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A Conjoint Analysis on Students' Choice of Mathematics Instruction

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ABSTRACT

Individuals' differences in terms of their interest, intellectual capacity, and valuing excellent teaching of mathematics contribute to the toughness in designing and developing effective strategies. This study analyzes students' preference of mathematics instruction using conjoint analysis. It was sometimes called "trade-off analysis" which reveals on how individuals' draw critical judgements on a certain product or service. There are 271 respondents in the survey asking them to choose different factors of mathematics instruction. The respondents ranked the four attributes as follows: instructional method, assessment type, instructional medium/media, and instructional activity. The set of instruction that students prefer is the instruction profile that is composed of lecture discussion, chalk/marker and board, problem solving, and learner focused. Demographic and psychographic segmentation showed that freshmen female BSEDMand sophomore female BSCE students, BSEDM who are members of SGO with an average GPA of 1.99, and non-scholar BSCE students choose all instruction profiles. Another group of students taking BSMBF and are STUFAPS scholars with average GPA of 1.95 chose instruction Profile 1 and the other group of senior and sophomore male non-scholar civil engineering students choose instruction Profile 5. Instruction profile 1 is composed of lecture-discussion, chalk/marker and board, problem solving, and learner focused while instruction Profile 5 is composed of cooperative learning, chalk/marker and board, problem solving, and learner focused. In the simulation, the profile that gained the greatest share is instruction Profile 6 which is composed of lecture-discussion, chalk/marker, solving mathematics expression, and learner-focused. Evident information found in this study conclude that students look forward for a set of instruction that would make the class interactive, challenging, and of course informative.

Keywords: Conjoint analysis, Mathematics education, Psychographic segmentation, Trade off analysis, Trade offs students,

INTRODUCTION

Incessant quality improvement of the educational process and its modernization are some of the most important factors for ensuring the achievement of educational institutions (Popovic et.al., 2015). According to Safer & Fleischman (2005), school achievement is defined as ensuring achievement for every student. That is why educators and administrators find ways just to reach this. But due to fast changing strategies and rapid innovations of curriculum including instruction improvement, effective methodologies for teaching is difficult to determine (Hagos & Dejarme, 2008).

Teaching and learning mathematics are complex tasks. Hodara (2013) stated that there are no national studies in United States that document the common features of math instruction in developmental and college math courses. In mathematics psychology, Mathematics is more clearly bounded and better defined than any other subject taught in school (Seigler, 1983). Resnick & Ford added that indeed, mathematics provides favorable domain for research and for the application of research to instruction. Literatures commonly stated that in the past years, finding effective mathematics instruction has been the problem of the administrators and educators due to fact that students value various aspects of excellent teaching differently (Kuzmanovic et. al., 2012) both in secondary and tertiary levels of education.However, studies which seek to evaluate effective instruction styles and strategies are numerous but research that analyzes students' preferences for various methodologies using conjoint analysis are less (Garcia-Ros et.al., 2008).

The context of this study falls likely to the existing studies that analyze the students' preferences of an instruction. This study sought to determine and analyze the students' choice of mathematics instruction using full profile conjoint analysis. Conjoint analysis is a multivariate technique used to analyze the structure of individuals' preferences and is the most appropriate method to elicit those preferences (Kuzmanovic et al., 2012). This study used full profile conjoint analysis. Students as the respondents were asked to rate and rank experimentally controlled combinations of attribute levels called profile. There were very few studies that explicitly address tertiary mathematics learning difficulties, but several do this implicitly (Lithner, 2011). These difficulties could be the accumulations of lack of knowledge from primary to secondary or the dynamic changes of teaching approaches. The notion of difficulty is not really determined. In Sweden, clear signs of difficulties and deficient mathematical competence were detected even among those who pass their mathematics courses (Lithner, 2011).

This study was more concerned with the students' choice towards mathematics instruction. That is important to consider the choice of the students to avoid mismatch of teaching and learning styles (Wilson, 2011). This was also a means of meeting the level and need of the students since the students' point of view will be heard and likely the study will be focused to the students' side. Moreover, this could help alleviate students' mathematics deficiency of understanding since the solution will come from them. The main objective of this study was to determine the students' choice of mathematics instruction using full profile conjoint analysis. This study will be significant to the educators, administrators, lecturers, and policy makers in the field of mathematics. For the outcome of this research it will help them improve their strategy and approach in teaching mathematics in line with the student's preferred way of instruction.

METHODOLOGY

The research technique used in this study was conjoint analysis. Conjoint analysis was originally applied in mathematical psychology which known as best in eliciting preferences (Green & Srinivasan, 1978). This statistical tool is used to study the factors that influence consumers'purchasing decisions (Kuhfeld, 2010). This involves identifying attribute and attribute levels, generating experimental design, utility calculation, market simulation and mass segmentation. Specifically, this study used full profile conjoint analysis. This study falls under quantitative research design since this study determined the students' choice of mathematics instruction. The students' choice was quantitative in a sense that scoring was used to rate each instruction profile to determine the most preferred set of instruction. Survey questionnaire was used in the data gathering and statistical methods were used in analyzing them the information.

Sampling

In this study, 95% level of confidence was applied. The sample respondents denoted n was computed below by substituting the value of the population size (N) which is 840. This was the total number of Engineering, Mathematics, and Education major in Mathematics student in DOSCST. And also e with 0.05 which also means a 5% margin of error.

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{840}{1 + (840)(0.05)^2}$$

$$n = \frac{840}{3.1}$$

$$n = 271$$

Representative samples for each program was obtained using stratified random sampling. Stratified random sampling is a sampling technique that allows division of population size into smaller groups called strata (Hunt & Tyrrell, 2001). Proportionate allocation was used to get the representative sample. The BSCE, BSEE, BSGE, and BSMEE programs were grouped. The details are shown in Table 1.

Table 1. The number of population and their representative each program.

