APPLYING STRUCTURAL EQUATIONS TO EVALUATE ONLINE INSTRUCTIONAL MODALITIES IN HIGHER BUSINESS EDUCATION

ABSTRACT

Academic institutions rapidly deployed virtual technologies and faculty training to minimize disruption following the Spring 2020 COVID-19 pandemic. The future of higher education in the "new normal" includes an assessment of the success and challenges of online course offerings. Therefore, administrators are tasked with determining optimal online modalities across various programs. Our findings demonstrate that beyond quality factors such as instruction and technology, curriculum rigor factors (graduate/undergraduate, upper/lower divisions) and field of study (quantitative/qualitative, MBA/MS) influence student satisfaction of online courses. To aid administrative decision-making, we provide a suggested model of structural equations incorporating these critical factors and their significance across online modalities such as synchronous, asynchronous, and hybrid formats.

Key Words Online Instructional Modalities, Structural Equations, Curriculum Rigor Factors, Field of Study

1. Introduction

The confluence of needs for learners' support and mitigation of a COVID 19 outbreak, forced online instruction to the forefront of higher education efforts in Spring 2020. Nonetheless, the global pandemic presented enormous logistical challenges for higher education forced to launch virtual instructional operations within weeks. In response, academic institutions dispensed vast resources to support instructional training and auxiliary academic technology services. For example, approximately $1.3 million was spent on training and technology for a College of Business at one Southern California State University. Despite these resources, first-time online faculty and administrators braved the rapid conversion of course modalities while in some cases learning to differentiate meaning between online teaching jargon including synchronous, asynchronous, or hybrid formats. Administrative challenges were also compounded by faculty concerns over the lack of institutional support, fear of losing control of instructional autonomy, and unfamiliarity with technologies used in the digitization required for the online teaching environment (Ubell, 2017). Despite the clear challenges, online education has gained momentum and administrative interest in the wake of the COVID-19 global pandemic (Bao, 2020; Basilaia and Kvavadze, 2020; Dhawan, 2020). Administrators must now address lasting demand for high-quality online offerings. In response, leadership at a Southern California State University, offered a series of online instructional training workshops during Summer 2020 to prepare faculty for the Fall semester 2020.

Thus, the critical and intriguing question to address is how a College of Business should leverage the benefits of the Summer 2020 online teaching training toward optimizing face-to-face and online modalities in the post-COVID era. Our student-centered and timely survey emphasizes "learners' perspectives" during this pandemic aiming to assess which critical factors influence students' satisfaction with online instructional modalities: asynchronous, hybrid, and synchronous.

Our study also captures learner academic demographics, including number of years at school, qualitative majors vs. quantitative majors, and undergraduate vs. graduate programs. Our results are derived from structural equations toward predicting which critical factors drive learner satisfaction across various online modalities. Our study aims to provide administrators with a predictive model to further optimize course modality toward fostering student interest and boosting student satisfaction.

Our study contributes to extant online learning in higher education in the following ways: (1). The demographic data enables us to explore what course-related factors influence student satisfaction with online instruction modalities, (2). The proposed structural equations can be modified to reflect varying institutional needs toward building tailored predictive models to better anticipate students' satisfaction with online course experiences, (3). The scalability of our structural equations can be further applied to predict learners' satisfaction with the innovative pedagogical design, and (4). Higher education can emulate our structural equations to identify critical factors which support learner educational progression and a loyal lifelong learner mindset.

The remainder of the paper is structured in six sections. Section 2 reviews prior literature related to assessments of online instructional modalities, learner perceptions, and faculty responses toward hypotheses development. Section 3 describes survey design and empirical methodology. Section 4 reports hypothesis testing along with our interpretations. Section 5 outlines the practical implications of this paper. Section 6 concludes and provides suggestions for higher education institutions.

