

Article

A Conjoint Analysis Approach, Implications, and Mitigation Plans in Analyzing Students' Preferences for Online Learning Delivery Types during the COVID-19 Pandemic for Engineering Students: A Case Study in the Philippines

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Abstract: Traditional face-to-face classes were replaced with online learning when the COVID-19 pandemic happened. Students were unfamiliar with the virtual setup, as well as the technological challenges, which led to dissatisfaction and affected their academic performance. This research study surveyed 230 engineering students and applied conjoint analysis to analyze their preferences in online learning delivery. Using SPSS Statistics software, we revealed the top three attributes for delivery type: interaction, flexibility, and proctored exam. In addition, the most favored combination from the generated stimuli was a form of blended mode delivery. The synchronous meetings and asynchronous activities allowed students to manage their time efficiently. It could be deduced from the findings that students highly preferred the combination considering learner–instructor, live chats, real-time lecture meetings, and automatic availability, with a focus on synchronous online learning modes. Higher education institutions may reflect on the results of this study to reassess the online learning environment they implement among students. Incorporating a student's learning style to determine the relationship between their preference for online learning delivery type will be helpful for further research through application and study extension. It is suggested that the perceptions of instructors and students enrolled under different learning modalities and their effectiveness should also be addressed. This is a recommendation for future research to consider. Especially near the end of the COVID-19 pandemic, traditional face-to-face learning was being implemented. Thus, future studies may want to consider an analysis of the behavioral intentions of students. On the other hand, analyses such as student behavioral intentions for the future applications of the different modalities and comparisons thereof may be conducted to enhance the implications for, policies of, and strategies of universities.

Keywords: online learning; conjoint analysis; delivery type; blended learning; learning type



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1. Introduction

Engineering is an occupation that covers different disciplines, such as mechanics, production, business operations, and more. Engineers use their science, mathematics, and logic knowledge to find a suitable solution to a problem. They weigh the pros and cons of various design options before selecting the one that best meets their needs [1]. According to Engineers Australia [2], “They improve the state of the world, amplify human capability and make people’s lives safer and easier”. From the U.S. Bureau of Labor and Statistics [3], the number of new jobs for engineers in the next ten years will be approximately 135,000, as projected since 2016. Having a bachelor’s degree is considered enough to provide one with the needed background to enter the field of engineering [4]. In the Philippines, 17 universities have engineering programs accredited by the Accreditation Board for Engineering and Technology (ABET) [5], and this has proven essential for institutions as it

shows that graduates of accredited programs will be equipped with the best practices to be globally competitive [6]. To become a professional, one must take licensure exams for specific engineering courses such as civil engineering and chemical engineering.

When the COVID-19 pandemic began in 2020, people had to adjust to working or studying in a virtual setup. Even though online learning was not new in the education sector, it was still a big challenge for students—especially those in developing countries. The transition from face-to-face to fully online was abrupt as students were more accustomed to having lectures, exams, classwork, and other outputs performed in a classroom setup. For example, higher education students at the Polytechnic University of the Philippines (PUP) Camarines Sur were concerned about student and faculty training to use digital platforms for online classes [7]. Different delivery methods are now being held virtually for courses, contrary to what teachers previously practiced. According to Martin and Oyarzun [8], some classifications that fit in the Philippine online education setting were synchronous, asynchronous, and blended online learning. As defined, synchronous online learning is a delivery method where content is delivered online and is accessible at any time, with real-time meetings for students to participate at the same time. Asynchronous online learning provides course content online where students are not required to join in real-time sessions. Blended online learning combines both modalities such that students and instructors can schedule convenient times to attend online meetings. According to the University of Waterloo in Canada, when deciding the online delivery method(s) to consider, it is vital to consider that some students may have other responsibilities at home that can prevent them from engaging in class at a particular time [9]. In the Philippines, only top and private universities have offered online classes as part of the curriculum for practice. However, challenges, setup, and implementation were not completely established before the COVID-19 pandemic.

Despite this advancement in technology and education, the Philippines still has not completely adopted the technological implementation of online learning. This is similar to other developing countries, especially with the abrupt changes during the COVID-19 pandemic. A study in Indonesia claimed that students' perceptions of online learning during the COVID-19 pandemic were that it was ineffective and unpleasant because not all students had the resources to access online materials smoothly [10]. Similar to the Philippines' situation, a survey by the Safe, Equitable, Quality, and Relevant (SEQuRe) Education Movement revealed that 71 to 72% of students and parents encountered problems attending classes online due to internet connection, gadgets, and distance learning expenses [11]. According to Baturay and Yukselturk [12], students' successes in online learning were subject to their satisfaction when their preferences were met. Balta-Salvador et al. [13] stated that engineering students were not satisfied with the quality of online learning education, which was correlated with their workspace conditions, and this had negatively affected their academic performance. Thus, a conjoint analysis approach was applied to determine engineering students' preferences for online delivery types. Little to no literature were available for preference analyses of online delivery types in the Philippines. Most of the existing literature has focused on the generalization of the population, rather than the specifics which could provide in-depth analyses and findings that could be extended to more aspects of management, strategies, and implementation-building.