Program	Population	Sample
Engineering (BSCE, BSEE, BSGE, & BSMEE)	478	154
Mathematics (BSMBF & BSMRS)	185	60
Education major in Mathematics (BSEDM)	177	57
Total	**840**	**271**

DATA COLLECTION

The data gathered in this study were both qualitative and quantitative. The qualitative data are the respondents' demographic profile, psychographic profile and their opinions regarding the factors that influence their choice of mathematics instruction (Pre-survey for the attributes). On the other hand, the quantitative data are the students' choice of mathematics instruction.

The data were collected during the second semester in the academic year 2015-2016, at Davao Oriental State College of Science and Technology. Survey questionnaires were used as instrument for data collection. The questionnaire also underwent expert validation and evaluation. The purpose of this process was to ensure that the questionnaires used in the final survey was valid and reliable. Moreover, this would also help improve the items that were needed to be revised for the sufficiency of the tool. Also, it was tested through a pilot study to measure its reliability.

Table 2. Average ratings for questionnaire validation.

Items	Average Rating
Clarity of directions and items	478
Presentation and organizations	4.3
Suitability of items	4.7
Adequateness of items per category of indicator	5
Attainment of the purpose	4.7
Objectivity	4.7
Scales and evaluation rating scale	4.7

5 – Excellent 4-4.9 – Very good 3-3.9 – Good 2-2.9 – Fair 1-1.9 – Poor

The overall rating for the questionnaire was "very good" as what can be observed in Table 3. In the reliability test also found in Table 4, the Cronbach's alpha based on number of items of 55 was 0.735. Cronbach's alpha measures the internal consistency of each item, based on the average inter-item correlation. According to Tavakol & Dennick (2011), there are different reports about the acceptability of Cronbach's alpha ranging from 0.70 to 0.95. Cronbach's alpha with values 0.7 to 0.8 are regarded as satisfactory according to Bland (1997). A maximum alpha value of 0.90 has been recommended according to Streiner as cited by Tavakol & Dennick (2011) and high values of alpha, those alpha values which are greater than 0.90 suggest redundancies and show that the test length should be shortened (Tavakol & Dennick, 2011). In this study, the value of alpha is 0.735 which means that the items in the questionnaire were acceptable. In other words, there is an internal consistency between each item in the questionnaire.

Data Analyses

Conjoint analysis enables institutions and companies to decompose respondents' preferences for products and services into "part-worth" associated with each level of each attribute. Full profile studies allow for the estimation of interaction terms and generally present more realistic choices to the respondent than partial profile or self-explicated approaches (Figure 2).

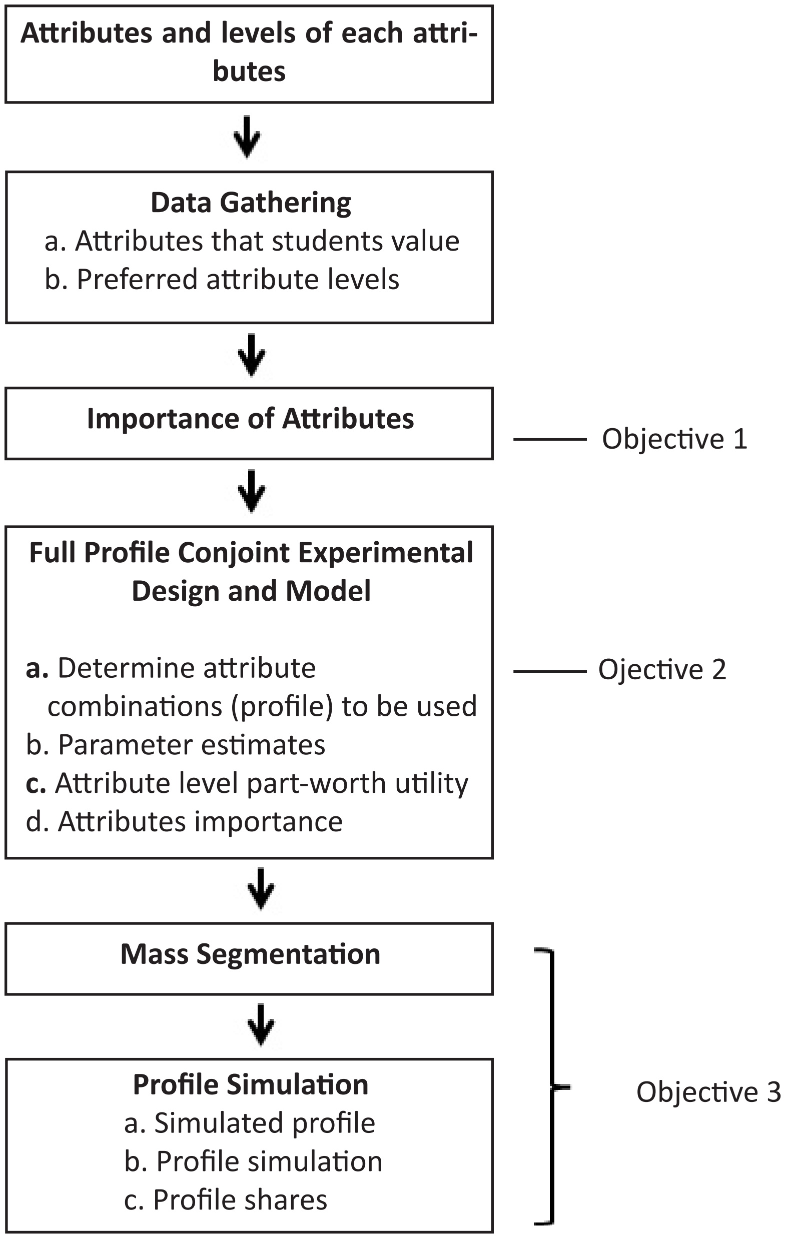

Figure 1. Flow diagram of data analysis

Importance of Attributes

The attributes were determined based on existing literatures and pre-survey. The respondents were asked to rank the attributes according to level of importance, 1 as the most important, 2 as important, 3 as not so important and 4 as the least important. By that through direct ranking, importance within attributes can be determined.