2. Literature Review and Hypothesis Development

Assessment on Online Learning

Prior studies document evidence to support a positive association between student learning outcomes and online teaching modalities before and during the COVID pandemic (Jesus et al., 2017; Agarwal and Kaushik, 2020; Taghizade et al., 2020; Baber, 2020; Wei et al., 2021). Nonetheless, other studies suggest learner success is not universally and positively associated with face-to-face or online teaching modalities. Contrary to a belief in the lack of efficacy in online teaching, Yen et al. (2018) suggest learners are equally satisfied with their online and blended learning experience. Despite evidence-based studies (Means, et al., 2009; Nguyen, 2015) articulating the merits of online learning modalities measured by student completion and success rate, some faculty in higher education do not fully embrace online teaching modalities, citing concerns about the loss of intellectual property, the lack of institutional support, the maintenance of academic integrity (Ubell, 2017). Thus, an underlying issue is determining how to meet learners' demands for online learning and allay instructional resistance to online teaching. Finally, when considering the merits of online teaching, it is imperative to acknowledge key features, for instance, convenience, a distinct feature of online learning, that amplifies students' satisfaction or preferences in the online learning system (Cole and Swartz, 2014; Chen et al., 2021).

Bandura's (1995, 1997) framework of self-efficacy, the belief in ones' capabilities to organize and execute the courses of action to produce results, might explain why certain learners succeed over others in online learning depending on their range of self-efficacy. Hodges (2008) adds self-efficacy may even predict learners' academic performance. However, self-efficacy may be

context-specific and could vary by learner across face-to-face and online educational environments. Considering self-efficacy research in conjunction with an emphasis on curriculum rigor factors, field of study, and quality technology and instruction may help assess the appropriateness of an online course modality.

Curriculum Rigor Factors

As advocated in Astin's (1993) study, the extent of faculty interpersonal relations with students affects the levels of learner success. Graduate-level curriculum focusing on mastery of critical thinking is assessed through collaborative team projects. Thus, graduate classes are relatively more challenging as compared to those within the undergraduate program. This demonstrates a need for timely guidance from instructors and increased opportunities to stimulate analysis. However, despite online course design efforts to simulate an "in-person" learning experience (Shea et al., 2003; Dykman and Davis 2008b), a synchronous modality with real-time interactions may be more suitable for graduate-level or upper-division undergraduate courses which often adopt seminars or research-oriented projects. Arguably, a self-paced and flexible asynchronous modality with a vital learning management system could be considered a preferable option for graduate students, providing learners are able to overcome any negative perceptions about online learning technologies (Chen et al., 2021).
Hence, our hypotheses are as follows:

H1a: Graduate students have different preferences of online modality as compared to undergraduates.

H1b: Undergraduate students have different preferences of online modality when taking upper division courses as compared to lower division courses.

Field of Study

Studies on online learning satisfaction tend to differentiate undergraduate quantitative and qualitative student preferences. For instance, Blau et al. (2016) report "perceived learning" as the factor that positively drives quantitative undergraduate student satisfaction with online education. Conversely, qualitative undergraduate student satisfaction is driven by prior online learning experience and "ease of technology tool use". Eastman et al. (2017) emphasize the importance of virtual interactions in qualitative online courses and self-efficacy and motivation in quantitative online courses. Furthermore, Comer et al. (2015) find undergraduate qualitative majors engage more in active learning as compared to their quantitative counterparts. Instructors who incorporate appropriate technologies together with active learning pedagogies are likely to impact the satisfaction of learners through generating "deep learning" (Mishra et al., 2020; Donnelly, 2010).

Finally, while some self-regulated qualitative majors may successfully balance the conveniences of asynchronous modalities, quantitative majors face a greater need for engaging course design and "live" instructor-learner interactions to support building their mathematical, data analytics, or technical skills.[1] Similarly, graduate students in MS programs are required to attain advanced

[1] Our argument is built upon the comments solicited from STEM majors at UTSA who have experienced a virtual learning environment during a national pandemic (https://paisano-online.com/23718/arts-life/covid-19-negatively-affects-stem-majors-at-utsa/).

technical knowledge when compared to students in a general MBA program. Despite faculty efforts to simulate quality instruction through interactive media or technology usage, undergraduate and graduate students in quantitative or highly technical fields may experience lower levels of satisfaction in asynchronous environments.

Therefore, our hypothesis is as follows:

H2a: Undergraduate qualitative majors have different preferences in online instructional modality as compared to undergraduate quantitative majors.

H2b: Graduate students in MBA programs have different preferences in online instructional modality as compared to graduate students in MS programs.