A conjoint analysis approach is used as a research method to measure preferences beyond sales and marketing. It is a statistical technique based on surveys to determine the importance of given factors [14]. Several studies conducted pre-COVID-19 used a conjoint analysis approach to determine students' preferences concerning online learning. The results from Malarkodi et al. [15] showed that the top two reasons students in India preferred online learning were the flexibility of study location and study time. Similarly, the results obtained by Daghan and Akkonyulu [16] showed that a student's learning style was correlated with their preference for online learning environment. Another study from Turkey showed that students greatly valued the following employed technology characteristics: the learning materials provided by teachers, the interaction types between

the instructor and students, and flexibility. In Serbia, students expressed that their preferred method of knowledge assessment was 100% online, as most students showed that they were more results-oriented [17]. In the Philippines, nursing students were surveyed about their preferences for clinical instructors and conveyed that the attributes of high value to them were the instructor's teaching capabilities [18].

A recent study by Agyeiwaah et al. [19] showed the attributes influencing student satisfaction regarding online education during the COVID-19 pandemic. Applying a quantitative method using principal component analysis, the attributes identified resulted in three factors:

"Factor 1: "Perspicuity and dependability", comprises items that explain the clarity, understandability, and safety of online learning. Factor 2, named "Stimulation and attractiveness", comprises items that explain how the online learning classroom is motivating, exciting, and attractive to students. And lastly, Factor 3, named "Usability and innovation", denotes how students find their new online learning classroom user-friendly and innovative".

The correlation matrix and regression analysis showed a significant association between these factors and student satisfaction. The hospitality and tourism students in Macau expressed that it was challenging to learn from home because of overwhelming interruptions. Accordingly, the degree to which the online learning environment is stimulating and attractive is the most crucial factor motivating one to engage.

Another qualitative study by Muthuprasad et al. [20] about students' perceptions of online learning during the COVID-19 pandemic showed that a significant percentage of the respondents stressed that online learning was not as effective as face-to-face learning classes. Most students preferred recorded classes, meetings with the instructor twice per week, a 1-week deadline for assignments, and other preferences. It also showed that students' most significant challenges were the technical aspects of online learning and their learning environments.

Moreover, in the study by Ong et al. [21], a conjoint analysis approach was used to determine students' preferred online learning attributes. They obtained results showing that industrial engineering undergraduate students placed the highest importance on the final requirement of the multiple-choice exam as it held one of the highest percentages for their final grade. The choice to delivering mixed synchronous and asynchronous online learning ranked fourth in their preferred attributes. Thus, it showed that students also prioritized guidance and learning at their own pace. To further decipher which delivery type fit a specific course subject depending on the preferences of students, this study proved its relevance.

Limited studies have expressed students' preferences for the general concept of online learning without further exploring their preferences for delivery type. Therefore, this paper aimed to determine the preferred delivery type for online learning engineering students and its attributes during the COVID-19 pandemic. Hence, conjoint analysis with an orthogonal design was utilized in this context. The following research questions were created alongside the research objectives:

1. What are the preferred attributes and specifications of engineering students among interactions, flexibility, communication, materials, assessments, and proctored exams?
2. What are the least preferred attribute combinations among students?
3. Based on the outcome and findings, what mitigation plans would be created for students for student experiences, technological issues, and course concerns?

Moreover, this study will help higher education institutions deliberate the delivery types instructors should consider executing to move toward better quality education from an educational point of view.

2. Methodology

2.1. Research Design

The overall conceptual framework of this study is shown in the below figure. In the first stage of the study, attributes and their levels were determined (Table 1), formulating the conjoint design and creating the survey questionnaire based on the generated stimuli. From this, students rated the generated combinations of stimuli through a seven-point Likert scale. The preliminary distribution of the survey determined the acceptability of the orthogonal design of the study based on the initial Pearson's R-value. A total of 18 questions were created, as seen in Table 2. These attributes were presented using Google Forms in the data gathering process (sample in Figure 1). The second stage followed the entire survey distribution through social media platforms and obtained the data. The last stage was the application of the conjoint analysis and interpretation of the results to determine the preferred attributes for the delivery type of online classes for engineering students at private universities.