Table 4. List of attributes and attribute levels.

Attributes	Levels
Instructional method	Lecture type Lecture-discussion

	Cooperative learning
	Problem-based and Inquiry learning
	Independent study
	Book/Hand-outs
Instructional media	Chalk/Marker and board
	Video presentation
	PowerPoint presentation
Assessment type	Higher level multiple-choice question
	Problem solving
	Solving mathematics expressions
	Teacher-focused
Instructional activity	Learner-focused

RESULTS AND DISCUSSION

Importance of the attributes

The importance value of the four attributes: instructional method, instructional medium/media, assessment type, and instructional activity, was determined by asking the respondents to rank them.

Table 4. The importance of the attributes of mathematics instruction.

	Cluster 1	**Cluster 2**
Size	144 (53.1%)	127 (46.9%)
Inputs	Instructional Method 2 (50.0%)	Instructional Method 1 (87.4%)
	Assessment Type 1 (38.2%)	Assessment Type 3 (40.9%)
	Instructional Medium/Media 1 (34.0%)	Instructional Medium/Media 2 (40.2%)
	Instructional Activity 3 (30.6%)	Instructional Activity 2 (31.5%)

Table 4 shows that there were two clusters found. The first cluster was composed of 144 students or 53.1% of the total respondents and the second one was composed of 127 students or 46.9% of the total respondents.

In cluster 1, 38.2% of the respondents ranked assessment type as first, 30.6% of them ranked instructional activity also as first, 50% ranked instructional method as second, and 34% ranked the instructional medium/media as the third. In cluster 2, 87.4% of the respondents ranked the instructional method as the first, 40.2% also ranked instructional medium/media as first, 31.5% ranked instructional activity as the second, and 40.9% ranked assessment type as the third.

Figure 2 shows the cluster predictor importance of the attributes according to rank order. Instructional method was considered as the most important attributes in choosing mathematics instruction to students followed by instructional media, then assessment type and last was the instructional activity. Meaning, the students look first to the method that the teacher used in teaching mathematics. Instructional method refers to the strategy that the instructor used in transferring the learning to students. On the other hand, they least consider the instructional activity in choosing a math instruction which refers to objective focus of every activity the instructor gives.

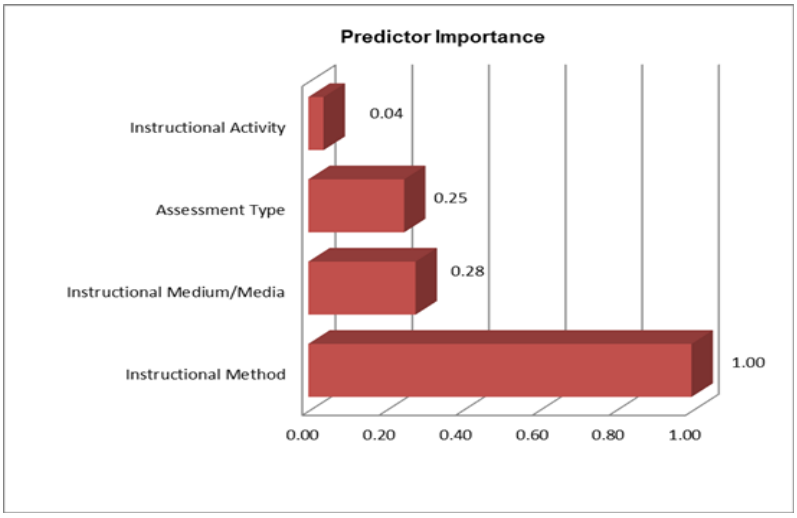

Figure 2. Predictor importance of attributes in mathematics instruction preference.

Full profile conjoint experimental design and model

The randomized experimental design of full profile conjoint analysis generated 25 cards for rating by the respondents. Five of which were the top instruction profiles determined from the part 1 survey. Full profile conjoint analysis model involves estimation of parameters, attribute importance prediction, and individual part-worth utility of attribute levels. There are 14 individual parameters estimated (Table 5). Among the individual attribute levels, chalk/marker and board under instructional medium/media gained the highest part-worth utility value which is 19.953 followed by lecture-discussion under instructional method which gained 14.344 part-worth utility. This means that students highly prefer these attribute levels because the greater the utility value, the greater the preference by the respondents. Also, cooperative learning, problem-based and inquiry learning, chalk/marker and board, problem solving as well as learner-focused attribute levels gained a positive utility value. Attribute levels such as lecture type, independent study, book/hand-outs, video presentation, higher level multiple-choice question, and teacher-focused gained negative part-worth utility values and among them, teacher-focused gained the least estimation of part-worth utility which is -9.422. The negative value of part-worth utility estimates implies that students lesser preferred those levels of attributes compared to the attributes that gained positive utility values.

Table 5. Individual attribute levels utilities.

Attribute	Attribute Levels	Utility Estimate
Instructional Method	Lecture type	-7.538
	Lecture-discussion	14.344
	Cooperative learning	.418
	Problem-based and Inquiry learning	.314
	Independent study	-7.538
Instructional Medium/Media	Book/Hand-outs	-3.484
	Chalk/Marker and board	19.953
	Video presentation	-8.234
	PowerPoint presentation	-8.234
Assessment Type	Higher level multiple-choice question	-2.663
	Problem solving	8.945
	Solving mathematics expression	-6.281
Instructional Activity	Teacher-focused	-9.422
	Learner-focused	9.422

The succeeding figures are the utilities of attribute levels within an attribute. In Figure 3, the attribute levels lecture type and independent study gained a negative part-worth utility value, both -7.538 respectively. Among the attribute levels of instructional method, lecture-discussion garnered the greatest part-worth utility value which is 14.344 followed by cooperative learning with 0.418 utility value, problem-based and inquiry learning, 0.314 utility value respectively.