Quality Thresholds for Technology & Instruction

Ease of technology use and online content delivery are factors that influence student perception of quality online instruction (Blau et al., 2016; Donnelly, 2010). However, depending on the online modality (asynchronous, hybrid or synchronous), the needs for technology will likely vary. For instance, synchronous formats will depend more heavily on virtual classroom technologies such as Zoom or Team while asynchronous and hybrid formats will benefit more from meaningful media application to fill in for the lack of synchronous instruction (Means et al., 2009). Instructor competency is also associated with perceived quality of online education (Corsby and Bryant, 2020; Vaughan et al., 2017). However, online teaching modalities (asynchronous, hybrid or synchronous) contribute variants in dependency on instructor engagements leading to our hypothesis:

H3: Dependence on quality factors (instruction competency and technology effectiveness) vary from asynchronous, hybrid and synchronous.

3. Survey Design, Variable Definition and Empirical Model

3.1 Survey Design

This study used an IRB-approved online structural questionnaire as an instrument for data collection. Perceptual measures in the form of statements were used for measuring each variable with a corresponding Likert scale anchored as 1 for “Strongly Disagree,” 2 for “Disagree,” 3 for “Neither Agree Nor Disagree,” 4 for “Agree” and 5 for “Strongly Agree”. The targeted population of the study was graduate and undergraduate business students. The Qualtrics survey link was emailed to students on November 9, 2020, and response collection ended on December 18, 2020, marking the end of the Fall 2020 semester. 1,312 students participated in this survey. Among these respondents across eight options in Business: Accountancy, Finance, Human Resource Management, Information Systems, International Business, Management, Marketing and Supply Chain Management, 21.79% are graduate students (286) and 78.21% are undergraduate students (1026). Most respondents in the undergraduate program are juniors (30.18%) and seniors (35.67%).

3.2 Structural Empirical Models and Variable Measures

Our study finds learner satisfaction with online instruction is enhanced by quality factors such as appropriate implementations of technologies and capable instructors and is differentiated by critical factors such as curriculum rigor and field of study. As such we develop the following structural equation model with these factors in mind. We further propose the following structural equations can be adapted by higher business education institutions to reflect their own institutional factors that drive learner satisfaction across various online modalities. Accordingly, this objective benchmark tool can be used to support administrative scheduling decisions on online course offerings.

For instance, we construct the following structural equations to test the interactions between online courses and the proposed factors which may be used to assess future online course offerings at our business school starting with quality factors.

$$Online\ Modality = \alpha_0 + \alpha_1\ Program + \alpha_2 Tech + \alpha_3 Instructor + \varepsilon \qquad (1)$$

Where the dependent variable is the average Likert scale of answers to "What is your opinion about the adequacy of the following instructional design options? ", including asynchronous, synchronous, or hybrid as options where the terms are defined as follows:

Asynchronous- 100% asynchronous self-paced study combined with synchronous office hours.
Synchronous- online course with a regular set time to meet.
Hybrid- a combination of self-paced online study and synchronous class meetings

Furthermore, "Program" is a dummy variable (Un/Graduate), "1" for undergraduate students and "0" for the graduate students. "Technology Effectiveness" (Tech) is a Likert scale of answers to " What is your opinion about the effectiveness of the instructional delivery technologies such as BeachBoard, Zoom, Emails and Publisher's website?". "Instructor Competency"(Instructor) is the average Likert scale of responses to five aspects of instructor activities: (1) Instructors provide clear guidance on how to participate in online learning activities. (2) Instructors keep the class informed about due dates/times of learning activities. (3) Instructors provide feedback in a timely fashion. (4) Instructors help familiarize the class with how to use online learning technology, like Zoom, LMS, and the Publisher's website. (5) Instructors keep the class engaged to achieve learning outcomes as best online teaching practices. A negative coefficient indicates a tendency to reject the proposed instruction method, while a positive coefficient shows the factor tend to accept. For example, if α1 in Model 1 is significantly positive, we will accept the hypothesis that given the same technology or instructional effectiveness, undergraduate students are more satisfied with the specific online class format.