Table 1. Attributes and levels for online learning delivery type.

Attributes	Levels	Citation
Interaction	Learner–instructor Learner–content Learner–learner	Moallem [22]
Flexibility	Immediate Self-paced Scheduled	Soffer, Kahan, and Nachmias [23]
Communication	Discussion board Live chat	Xie, H.; Liu, W.; Bhairma, J.; and Shim, E. [24]
Material	Consultation meeting Pre-recorded lecture Real-time lecture meeting Reading materials and supplementary videos	Muthuprasad, T.; Aiswarya, S.; Aditya, K.S.; and Jha, G.K. [20]
Assessment	Automatically available Adaptive release	Martin, F. and Whitmer, J.C. [25] University of Waterloo [9]
Proctored exam	Yes No	Ong et al. [21]

Table 2. Student profiles.

Characteristics	Category	N
Year Level	First year	51
	Second year	56
	Third year	100
	Fourth Year	19
	Fifth year	4
School	School of Chemical, Biological, and Materials Engineering and Sciences (http://che-chm.mapua.edu.ph/ (accessed on 28 January 2023))	47
	School of Civil, Environmental, and Geological Engineering (http://cege.mapua.edu.ph/ (accessed on 28 January 2023))	37
	School of Electrical, Electronics, and Computer Engineering (http://eece.mapua.edu.ph/ (accessed on 28 January 2023))	15
	School of Industrial Engineering and Engineering Management (http://ie-emg.mapua.edu.ph/ (accessed on 28 January 2023))	34
	School of Mechanical and Manufacturing Engineering (http://mme.mapua.edu.ph/ (accessed on 28 January 2023))	97

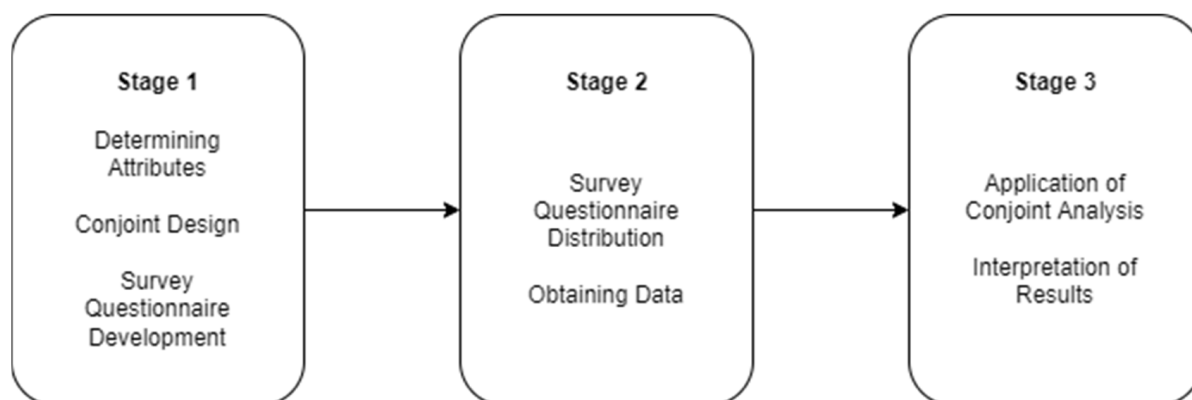


Figure 1. Overall conceptual framework.

2.2. Data Gathering

Survey questionnaires were distributed online among private institutions with recognized engineering programs in the Philippines. The study by Ong et al. [21] explained that conjoint analysis might consider a minimum of 150 respondents to have an acceptable output. Thus, Google Forms was used to obtain at least 200 responses from currently enrolled engineering students from different programs, from the first to the fifth year.

2.3. Conjoint Design

Conjoint analysis, specifically, orthogonal design conjoint analysis, is a tool utilized to assess consumer preference [21]. Compared to other choice-based modelling methods, conjoint analysis with orthogonal design generates the optimum output that represents and can present the optimum findings [22]. As commonly presented, choice-based analysis provides multiple combinations which attempt to measure all possible outcomes. With orthogonal design, manageable and optimum sets of combinations that participants can consider will be generated. This provides less strain for respondents, with only limited combinations, compared to an all combinations analysis.

Table 1 shows the attributes identified in this study for online learning delivery type. Six attributes (interaction, flexibility, communication, material, assessment, and proctored exam) were considered, along with their corresponding levels from various online literature. Furthermore, SPSS Statistics software was used to generate multiple combinations of attributes and levels, which is known as the stimulus in the conjoint analysis, as shown in Table 2.