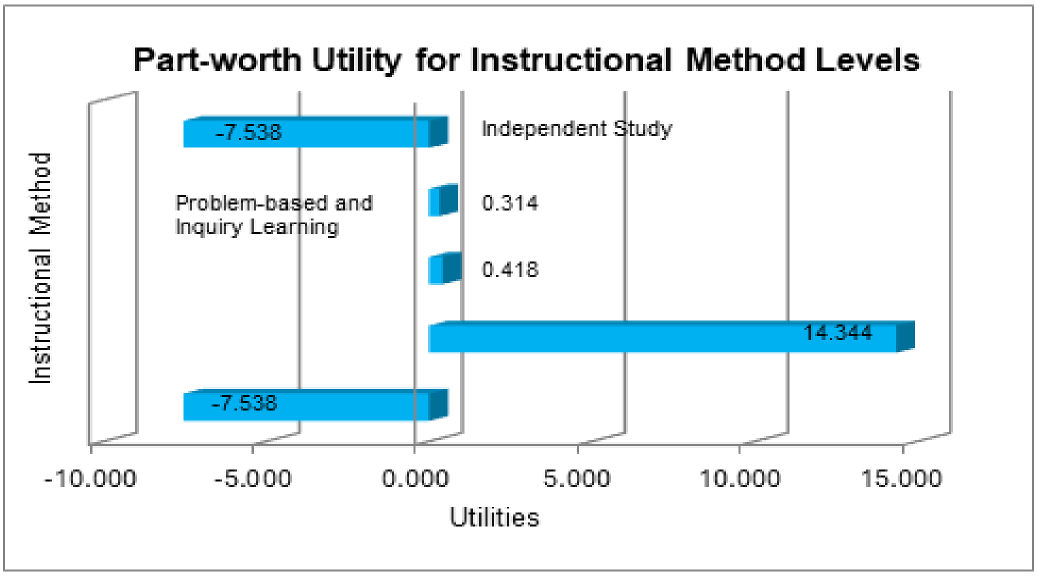

Figure 3. Part-worth utility for the levels of instructional method.

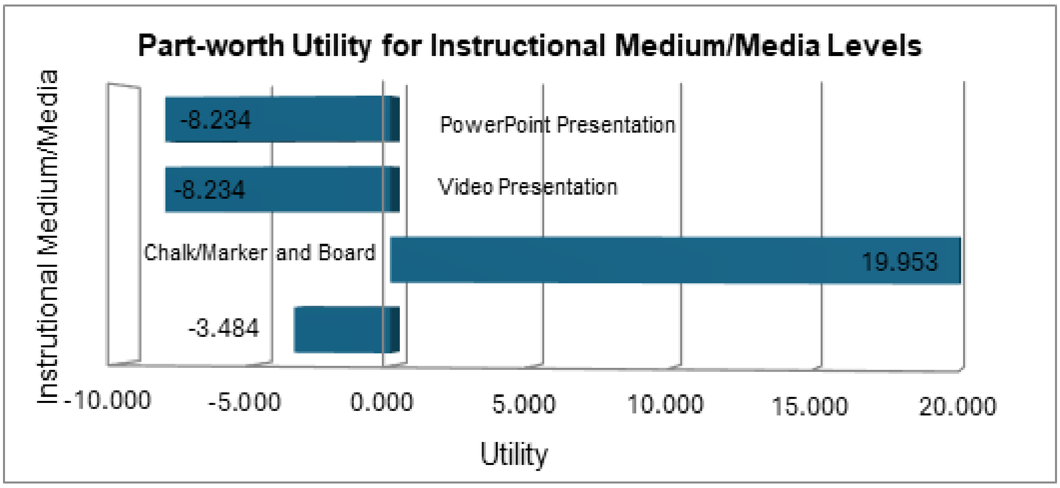

Figure 4. Part-worth utility for the levels of instructional medium/media.

For the attribute levels of instructional medium/media (Figure 4), students preferred the chalk/marker and board which garnered 19.953 part-worth utility value. Book/hand-outs gained -3.484, and video presentation and PowerPoint presentation gained -8.234.

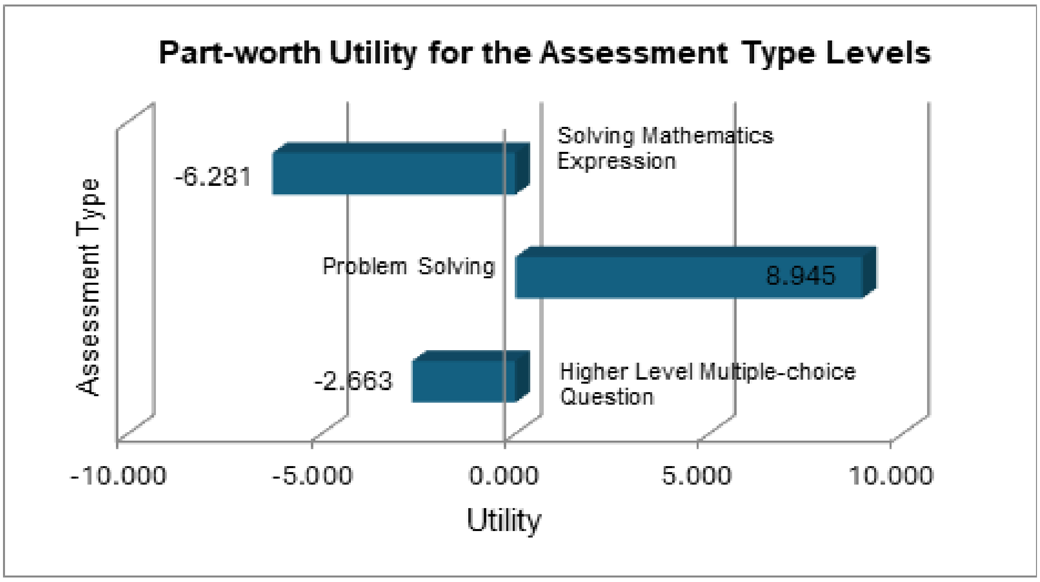

Figure 5. Part-worth utility for the levels of assessment type.