Secondly, for undergraduate students, we develop the following equation to test hypotheses related to majors and student experience (years in school).

$$Online\ Modality = \alpha_0 + \alpha_1\ Major + \alpha_2 Tech + \alpha_3 Instructor + \alpha_4 Experience + \varepsilon \qquad (2)$$

Additionally, "Major" is a dummy variable (Quan/Qual), "1" for undergraduate students in quantitative majors such as Accountancy, Finance, Information System, and Supply Chain Management while "0" is for the qualitative majors such as Management, HRM, Marketing and

International Business. "Experience" is an indicator variable of the student experience in college (Year) on a scale from 1 (Freshman), 2 (Sophomore), 3 (Junior) to 4 (Senior). It is a proxy of upper-division vs lower-division courses.

Thirdly, for graduate students, we have a dummy variable (MBA/MS) to differentiate MBA students noted as dummy variable "1" while "0" is for Master in Science (MSMA, MSF, MSA, MSIS).

$$Online\ Modality = \alpha_0 + \alpha_1\ (MBA/MS) + \alpha_2 Tech + \alpha_3 Instructor + \varepsilon \quad (3)$$

Figure 1 further highlights the connection between hypotheses and 3 proposed structural equations. As displayed in Figure 1, online modality is tested from three aspects: quality factors (technology effectiveness and instructor competency), curriculum rigor factors (graduate vs. undergraduate; upper-division vs. lower-division), and field of study (quantitative vs. qualitative; MBA vs. MS). Structural equation Model 1 and Model 2 are employed to test Hypothesis 1a and Hypothesis 1b, respectively. Structural equation Model 2 and Model 3 are applied to test Hypothesis 2a and Hypothesis 2b, respectively. Finally, structural equation models 1 to 3 collectively test Hypothesis 3. All the corresponding results are exhibited in Table1.

[Please insert Figure 1 here.]

4. Hypothesis Testing and Interpretation of Empirical Results

Shown in Table 1, as hypothesized, both technology effectiveness and instructor competency are significantly positive related to learners' satisfaction across all online teaching modalities at our school. Noticeably, the program dummy variable (undergraduate vs. graduate) in Model 1 is insignificant for hybrid. That is, graduate and undergraduate learners do not have distinctive preferences in their satisfaction with the hybrid modality. In contrast, graduate learners prefer synchronous more than undergraduate learners (-0.161, $p<0.01$), while undergraduates prefer asynchronous (0.410, $p<0.01$). The findings strongly support our hypothesis H1a. The evidence corroborates our proclamation that graduate learners are more likely to prefer instructor and collaborative engagement in a synchronous online modality to support rigorous learning. The evidence also highlights undergraduate learners' satisfaction with the asynchronous modality which is likely attributable to flexibility and convenience.

[Please insert Table 1 here.]

Most of the results of Model 2 concur with our hypotheses: H1b and H2a that qualitative undergraduate majors and undergraduate learners taking upper-division courses prefer different online modalities. In particular, the evidence indicates that undergraduate qualitative majors are more satisfied with asynchronous than quantitative majors at a significant level of 1% (-0.288) and senior students (proxied as upper-division courses by Year) prefer less asynchronous (-0.107, $p<0.05$). As we evaluate the hybrid and synchronous modality, the number of years in school is not a significant factor.

Model 3 present the critical factors in various graduate programs. Per our hypothesis: H2b MBA learners prefer different online modalities as compared to MS program learners. MS programs are

required to attain more advanced technical skills; thus, we posit that qualitative graduate programs (MBAs) are more satisfied with self-paced and self-regulated online learning than quantitative graduate programs (Master of Science, MS). The results support the notion that MBAs prefer more of an asynchronous format as compared to MS graduate learners (0.509, $p<0.05$).

5. Practical Implications

The recommended application of our structural equation model enables administrators to adapt accordingly to manage course offerings by better aligning modalities with predictive student satisfaction. For example, based upon the regression results of Model 2, the structure of significant factors influencing undergraduate learners' satisfaction is explicitly illustrated in Figure 2 for asynchronous, hybrid, and synchronous. Noticeably, the structure of course-related quality, curriculum rigor, and field of study factors move from complex to simple in the order from asynchronous, hybrid, to synchronous.

[Please insert Figure 2 here.]