The software also generated Pearson's r correlation, Kendall's tau, and Kendall's tau holdout values. The ideal values for Pearson's r correlation lie between 0.50 and 1.00, indicating that the variables are moderately highly correlated. From the study by Ong et al. [21], the acceptable value for Kendall's tau is equal to or greater than 0.70. The holdout value should be close to or equal to 1.00 but not exceed the cut-off, which indicates data overfitting.

The study by Ong et al. [21] found that the delivery type was one of the essential attributes of online learning. The preferred levels are a mix of synchronous and asynchronous classes, which are not considered in this study. However, the attributes considered in this research focused on classifying the delivery type preferred from the combinations generated. The first attribute was interaction, which, according to Moallem [23], is the heart of online learning education. The three levels are learner–instructor, learner–content, and learner–learner. A learner–instructor interaction is the communication between a student and an instructor. It emphasizes the importance of an instructor's role in defining the course's objectives, activities, and materials and providing feedback to students as they progress through the course. Learner–content interactions are how a student processes the information presented through the educational experience. This helps students achieve

intellectual growth. Finally, the communications between students in a class are learner–learner interactions, which foster working together to learn from one another.

The second attribute in the list is flexibility. Soffer et al. [24] indicated that integrating flexibility in online courses allows students to learn according to their needs, and it often considers their complex lives. There are three levels for this attribute. Immediate refers to the same pace an instructor teaches and releases learning materials. Self-paced is when students can access all learning materials at their own convenient time. Lastly, scheduled is the option to access learning materials at any given time while an instructor conducts a real-time discussion on a set date. The third attribute to consider is communication. Xie et al. [25] mentioned that communication is a crucial knowledge transfer component between instructors and students. The levels for this attribute are the tools used: discussion board in the learning management system, live chat using messaging platforms such as MS Teams, and a consultation meeting with an instructor.

The fourth attribute is the material with which instructors educate their students, which is considered in the study by Muthuprasad et al. [20]. The first level for this attribute is when an instructor discusses a lesson in a pre-recorded video lecture. The second level is real-time lecture meetings on platforms such as Zoom or Google Meet, and the third is reading material with supplementary videos. An article by the University of Waterloo [9] found that in doing assessments, students should be given an element of choice for when they should complete deliverables for a course. For the fifth attribute, the considered levels are automatically available, wherein an instructor provides the seatwork or exam at any time, and adaptive release refers to students accessing content when initial conditions are met [26].

In the same study by Ong et al. [21] mentioned previously, the final requirement ranked first as the essential attribute that undergraduate industrial engineering students preferred was the multiple-choice exam as the chosen level. Moreover, because educational institutions value integrity among the students taking exams, the proctored exam is considered the sixth and last attribute, even for an online setup. The levels are whether students preferred to be proctored (yes) or not (no).

After encoding the attributes and their levels, the combinations of orthogonal design were generated (Appendix A). The SPSS software generated 16 combinations with two holdout cases, and having a holdout could be used to determine how consistent the responses were [21]. The results from the survey were used to determine the importance of each attribute, thus selecting the preferences of the engineering students for online learning delivery types. After instructions and item specifications with descriptions were provided, the generation of each combination for the preference analysis was prompted (Appendix B).

3. Results and Discussion

This study gathered 230 valid responses from currently enrolled undergraduate engineering students, collected from August–November 2022. The demographics, composed of 132 male and 98 female individuals, and the overall student profile of the respondents are presented in Table 2. A breakdown of student respondents is as follows: 51 students for the first year level, 56 students for the second year, 100 students for the third year, and the fourth and fifth years had 19 students and 4 students, respectively. In each school or department of the university, mechanical and manufacturing engineering had the highest numbers of respondents, garnering 97 responses, followed by chemical, biological and materials science engineering with 47, then civil, environmental and geological engineering with 37, and then industrial engineering and engineering management, which had 34. The least were from electrical, electronics, and computer engineering, which had 15 respondents.

3.1. Conjoint Study

A preliminary 40 respondents were gathered for the initial run. As shown in Table 3, the results met the acceptable values of Pearson's r , with 0.977, and Kendall's tau, with 0.874, and the holdout value was 1.00. Thus, the researchers proceeded with the conjoint study to

analyze the preferences of engineering students on the delivery types for online learning. With the conjoint analysis output generated by the SPSS Statistics software, Table 4 shows the importance values of the six attributes.

Table 3. Correlations.

	Value	Significance
Pearson's r	0.977	0
Kendall's tau	0.874	0
Kendall's tau for holdout values	1.00	

Table 4. Importance values.