In Figure 5, the attribute level which showed the greatest utility is the problem-solving type of assessment which also implies greater preference from the students. Problem solving gained 8.945 part-worth utility while higher level multiple-choice question gained -6.281 and solving mathematics expression, -2.633.

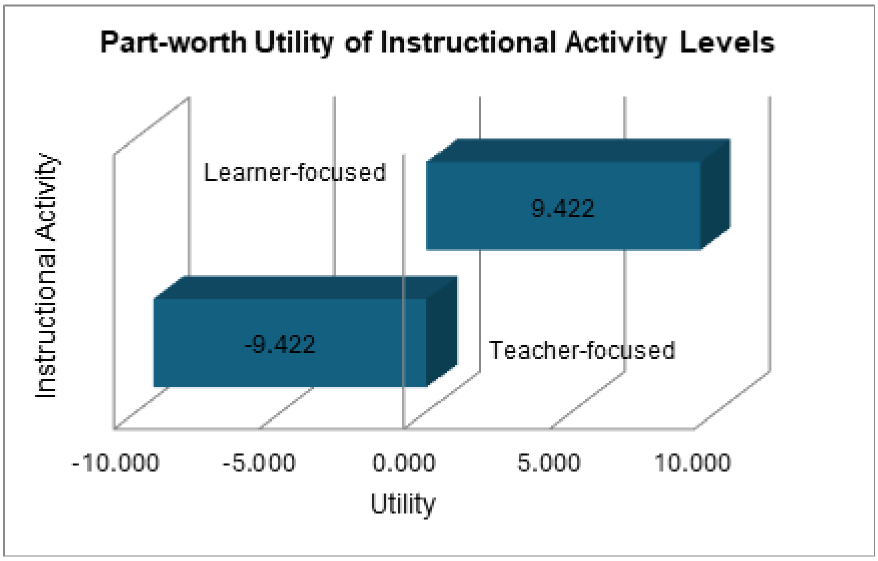

Figure 6. Part-worth utility for the levels of instructional activity.

For the part-worth utility value of the levels of instructional activity, learner-focused gained the greater preference over teacher-focused. In the five profile combinations that the students have preferred, we can notice that none of the cards have teacher-focused as the preferred instructional activity. Hence it is expected that one of the two levels would really gain a negative value. The learner-focused gained 9.422 while the teacher-focused gained -9.422 (Figure 6).

Table 6. Averaged importance values of each attribute.

Importance Values	
Attributes	**Utility value**
Instructional method	26.0106
Instructional Medium/Media	33.501
Assessment Type	18.09610
Instructional Activity	22.39640

The range of the utility values for each attribute provides a measure of how important the factor was to overall preference. This is generated through aggregation of all students' responses. The greater will be its utility ranges, the more significance it is to those with smaller ranges (IBM SPSS 20, 2011). In this study, the most important characteristic for the students is instructional medium/media with 33.501 utility value, followed by instructional method with 26.006, then instructional activity with 22.369, and last is the assessment type with 18.096 respectively (Table 6 and Figure 7).

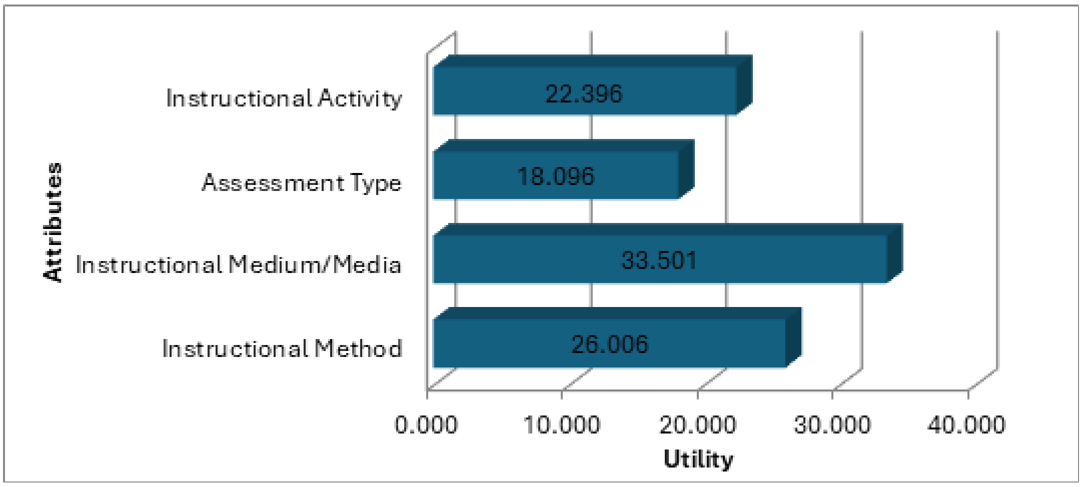

Figure 7. Averaged importance values of each attribute

Mass Segmentation and profile simulation

Mass Segmentation

All factors from the students' demographic and psychographic profile are tested. Those clusters with fair or good cluster quality, which were considered as acceptable clusters, were presented. Statistical software was used to run the factors. Since this is a full profile conjoint study, their choice according to their ratings was determined first so that it can be included in the factors too. Their preferred card or cards were labeled as Preferred Instruction Profile.

The clusters are the following:

1. **Cluster A** is featured with the following inputs:
   Gender, Course, Year Level, and Preferred Instruction Profile.

