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COVID-19 Technology Student Success Challenges: Influence of Tools and Strategies

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RESEARCH PAPER

Abstract

COVID-19 brought rapid and substantial change to course formats as colleges and universities transitioned from on-campus to online instruction to mitigate the spread of the pandemic. While faculty and administrators sought solutions to maintain instructional quality and student success, students endeavored to adapt to the changes. This study investigated a) College of Technology students' perceptions of their potential for success including initial reactions, adaptation, and perceptions of impacts to grades and learning; b) course features and tools preferred by Technology students; and c) factors that enabled Technology students' course completion.

1 Introduction

The declaration of COVID-19 as a pandemic brought expansive changes to higher education including massive disruptions to students as they were forced to transition from on-campus to online classes [1, 2]. The move underscored the digital divide among students and society, especially in rural and low-wealth communities [1] and worsened some of higher education's biggest challenges, including funding, student mental health, and inclusion [3]. Faculty scrambled to deliver quality instruction, yet fewer than half had any prior experience with online course delivery [4]. This left them inadequately prepared to adjust teaching practices, transition content to the remote environment, and provide support and remediation to students [4].

The purpose of this study was to investigate student success factors for technology students during the pandemic including, initial reactions, adaptations, and potential for learning. Course features valued by technology students were also studied with before and during pandemic opinions compared. The focus of the study was students enrolled in College of Technology courses in a large urban university. Programs for students enrolled include Biotechnology, Computer Information Systems, Digital Media, Engineering Technology (Computer, Mechanical, Power), Human Resource Development, Retailing and Consumer Science, and Supply Chain and Logistics Technology.

While numerous studies are emerging in the wake of COVID-19, a salient value of this work is its focus on technology students and the inclusion of their perceptions of impacts on grades and ability to learn content. The research questions that guided this work include:

1. How did technology students perceive their potential for success during COVID-19?
2. What course features or tools did technology students value during COVID-19?
3. What factors enabled technology students' course completion?

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2 Review of Literature and Background

2.1 Student Perceptions of Success Potential

In the early years of online education, [5] and [6] expressed recognition that learning can be successfully mediated by technology. Now, years later as the pandemic forced extended use of technologies for learning, both positive and negative results ensued. While examining students' experiences resulting from the abrupt transition to online courses in 2020, one study of 1300 students reported that more than 75 percent of students did not think they were getting a quality learning experience [7]. Another project stated that 67 percent of the surveyed students (14,000) said they did not find online classes as effective as in-person ones [7]. Students reported being unimpressed by the caliber of education they were receiving [8]. Others, dissatisfied by their experience, sought tuition refunds [7] as classes were being taught almost entirely through recorded videos without live lectures or discussions, yielding experience that was not equivalent to what they would have received on campus [8]. While prior to the pandemic, students rated overall learning experiences as 4.47 on a five-point scale, in March 2020 at the start of campus shut-downs, student ratings dropped to 3.11 with an increase to 3.67 by May [9].

Yet, while some students felt they were not learning nor being challenged [10], student reactions were varied. At the onset of the transition to online courses, 24% reported feeling nervous. By May only 6% were nervous, and eventually 28% felt "okay" with remote instruction while 20% felt "resigned" to it [9]. These relatively low percentages for "okay" and "resigned" have implications for educators. Positive responses included that online learning provided opportunities to develop greater understanding of topics by reviewing available resources or recorded lectures, and that online learning gave students more freedom with their schedules [9].

As part of the foundation for academic success, it is noted that students' personal lives were in upheaval. Pandemic related influences included family responsibilities, especially balancing parental and family duties with schoolwork [11–15]; financial hardships and stress due to job loss or wage reductions for self or family members [14, 16–18]; food insecurities [12, 14, 16, 18]; housing concerns [12, 14, 15, 17–19]; mental and physical health [17]; isolation [8, 20, 21]; and technology access [1, 14].

2.2 Academic Continuity

For some students, the harsh realities related to pandemic induced changes meant reconsideration of academic goals and progression toward degrees. More than 13.3 million college students worried about factors related to their financial future including extreme economic uncertainty, rising student debt balances, and a deteriorating job market [22]. Seventy percent of students believed the pandemic made it harder to get a job [22]. Thus, economic instability and uncertainty forced many students to delay or discontinue their education as the only viable option in their struggle to care for families and cover costs associated with obtaining their degree [17].

Common threads in both popular and education-focused literature about pandemic effects were the surge of interest in gap years where students engage in another activity for a year before college [10, 23–25], deferring enrollment [25–27] , and returning or staying at home to attend community college [24, 25, 27, 28]. While research indicated that students who delay enrollment, study part-time, or start at a community college are less likely to graduate from college than those who enroll in a four-year college immediately after high school and attend full-time [24], necessity called for other student options. By April 2020, one in six high school senior students who planned to attend a 4-year college full-time in fall of 2020 no longer planned to do so [24]. Similarly, a National Society of High School Scholars survey, also in April 2020, reported that 32% of students said they wouldn't go to college in fall of 2020 if classes were only online [29], and a second April study reported that 26% of college students said they were unlikely to return to their current college or university for the fall [27].