Attributes	Score	Rank
Interaction	43.798	1
Flexibility	20.198	2
Communication	11.636	4
Material	5.196	6
Assessment	5.891	5
Proctored exam	13.282	3

The interaction attribute had the highest average score of 43.798 among the six attributes. The second attribute in the ranking was flexibility, having a score of 20.198. The proctored exam had the third highest rank, with a score of 13.282. In fourth place, with 11.636, was communication, and in the last two places, assessment and material scored 5.891 and 5.196, respectively. For the levels of each attribute, Table 5 shows their utility scores. The utility is the subjective preference judgment of a person expressing a particular object's overall value or worth [27]. Therefore, the highest utility estimate is considered the preferred level of the students.

Table 5. Utilities.

Attributes	Levels	Utility Estimate	Standard Error
Interaction	Learner–instructor	0.358	0.034
	Learner–content	−0.043	0.04
	Learner–learner	−0.316	0.04
Flexibility	Immediate	−0.166	0.034
	Self-paced	0.145	0.04
	Scheduled	0.022	0.04
Communication	Discussion board	−0.106	0.034
	Live chat	0.073	0.04
	Consultation meeting	0.033	0.04
Material	Pre-recorded lecture	−0.001	0.034
	Real-time lecture meeting	0.041	0.04
	Reading materials and supplementary videos	−0.039	0.04
Assessment	Automatically available	0.045	0.026
	Adaptive release	−0.045	0.026
Proctored exam	Yes	−0.102	0.026
	No	0.102	0.026
(Constant)		4.727	0.031

For the highest-ranked attribute, the most preferred level was learner–instructor. It was evident from the study of Parker et al. [28] that college students performed on a stronger academic level when instructors posted frequently, responded to queries immediately, and integrated student feedback. The interpersonal interaction between a student (learner) and a teacher (instructor) encouraged students to commit to online courses. Hollister et al. [29]

mentioned online teaching in higher education wherein students who perceived teachers being actively involved in teaching were more effective at learning. Cranfield et al. [30] also concluded that the learner–instructor interaction is one of the significant predictors of student satisfaction in online learning. Hence, these findings emphasized the substantial role of learner–instructor interactions in student achievement and satisfaction. Contradicting the study of Ong et al. [21], it was seen that students more preferred self-paced learning compared to having an instructor around. However, this study was conducted during the early start of the COVID-19 pandemic, when all students and instructors were adjusting. It could be deduced that students had figured out that the learner–instructor interactions were relatively important and were still needed to foster learning.

The level for the second highest attribute that students considered for flexibility was self-paced. Waheed et al. [31] stated that flexibility was an element defining online learning. Students require a mechanism that encourages them to prioritize their studies, which usually takes the form of assignment deadlines and a set end date for the course, while still giving them the flexibility to schedule their work around them. This supports the study of Marciniak et al. [32], wherein students in self-paced learning showed excellent academic performance based on performance measures, including average scores on chapter tests and average performances on the final exam. The students were also more satisfied with self-paced as it gave them a sense of freedom in learning. However, the study by Mshayisa and Ivala [33] expounded on the idea that instructors at the back-end should be present for any concerns of the students in their self-paced learning. This means that teachers and instructors should not be totally unidentified during the flexibility of a learning experience.

In the third highest of the attributes, students preferred that online exams not be proctored. A study by Gumasing et al. [34] stated that students were concerned about the environmental and psychological factors of using e-proctoring tools while taking online exams as they imposed stress and anxiety among students during examinations. Alshammari et al. [35] stated that the implications of experiencing high test anxiety resulted in lower exam scores. In contradiction to the explanation, it could be supposed that when students have the proper time management skills, ability, and motivation, thorough effort and learning activities would still be accomplished in online learning [33].

Having a live chat through messaging applications with a professors was the students' preferred level of communication. The study by Sobaih [36] stated that students recognized live chat as most useful if an urgent response was needed, especially when taking assessments or doing assignments. When using a live chat as a tool for online academic help-seeking, blended learning students and online students were overwhelmingly satisfied. Most notably, students believed that teaching staff cared about assisting with their learning using live chats and they found it useful for real-time support. However, the appropriateness of LMS and online learning communication should be chosen according to the students' interests and to accommodate their general needs [37].

As for the assessment, students preferred it to be automatically available or accessible when professors released it on the learning management system (LMS) without initial conditions such as reading or watching additional lecture materials. It may also have fallen under the proctored exam attribute as students prioritized taking assessments on time. Regarding the materials for delivering course topics, real-time lecture meetings were the most preferred among the levels. Real-time lectures, also called synchronous sessions, are performed through video meetings. While technological difficulties are recognized to obstruct students from understanding lectures and discussions during synchronous sessions, Serdyukov [38] revealed that students appreciated synchronous sessions as they were given a platform to clarify complex topics to their professors.