2. **Cluster B** is featured with the following inputs:
   Course, Scholarship, Year Level, and Preferred Instruction Profile.

3. **Cluster C** is featured with the following inputs:
   Course, Scholarship, GPA, and Preferred Instruction Profile.

4. **Cluster D** is featured with the following inputs:
   Affiliation, GPA, Course and Preferred Instruction Profile.

5. **Cluster E** is featured with the following inputs:
   Course, Scholarship, Gender and Preferred Instruction Profile.

6. **Cluster F** is featured with the following inputs:
   Year Level, Affiliation, GPA and Preferred Instruction Profile.

The model summary indicates that three (3) clusters were found based on the four (4) input features assigned which are the students' gender, course, year level and preferred instruction profile. The cluster quality indicates that the overall model quality is in the "Fair" range.

Table 7. Clusters based on students' gender, course, year level, and preferred instruction profile.

Cluster	Size	Inputs			
1	31.7% (86)	Gender (Male -100%)	Course (BSCE- 86%	Year Level (2nd – 31.4%)	Preferred Instruction Profile (All – 22.1%)
2	32.8% (89)	Gender (Female -100%)	Course (BSCE- 57.3%	Year Level (2nd – 25.8%)	Preferred Instruction Profile (All – 18%)
3	35.4% (96)	Gender (Female -53.1%)	Course (BSEDM- 59.4%)	Year Level (1st – 57.3%)	Preferred Instruction Profile (All – 20.8%)

First Cluster: In Table 7, it can be observed that there are 86 (31.7% of the total respondents) who are composed of male sophomore civil engineering students. Their preferred instruction profile is number 5 which consist of: cooperative learning as the method, chalk/marker and board as the media, problem solving as the assessment type and learner-focused as the instructional activity in teaching mathematics subject.

Second Cluster: Cluster 2 is composed of 89 (32.8% of the total respondents) who are sophomore female civil engineering students and preferred all instruction profiles. Therefore, any of the methods, media, assessment type and instructional activity will do in teaching mathematics.

Third Cluster: In cluster 3, 96 (35.4% of the respondents) who are composed of freshmen female students taking up Bachelor of Science in Secondary Education major in Mathematics. They preferred also all of the instruction profiles presented.

The model summary indicates that two (2) clusters were found based on the four (4) input features assigned which are the students' course, scholarship, year level, and preferred instruction profile. The cluster quality indicates that the overall model quality is in the "Fair" range.

Table 8. Clusters based on course, scholarship, year level, and preferred instruction profile.

Cluster	Size	Inputs			
1	70.8% (192)	Course (BSCE-41.7%)	Scholarship (None- 51.6%)	Year Level (2nd – 37%)	Preferred Instruction Profile (All – 16.1%)
2	29.2% (79)	Course (BSCE -82.3%)	Scholarship (None- 75.9%)	Year Level (4th – 57%)	Preferred Instruction Profile (Card 5 – 25.3%)

First Cluster: Cluster 1 is composed of 192 individuals (or 70.8% of the total respondents) who are non-scholar sophomore civil engineering students (Table 8). They preferred all instruction profiles which means, any of the methods, media, assessment type and instructional activity is preferred in teaching mathematics.

Second Cluster: Twenty-nine (29) students are in cluster 2. These students are non-scholar fourth year civil engineering students. They preferred instruction profile number 5 which is composed of cooperative learning as the method, chalk/marker and board as the media, problem solving as the assessment type and learner-focused as the instructional activity. The model summary indicates that two (2) clusters were found based on the four (4) input features assigned which are the students' GPA, scholarship, course, and preferred instruction profile. The cluster quality indicates that the overall model quality is in the "Fair" range.

Table 9. Clusters based on course, scholarship, GPA, and preferred instruction profile.

Cluster	Size	Inputs			
1	41% (111)	Course (BSM BF-40.5%)	Scholarship Stufaps- 25.2%)	GPA 1.95	Preferred Instruction Profile (Card 1 – 12.6%)
2	59% (160)	Course (BSCE-76.9%)	Scholarship (None- 86.2%)	GPA 2.49	Preferred Instruction Profile (Card 5 – 20%)

First Cluster: The first cluster is composed of 111 students (Table 9) that are Bachelor of Science in Mathematics with Business and Finance. The average of their grades is 1.95. These students are STUFAPS (a scholarship) grantees, and they preferred instruction profile number 1 to be used for teaching their mathematics subject.

Second Cluster: Fifty-nine (59) students are in cluster 2. These students are none scholar civil engineering students whose average of grades is 2.49. They preferred instruction profile number 5 which is composed of cooperative learning as the method, chalk/marker and board as the media, problem solving as the assessment type and learner focused as the instructional activity.

The model summary indicates that two (2) clusters were found based on the four (4) input features assigned which are the students' affiliation, GPA, course, and preferred instruction profile. The cluster quality indicates that the overall model quality is in the "Fair" range.

Table 10. Clusters based on the students' affiliation, GPA, course and preferred instruction profile.

Cluster	Size	Inputs			
1	37.6% (102)	Affiliation (SGO -85.3%)	GPA 1.99	Course (BSEDM– 33.3%)	Preferred Instruction Profile (All – 12.7%)
2	62.4% (169)	Affiliation (None-95.9%)	GPA 2.44	Course (BSCE– 67.5%)	Preferred Instruction Profile (Card 5 – 20%)

First Cluster: There are 102 students of this cluster (Table 10). These students are education major in mathematics students who are affiliated to the college's official Scholars and Grantees Organization. Their average GPAs is 1.99 and they preferred all those five instruction profiles.

Second Cluster: This cluster is composed of 169 civil engineering students who are not affiliated with any school organization in the college. Their average GPAs is 2.44 and they preferred instruction profile number 5 which consist of: cooperative learning as the method, chalk/marker and board as the media, problem solving as the assessment type and learner focused as the instructional activity.

