agree	Decision
C_{11}	0.4683	0.4700	0.4718	0.4747	0.4754	Very Agree
C_{12}	0.4594	0.4609	0.4627	0.4655	0.4661	Very Agree
C_{13}	0.4595	0.4611	0.4630	0.4655	0.4656	Very Agree
C_{14}	0.4629	0.4647	0.4666	0.4692	0.4694	Very Agree
C_{15}	0.4468	0.4482	0.4498	0.4524	0.4530	Very Agree
C_{16}	0.4553	0.4571	0.4590	0.4613	0.4611	Agree

The overall result presented in Table 3 showed that students were not satisfied with their self-confident (anxiety) in learning integration topics using PowerPoint. The outcomes using fuzzy conjoint model showed that students were very agreed with felt afraid of integration, felt nervous about integration, not be able to solve integration by themselves and in the opinion, that they were more confident in solving problems in group discussion. In general, based on these findings, there was no significant evidence that the PowerPoint presentations on integration have succeeded in reducing student's anxiety in Integration topics.

Table 4. Fuzzy similarity values based on learning enjoyment

Code Name	**Very Disagree**	**Disagree**	**Unsure**	**Agree**	**Very Agree**	**Decision**
C_{21}	0.4663	0.4682	0.4702	0.4730	0.4732	Very Agree
C_{22}	0.4512	0.4525	0.4542	0.4568	0.4575	Very Agree
C_{23}	0.4620	0.4644	0.4665	0.4685	0.4676	Agree
C_{24}	0.4630	0.4650	0.4670	0.4694	0.4693	Agree
C_{25}	0.4627	0.4649	0.4669	0.4693	0.4688	Agree
C_{26}	0.4631	0.4647	0.4665	0.4697	0.4706	Very Agree
C_{27}	0.4665	0.4690	0.4711	0.4735	0.4727	Agree
C_{28}	0.4523	0.4539	0.4557	0.4583	0.4584	Very Agree
C_{29}	0.4660	0.4680	0.4701	0.4727	0.4727	Very Agree

Table 4 showed that students satisfaction in learning enjoyment. The results re-vealed that using fuzzy conjoint model, students were very agreed in learning integra-tion using PowerPoint application is more enjoyable than using the traditional 'Chalkboard' because the video added in it. They also very agreed that the use of colorful graphics made learning more interesting. They

also agreed that the historical facts were interesting because of the historical figures in the development of Calculus. In conclusion, most students agreed that PowerPoint presentations on integration made learning enjoyable.

Table 5. Fuzzy similarity values based on mobility

Code Name		Disagree	Unsure	Agree	Very Agree	Decision
C_{31}	0.4429	0.4442	0.4458	0.4483	0.4487	Very Agree
C_{32}	0.4409	0.4422	0.4438	0.4462	0.4466	Very Agree
C_{33}	0.4389	0.4401	0.4416	0.4441	0.4447	Very Agree

As can be seen from Table 5, result by fuzzy conjoint model shows majority of the students very agreed to the comfort of usage of the PowerPoint notes. In summary, they like to use PowerPoint application anywhere and anytime they want.

5 CONCLUSION

This study presents an investigation about the evaluation of students' satisfaction of using PowerPoint on learning Calculus using Fuzzy Conjoint Model. In this paper, students' satisfactions of using PowerPoint have been evaluated according to three main attributes and their sub-criteria. Fuzzy similarities values based on anxiety, learning enjoyment, and mobility have been calculated and evaluated by the highest value on each agreement level. In this research has proven that using fuzzy conjoint method has given the expected result and suitable in evaluate of students' satisfaction, the result was very noteworthy. It was clearly show that students like to use PowerPoint application anywhere and anytime they want when learning. Student's previous learning had been overlook by traditional method which is chalk and board as their learning method and it varies with the 21st century learning approaches. Thus, it is challenges for experts to find another learning method or another application that can improve their anxiety towards learning mathematics. The results obtained in the study also can inform lecturers about how they should provide the best method in teaching and learning Calculus and improve mathematics instruction in higher education level.

ACKNOWLEDGMENTS

We are indebted to 48 undergraduate students randomly selected from applied and computer sciences program in UiTM Pahang Branch, Malaysia for the data provided in this research.

Ethical approval

The data collected in this study was approved by the Faculty of Computer and Mathematical Sciences, UiTM Pahang Branch, Malaysia.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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