Furthermore, we develop a projection table (Table 2) based on our structural equations for asynchronous in undergraduate majors given the estimated coefficients of Model 2.

[Please insert Table 2 here.]

As shown in Table 2, for an upper-division undergraduate course (e.g., Year=3) in quantitative majors (Quan/Qual=1), if college evaluation committee assigns "3" for quality factors: both technology effectiveness and instructor competency, the predicted learners' satisfaction score of this proposed course will be 3.0540 according to our structural model. The college evaluation committee may recommend using a score as a cutoff to determine whether the proposed course modality will meet learners' needs and achieve desired outcomes. For example, if we propose using 3 as neutral, requiring a contingent course offering, a score of <3 would be unsatisfactory, warranting a rejection and score of >3 would be satisfactory calling for approval of the course modality proposal.

Table 2 further reveals patterns consistent with evidence reported in Table 1. As the years in school increase, fewer scores are greater than 3 which suggests senior students prefer less of asynchronous. We denote the curriculum rigor factor of years of experience as a proxy for upper-division vs. lower-division courses taken by learners. Reasonably, upper-level courses are more challenging and require higher-order critical-thinking skills. Hence, senior students prefer more face-to-face interactions, group projects, and class engagement which are relatively difficult to excel in an asynchronous modality.

6. Conclusion

The enhancement of web-based learning platforms has profoundly contributed to the progression of online education. Further fueled by the disruptions of the COVID pandemic, online education has gained momentum in higher education. Our study differs from previous research in several important ways. First, our timely Fall 2020 survey reflects on learner satisfaction across synchronous, asynchronous, and hybrid modalities pertaining to several imperative factors: (1) quality factors: technology effectiveness and instructor competency, (2) field of study factors:

quantitative vs. qualitative majors, and (3) curriculum rigor factors: undergraduate vs. graduate and lower vs. higher division. Accordingly, we used the results to construct structural equations toward predicting student satisfaction with various modalities. Second, the practical implications of adapting our structural equations include guiding college evaluation committees in determining whether specific online teaching modalities will foster learners' satisfaction. Our predictive model factors in diverse online learning experiences with technology and instruction, academic rigor, and fields of study. Third, the scalability of our structural equations allows for the inclusion of other factors based on institutional-specific drivers. As the trends generate continued interest in online program development, our model aims to build sustainable, versatile, and viable online learning systems through incorporating "learners' voices". Using this study, other institutions could replicate the measurement of quality, the field of study, and curriculum factors on student satisfaction to develop unique predictive models. We propose that the resulting model will provide for an objective process of online course approval that centers on the needs of students toward meeting their demands for high-quality online courses offerings.

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Figure 1. Connections between hypotheses and models