From the generated stimuli using the SPSS software, the ranking was determined by substituting the values of the utility score of each level and summing it up for each combination. As seen in Table 6, the most favored stimulus of engineering students was combination #1, which was learner–instructor plus self-paced plus live chat plus pre-recorded lecture plus automatically available plus no. It was evident that among the top

three combinations, the highest utility score of each attribute was present, thus proving a strong relationship between the observed and estimated preferences [39].

Table 6. Ranking of combinations.

Combination Number	Stimuli	Score	Ranking
1	Learner–instructor plus self-paced plus live chat plus pre-recorded lecture plus automatically available plus no	0.722	1
16	Learner–instructor plus scheduled plus consultation meeting plus real-time lecture meeting plus adaptive release plus no	0.511	2
15	Learner–instructor plus self-paced plus consultation meeting plus reading materials and supplementary videos plus automatically available plus yes	0.44	3
7	Learner–instructor plus scheduled plus live chat plus pre-recorded lecture plus adaptive release plus yes	0.305	4
3	Learner–instructor plus immediate plus discussion board plus real-time lecture meeting plus automatically available plus no	0.274	5
5	Learner–instructor plus immediate plus discussion board plus pre-recorded lecture plus adaptive release plus no	0.142	6
9	Learner–instructor plus immediate plus discussion board plus pre-recorded lecture plus automatically available plus yes	0.028	7
14	Learner–content plus immediate plus consultation meeting plus pre-recorded lecture plus automatically available plus no	−0.03	8
10	Learner–instructor plus immediate plus discussion board plus reading materials and supplementary videos plus adaptive release plus yes	−0.1	9
2	Learner–content plus self-paced plus discussion board plus real-time lecture meeting plus adaptive release plus yes	−0.11	10
4	Learner–content plus immediate plus live chat plus reading materials and supplementary videos plus no	−0.118	11
13	Learner–content plus scheduled plus discussion board plus pre-recorded lecture plus automatically available plus yes	−0.185	12
8	Learner–learner plus self-paced plus discussion board plus pre-recorded lecture plus adaptive release plus no	−0.221	13
11	Learner–learner plus scheduled plus discussion board plus reading materials and supplementary videos plus automatically available plus no	−0.292	14
17	Learner–learner plus self-paced plus discussion board plus reading materials and supplementary videos plus automatically available plus yes	−0.373	15
6	Learner–learner plus immediate plus live chat plus real-time lecture meeting plus automatically available plus yes	−0.425	16
12	Learner–learner plus immediate plus consultation meeting plus pre-recorded lecture plus adaptive release plus yes	−0.597	17
18	Learner–learner plus immediate plus discussion board plus real-time lecture meeting plus adaptive release plus yes	−0.694	18

The levels from the preferred combination were learner–instructor, live chat, real-time lecture meetings, and automatically available, with a focus on the synchronous online learning mode. In contrast, the self-paced level focused on the asynchronous mode. In general, the combination fit the blended delivery type for online learning. Blended online learning is defined as the completely online, simultaneous, and complementary integration and implementation of an asynchronous mode, partially system-managed, partially faculty-led learning environment (i.e., a course management system (CMS)) and a synchronous mode, partially system-managed, partially faculty-led learning environment (i.e., a virtual classroom environment) [37]. Blended online learning, which can also be referred to as “Bichronous” online learning, as defined by Marfuah et al. [40], is the blending of synchronous and asynchronous online learning modes. In bichronous sessions, students can engage anytime and anywhere during the asynchronous portion of the course and participate in real-time activities during the synchronous sessions.

The blended mode of online learning delivery type does not only benefit student, it also benefits instructors and professors. According to Coman et al. [41], those who resisted

online instruction before learning new pedagogical techniques in delivering lessons will be more at ease modifying their Powerpoint presentations during real-time lecture meetings. While preserving the LMS benefits in managing assignments and grades and encouraging the critical thinking associated with asynchronous discussion, blended online learning may also address those limitations for instructors.

Moreover, a mitigation plan, shown in Table 7, for implementing a blended mode delivery type shows the possible risks in the following three categories: student experience, technological issues, and course concerns. Based on the study by Ranadewa et al. [42], personal commitments can affect student participation in online learning. This is seen as an identified risk during synchronous sessions. Scenarios such as caring for a family member will split a student's attention and may affect their engagement in the lesson taught. Thus, posting recorded lectures in the LMS, such as Blackboard, canvas, etc., can help students review their lesson again.