The model summary indicates that two (2) clusters were found based on the four (4) input features assigned which are the students' course, scholarship, gender and preferred instruction profile. The cluster quality indicates that the overall model quality is in the "Good" range.

Table 11. Clusters based on the students' course, scholarship, gender and preferred instruction profile.

Cluster	Size	Inputs			
1	48% (130)	Course (BSCE– 65.4%)	Scholarship (None – 63.1%)	Gender (Male– 100%)	Preferred Instruction Profile (Card 5 – 20%)
2	52% (141)	Course (BSCE– 42.6%)	Scholarship (None – 54.6%)	Gender (Female– 99.3%)	Preferred Instruction Profile (All – 21.3%)

First Cluster: As shown in Table 11, there are 130 students in the first cluster who are non-scholar male civil engineering students and preferred card number 5 as the set of instruction for teaching mathematics. Card five is composed of cooperative learning, chalk/board and marker, problem solving and learner focused.

Second Cluster: There are 141 students in cluster 2. This is composed of female non-scholar civil engineering students who preferred all instruction profiles presented. Meaning, any of the five set of mathematics instructions are preferred to be used in teaching math. The model summary indicates that three (3) clusters were found based on the four (4) input features assigned which are the students' year level, affiliation, GPA and preferred instruction profile. The cluster quality indicates that the overall model quality is in the "Fair" range.

Table 12. Clusters based on the students' year level, affiliation, GPA and preferred instruction profile.

Cluster	Size	Inputs			
1	38.4% (104)	Year Level (3rd – 55.8%)	Affiliation (None – 63.5%)	GPA 2.52	Preferred Instruction Profile (Card 5 – 19.2%)
2	38% (103)	Year Level (2nd – 37.9%)	Affiliation (None – 93.2%)	GPA 2.27	Preferred Instruction Profile (All – 24.3%)
3	23.6% (64)	Year Level (1st – 50%)	Affiliation (SGO – 95.3%)	GPA 1.87	Preferred Instruction Profile (All – 15.6%)

First Cluster: In the first cluster there are 104 students (Table 12). These are third year students whose GPAs averaged 2.52. Also, they are not affiliated with any organization in the college. This group of students preferred instruction profile number 5 which is composed of cooperative learning, chalk/board and marker, problem solving and learner focused as the set of instruction for teaching math.

Second Cluster: The second cluster is composed of 103 students. These are sophomores, whose mean of grades is 2.27 and are not affiliated with any organization in the college. This group of students preferred all instruction profiles presented.

Third Cluster: Sixty-four students constitute cluster number three who are freshmen and are members of the college's Scholars and Grantees Organization. These students have average GPAs of 1.87. They preferred five instruction profiles presented to them.

The segmentation among clusters above showed that there are three reoccurring preferred instruction profile resulted. These three are as follows: all instruction profiles, instruction profile 1, and instruction profile 5. Group of students who chose all instruction profiles are freshmen female BSEDM students and sophomore female BSCE students. Other group of students who also preferred all instruction profiles are also BSEDM students, members of the college's scholars and grantees organization with average GPA of 1.99 and the female non-scholar BSCE students. As observed, the common features of these clusters are the students' gender, course, year level, and scholarship. Thus, it can be deduced from here that the group of females second year non-scholar civil engineering students and group of females first year BSEDM who are scholars preferred all instruction profiles.

Group of BSMBF, STUFAPS' scholar students with average GPA of 1.95 preferred instruction profile 1. These students preferred a set of instruction which method is lecture discussion, chalk/marker and board as the media, the assessment type is problem solving, and activities are learner-focused.Most of the male second year and fourth year non-scholar civil engineering students preferred instruction profile 5. Another group of students who also chose this instruction profile are third year students who are non-affiliated with any organization in the college and average GPA is 1.87. These five instruction profiles are closely similar. However, difference of each set is important to the students. Instruction profiles 1 and 5 differ in instructional method. And looking at the results of segmentation, instruction profile 1 appeared only once in the result of which chosen by 111 students. Compared to instruction profile five, it appeared several times. However, comparison of preferred instruction profiles is not the purpose of segmentation. Segmentation helps find choice in a homogeneous group. It is a way to explicit choices in a smaller group sharing common opinion, interest and lifestyles. In here, all instruction profiles are preferred by the students yet some group of students, preferred specifically instruction profile 1 (STUFAPS scholar BSEDM with average GPA of 1.95) and instruction profile 5 (male second year and fourth year non-scholar civil engineering students).

Profile simulation

The real power of conjoint analysis is to predict preference for profiles which are not rated by the respondents. Twenty cards in this study are simulated (Table 13). These cards are part of the orthogonal design which is not rated by the students. There are two kinds of presenting simulations. These are through scores and probability. In this study, score was chosen to present the simulation. The score shows the share of each instruction profile in the market.

Table 13. Preference scores of simulations.

Card number	Score	Card number	Score
1	21.45	11	21.00
2	9.3	12	11.45
3	13.3	13	3.66
4	25.60	14	8.94
5	26.32	15	-2.80

6	57.20	16	7.14
7	2.98	17	-19.46
8	0.58	18	1.99
9	29.26	19	-8.53
10	-3.93	20	5.99

Table 14. Instruction profiles and their shares.