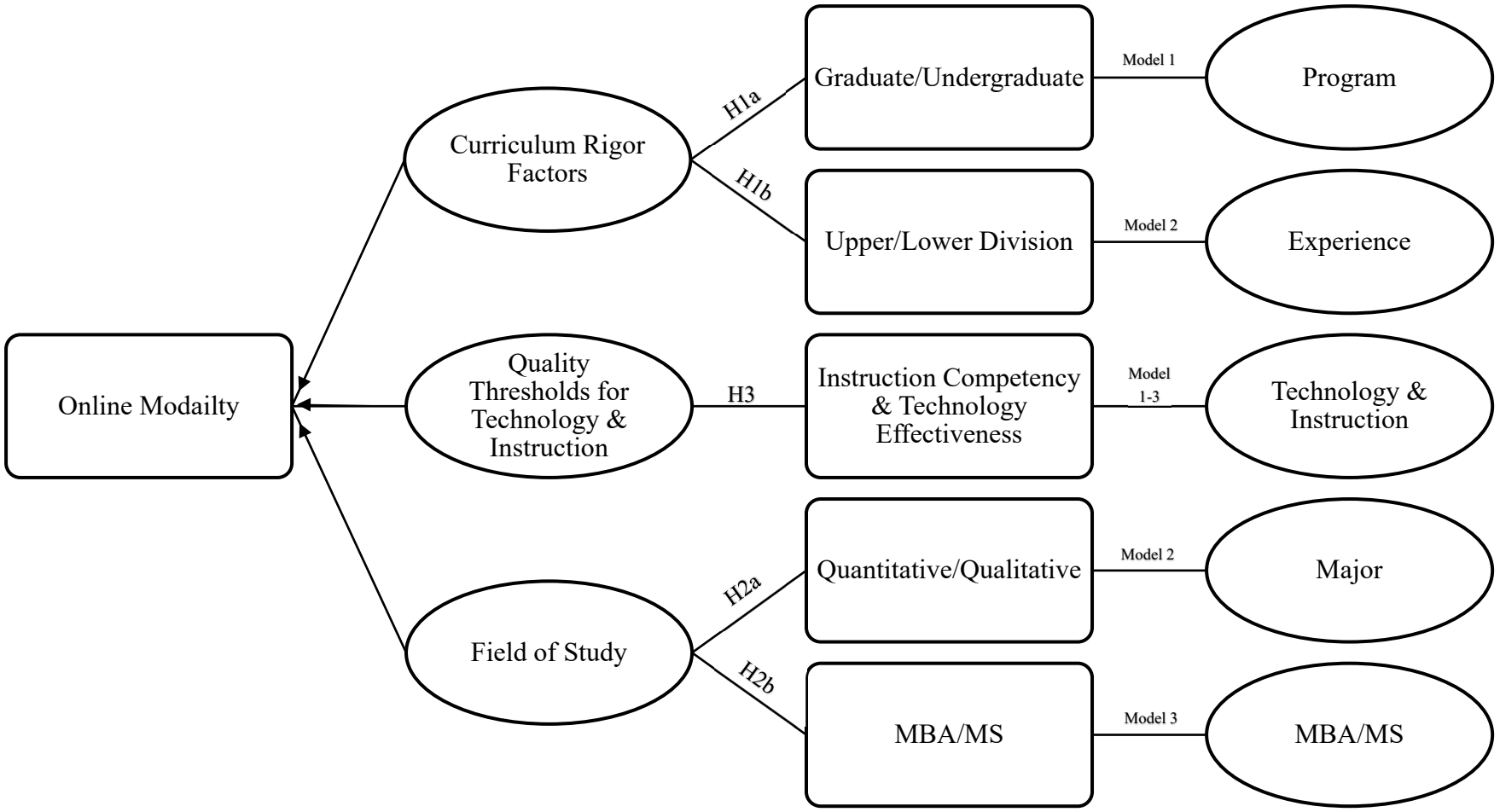

Table 1. Influencing factors to learners' satisfaction between online graduate and undergraduate courses

			Model 1						Model 2 (Undergraduate)						Model 3 (Graduate)					
			Asyn.		Hybrid		Syn.		Asyn.		Hybrid		Syn.		Asyn.		Hybrid		Syn.	
Intercept			1.398	***	2.190	***	1.199	***	2.494	***	2.231	***	1.066	***	0.461		1.403	***	1.689	***
			6.852		12.760		7.849		9.307		9.331		5.022		0.899		3.682		5.048	
Tech			0.199	***	0.255	***	0.279	***	0.190	***	0.199	***	0.279	***	0.170	*	0.325	***	0.268	***
			4.630		6.957		8.527		4.034		4.783		7.419		1.672		4.189		3.922	
Instruction			0.230	***	0.178	***	0.426	***	0.200	***	0.216	***	0.448	***	0.398	***	0.325	***	0.328	***
			4.649		4.217		11.348		3.725		4.533		10.481		3.364		3.614		4.128	
Un/Graduate			0.410	***	-0.071		-0.161	**												
			4.004		-0.826		-2.109													
		Undergraduate																		
		Quan/Qual							-0.288	***	-0.125	*	0.014							
									-3.024		-1.481		0.185							
		Year							-0.107	**	0.009		-0.032							
									-2.109		0.197		-0.807							
		Graduate																		
		MBA/MS													0.509	**	-0.032		-0.097	
															2.060		-0.172		-0.584	
Rsq			0.085		0.117		0.286		0.094		0.107		0.295		0.113		0.192		0.196	
N			969		969		1013		756		747		783		213		222		230	

Notes :

"*", "**", "***" is 10%, 5%, and 1% significance level

Figure 2. Critical factors to undergraduate student satisfaction of online instructional modality based on regression results of Model 2