Table 7. Mitigation plan.

Category	Identified Risk	Mitigation Plan
Student experience	Synchronous sessions may conflict with duties at home	Recording of the real-time lecture should be posted after the meeting
Technological issues	Unstable internet connection	Lenient deadlines for assignments
Course concerns	Possibility of cheating during non-proctored exams	Different sets of questions for exams or the use of a locked-down browser

Cahyani et al. [43] mentioned that internet connections and network issues are challenges in blended online learning. For example, the lagging of internet connections provided students with misunderstandings among faculty instructions related to coursework. Second, students may not totally comprehend the lesson proper due to inefficient connections, leading to lagging or choppy lessons that students have difficulties in comprehending. Others may also relate to assessments in class held synchronously, big-data-aligned learning management systems, technology tools, and communications, in general. The participation of students would therefore be hindered by slow internet connections. Thus, faculty members should be lenient towards deadlines and may impose policies on late submissions so that students will not take advantage of them and use them as excuses. Lastly, because students prefer that online exams not be proctored, using a locked-down browser or an application that disables students from opening any tab on the browser will tighten security during an examination. In an attempt to try to mitigate academic integrity, the current set-up being practiced is to have cameras behind and in front of the students taking the assessment synchronously. This manner of proctoring has been seen to be time-consuming to set-up, require larger internet data, and hinder students in quickly analyzing questions due to system loading. Instructors may also create different questions or sets of exams so that students cannot discuss answers among themselves.

3.2. Online Learning at Mapua University as a Benchmark

In the academic year 2021–2022, Mapua University offered two modalities for online learning. The first was UOx, which is a fully online learning delivered asynchronously. This state of learning modality provides students the option to take into consideration the lessons, activity, and performance any time of the semester. The other modality was blended learning. The blended learning modality adopted was a mix of bichronous (limited face-to-face meetings and online meetings assigned by the instructor) or synchronous online sessions. However, the face-to-face classes under blended learning were limited to particular courses per program and depended on the government's policy, which is why most classes are still held online in the Philippines [43]. The learning management system (LMS) used by the university was Cardinal Edge, a Mapua LMS powered by Blackboard Learn. During the first few months when online classes were implemented, Blackboard Collaborate was used to conduct synchronous sessions until Zoom was discovered as a

more effective and user-friendly application to conduct real-time lecture meetings and monitor students during online examinations. However, some professors required another application to be used for the students' screens to be shared while taking tests. Besides the online learning activities (OLA) and module exams, some courses required a research paper as an end-of-term project and completion of Coursera courses. Coursera courses are utilized in different applicable courses in an attempt to provide coherent and related academic tasks, offer more lessons from a different perspective and approach, and provide students with other learning materials that are related to the course being taken. The current grading system being implemented is a modular system wherein the course is divided into two to three modules. Every module has a corresponding grade computed every 3–4 weeks. By the end of the term, the average of all the modules will be the student's final grade.

3.3. Practical Implications and Suggestions

This study revealed engineering students' preferences for the delivery types of online learning. As universities continue to offer fully online courses, professors and administrators of higher education institutions may consider this study to improve the online learning experience of their students as the information given supports the need to implement a blended mode as the online learning delivery type. Since limited face-to-face instruction is now being implemented, administrators must know whether students prefer to attend class physically. Some students have moved back to provinces and overseas. In contrast, others may be anxious about contracting COVID-19 when frequently exposed outside their homes. They should also study which courses should be implemented as bichronous or synchronous delivery types depending on the nature of the course, if it is purely theoretical, etc.

For blended online learning, instructors must always upload a copy of the video recording of a synchronous class for students who cannot attend. Synchronous sessions can be held once per week and during exams. It is also preferable that all lecture materials to be discussed be uploaded at the start of the term. The submission of online learning activities should at least have a one-week deadline to avoid an overload of requirements.

3.4. Limitations of the Study and Future Research

Although this study had a relatively large sample size, it was limited to undergraduate students taking engineering courses. The students who answered the survey were also enrolled in the blended learning modalities offered by the universities. The perceptions of instructors and students enrolled under different learning modalities and their effectiveness should also be addressed. This is a recommendation for future research to consider. Especially now that we are nearing the end of the COVID-19 pandemic, the traditional face-to-face learning modality is being implemented. Thus, future studies may want to consider an analysis of the behavioral intentions of students. On the other hand, analyses such as behavioral intentions for future enrollment in the different modalities and comparisons thereof may be conducted to enhance the implications, policies, and strategies of universities. For a more comprehensive analysis, clustering techniques may be considered to segregate the demographics of students taking up the different modalities. Lastly, machine learning algorithms or multivariate analysis may be applied, aligning with the variables considered in this study to assess the impacts among the different aspects of behavioral, cognitive, and even physical latent variables for a holistic measurement.