Card number	Levels				Share
6	Lecture-discussion	Book/Hand-outs	Solving mathematics expression	Learner-focused	57.20
9	Lecture-discussion	PowerPoint presentation	Problem solving	Learner-focused	29.26
5	Cooperative learning	Video presentation	Solving mathematics expression	Teacher-focused	26.32
4	Lecture-discussion	Book/Hand-outs	Higher level multiple-choice question	Teacher-focused	25.60
1	Cooperative learning	Book/Hand-outs	Higher level multiple-choice question	Learner-focused	21.45
11	Lecture-discussion	Video presentation	Higher level multiple-choice question	Teacher-focused	21.00
3	Independent study	Chalk/Marker and board	Solving mathematics expression	Learner-focused	13.27
12	Lecture type	PowerPoint presentation	Solving mathematics expression	Teacher-focused	11.45
2	Cooperative learning	Book/Hand-outs	Problem solving	Teacher-focused	9.26
14	Lecture-discussion	Chalk/Marker and board	Problem solving	Teacher-focused	8.94
16	Lecture type	Book/Hand-outs	Problem solving	Learner-focused	7.14
20	Cooperative learning	Chalk/Marker and board	Higher level multiple-choice question	Learner-focused	5.92
13	Lecture type	Video presentation	Higher level multiple-choice question	Learner-focused	3.66
7	Cooperative learning	PowerPoint presentation	Problem solving	Teacher-focused	2.98
18	Independent study	PowerPoint presentation	Higher level multiple-choice question	Learner-focused	1.99
8	Problem-based & Inquiry learning	PowerPoint presentation	Higher level multiple-choice question	Teacher-focused	0.58

15	Independent study	Book/Hand-outs	Higher level multiple-choice question	Teacher-focused	-2.80
10	Independent study	Book/Hand-out	Problem solving	Teacher-focused	-3.93
19	Independent study	Video presentation	Problem solving	Teacher-focused	-8.53
17	Lecture type	Chalk/Marker and board	Problem solving	Teacher-focused	-19.46

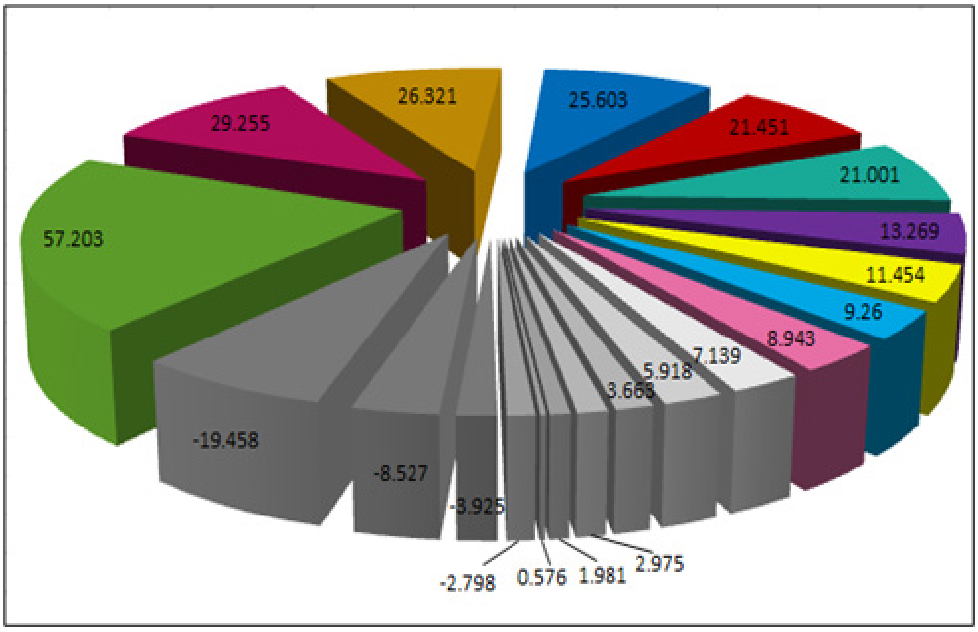

Figure 8. Profile share based on preference score.

Considering the information above (Figure 8), the instruction profile that gained the greatest share to the students – a prediction based on the rated instruction profiles, is the instruction profile number six with 57.203 score or share. Instruction profile six is composed of lecture-discussion, book/hand-outs, solving mathematics expression, and learner-focused. It is then followed by instruction profile number 9 which is composed of lecture-discussion, PowerPoint presentation, problem solving and learner-focused with 29.255 profile share. These profiles are the top two profiles which will probably be preferred by the students for teaching mathematics. Table 16 shows the descending arrangement of instruction profiles according to the predicted shares they will gain from the students.

On the other hand, the two bottom profiles on the list are profile instruction number 19 and instruction profile number 17. Instruction profile number 19 is composed of independent study, video presentation, problem solving and teacher focused. It gained a negative share of 8.53 while; number 17 which consist of lecture type, chalk/marker and board, problem solving and teacher-focused gained a negative share of 19.49. This means that the students will not probably prefer this set of instructions if applied in teaching mathematics.

General findings and implication

Indeed, merely guessing what should be applied strategies and methods for teaching mathematics is not an enough basis to say that students would probably prefer this or that.

As based on the results, students are unpredictable. One can't determine that they will choose the easiest assessment type (for example) to be used, which is the multiple-choice question. Instead, they most preferred problem solving. Mathematics oriented students are expected to be deep, logical, and more critical in analysis. From that notion, one might say that purely they would like problem-based and inquiry learning method, yet this study revealed that these students mostly preferred lecture-discussion type of strategy wherein both students and teacher exert effort to understand lessons. This study found out that students prefer a set of instruction that would make the class interactive, challenging, and of course informative to which the objectives must be focused on their part. Conjoint analysis is really a helpful tool for eliciting preferences in which the basis of determining choice is not merely by frequency count but by utility value.

Conclusion

This study concludes that students preferred a set of instruction which is composed of lecture-discussion method, chalk/marker and board for media, problem solving for assessment, and learner-focused for the activity (Instruction profile 1). Therefore, these students preferred the traditional way of teaching and learning process despite the presence of modernized techniques used nowadays. These students are traditional types of learners and at the same time critical. Critical in a sense that these students choose the challenging tasks over the easy ones. Looking into the entire picture of the levels preferred by the students, it is evident that students look forward for a set of instruction that would make the class interactive, challenging, and informative to which the objectives must be focused on their part.

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