4. Conclusions

Two years have passed since the implementation of online learning globally because of the COVID-19 pandemic. However, students and teachers are still adjusting to the online learning environment, especially in the Philippines. As studies prove the correlation between student satisfaction and academic achievement, this study focused on the delivery type of online learning that students would prefer. The researchers generated 18 combinations of stimuli and performed conjoint analysis using the SPSS Statistics software based

on the responses of the engineering students. The values of Pearson's r and Kendall's tau proved the validity of the responses as the correlation between the observed and estimated preferences is within the accepted range. The results led to defining the favored combination as blended mode where students interact with an instructor through real-time lecture meetings, ask for clarifications in live chat via messaging applications, are able to answer assessments with no surveillance during an exam, and are given the opportunity to access all learning materials at any time. This merging of the synchronous and asynchronous modes in online learning provides a learner with options for managing their time efficiently to perform better academically and to perform their responsibilities at home.

From the findings, it is suggested that professors and administrators of higher education institutions may consider this study to improve the online learning experience of their students as the information given supports the need to implement a blended mode as the online learning delivery type. With the current implementation of several learning modalities in the Philippines for students to choose from, universities may opt to consider and promote the attribute combinations found in this study for assurance of student satisfaction and motivation in continuous learning. This way, the modalities reflect towards students' academic motivation and determination in academic achievement, relating to the discussions made by related studies [21,34,44,45]. Similarly, the incident of providing the appropriate platform for both blended and fully online learning may enhance student satisfaction in an online learning engagement. For blended online learning, instructors must always upload a copy of the video recording of a synchronous class for students who cannot attend. Synchronous sessions can be held once per week and during exams. It is also preferable that all lecture materials to be discussed be uploaded at the start of the term. The submission of online learning activities should at least have a one-week deadline to avoid an overload of requirements.

Future studies may expand on this study by surveying numerous universities and including all undergraduate courses. Comparison and contrast may provide further insights and determinations, and future studies may incorporate these findings to provide a more holistic and generalized marketing and academic strategy. Researchers may also incorporate a student's learning style in determining their relationship to their online learning delivery type preference. Lastly, several approaches towards behavioral studies, clustering for the determination of similar characteristics and demographic profiles, and even multivariate and algorithm tools may be used for analysis.

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Appendix A. Generated Stimuli

Interaction	Flexibility	Communication	Method	Assessment	Proctored Exam
Learner–instructor	Self-paced	Live chat	Recorded	Automatically available	No
Learner–content	Self-paced	Discussion board	Real-time lecture	Adaptive release	Yes
Learner–instructor	Immediate	Discussion board	Real-time lecture meeting	Automatically available	No
Learner–content	Immediate	Live chat	Reading materials and supplementary videos	Adaptive release	No
Learner–instructor	Immediate	Discussion board	Pre-recorded lecture	Adaptive release	No
Learner–learner	Immediate	Live chat	Real-time lecture meeting	Automatically available	Yes
Learner–instructor	Scheduled	Live chat	Pre-recorded lecture	Adaptive release	Yes
Learner–learner	Self-paced	Discussion board	Pre-recorded lecture	Adaptive release	No
Learner–instructor	Immediate	Discussion board	Pre-recorded lecture	Automatically available	Yes
Learner–instructor	Immediate	Discussion board	Reading materials and supplementary videos	Adaptive release	Yes
Learner–learner	Scheduled	Discussion board	Reading materials and supplementary videos	Automatically available	No
Learner–learner	Immediate	Consultation meeting	Pre-recorded lecture	Adaptive release	Yes
Learner–content	Scheduled	Discussion board	Pre-recorded lecture	Automatically available	Yes
Learner–content	Immediate	Consultation meeting	Pre-recorded lecture	Automatically available	No
Learner–instructor	Self-paced	Consultation meeting	Reading materials and supplementary videos	Automatically available	Yes
Learner–instructor	Scheduled	Consultation meeting	Real-time lecture meeting	Adaptive release	No
Learner–learner	Self-paced	Discussion board	Reading materials and supplementary videos	Automatically available	Yes
Learner–learner	Immediate	Discussion board	Real-time lecture meeting	Adaptive release	Yes

Appendix B. Sample Survey Generation

(1) Learner-instructor + Self-paced + Live chat + Recorded + Automatically Available + No proctored Examination *

1 2 3 4 5 6 7

Strongly Disagree ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly Agree

Note: * dictates the required question to be addressed.

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