The option for students to choose community college rather than 4-year college enrollment

included both high school students who decided to begin college at community college rather than a 4-year school as planned [10] and college and university students opting to return home to study [24, 25]. Surveyed parents, too, were dubious of paying full tuition rates for online-only education, with 52% wanting their high school seniors to now enroll in colleges close to home, 56% advocating with their student for a delayed start of January 2021, and 46% supporting attendance at lower cost schools, including community colleges, and then transferring later [27]. Indeed, 10% of seniors who planned to attend 4-year colleges made alternate plans with nearly half planning to enroll at community colleges [10]. Thus, COVID-19 was seen to have substantial impacts on the continuity of students' academic progress as thousands reconsidered their college plans [24].

Many of the results reported here were not the result of formal and rigorous clinical trials, but were results reported through mainstream media channels for established organizations. This is consistent with the nature of the sudden onset of the pandemic and subsequent reactive remediation for its impacts. Further, the survey results cited were addressed to large numbers of students enrolled in higher education, which attests to their usefulness as information sources. What is lacking is a focus on the technology education subset of higher education.

2.3 Course Features

Previous work by the research team revealed that technology students vary in their preferences and use for online instructional tools and course features [30–41]. Other researchers also found variation in student preferences. Saeed, Yang, and Sinnappan [42] focused their early study of student preferences for instructional strategies on students' learning styles, especially in the use of emerging web technologies. Watson, Bishop, and Ferdinand-James [43] ranked course feature preferences as responsiveness to students, engagement with students, prompt feedback, communication among students and instructor, clear expectations, learning guidance, organized courses, meaningful coursework, offering synchronous sessions, and use various instructional methods. Mann and Henneberry [44] focused on student-content, student-instructor, and student-student preferences. Yu [45] found flexible schedules and instant access to be the best course features for students.

Through research during the pandemic, students expressed their reaction to the value of course features related to their transition to online instruction, and the features fell into two categories: technology-based and human-based. Students reacted strongly to the efforts of faculty to create online course delivery modes in as little as eight days [7], often with the assistance of commercial providers of education technology who offered products and services free or with steep discounts anticipating later sales [7]. While most experienced the transition without advance preparation, Alqahtani and Rajkhan [46], in research assessing critical success factors during the pandemic, reported that the readiness of faculty was highly critical. In some cases. Emergency financial aid was available from the Higher Education Emergency Relief Fund (HEEFR) of the CARES Act to enable universities to purchase new technologies including student laptops, hotspots, and other tech tools [1]. As a result, students said 69% of campus administrations and 78% of professors had been supportive during the pandemic [17].

2.4 Technology-Based Course Features

On the technology side, students concluded that their forced experience with online learning meant that everyone needed to become more "tech savvy" [9]. Alqahtani and Rajkhan's [46] study found the most influential factors for E-learning during COVID-19 to be technology management; support for technology; increased student awareness for use of E-learning systems; and demanding a high level of information technology use from instructors, students, and universities. [9] also reported that ninety-six percent of students used their desktop or laptop for coursework while only 14% worked using a mobile device. Courses relied heavily on video conferencing applications [9]. Tools noted as beneficial included Zoom for lectures and classroom interactions through breakout rooms and Google Docs & Google Slides for collaboration [9]. Students felt that video chats were, or felt like, more work than in person discussions, and that these modes

of communication without the social cues available in face-to-face interactions were problematic [19]. Zoom fatigue was real [47]. Interestingly, in some cases, the use of video communications provided an unsettling glimpse of the personal lives of individuals as sessions captured home environments [19].

Yet, course designs were also reported to mitigate some of the negative aspects of technology-based instruction and accentuate the positives. Students expressed that technology added personal touches via online chat groups and virtual office hours [48]. Online material could be produced and delivered in shorter segments of 10 to 15 minutes to retain student attention [48] and online formats offered flexibility for personal time management [9].

These experiences coincide with pre-pandemic student perceptions. Course design was previously found to be important by Reisetter and Boris [49] who reported that poor course design causes student frustrations that can lead to poor learning outcomes. Nath and Ralston-Berg [50] also found that students placed high value on well-organized courses. Additionally, Young and Norgard [51] expressed that students preferred consistent design across courses. This was not possible in the quick transition of courses to online formats.

2.5 Human-Based Course Features

On the human side, students wanted to be seen as individual people and not just as those reacting to learning strategies [9]. They expressed appreciation for faculty who communicated with them, and who offered both structure and flexibility [9]. They valued faculty who provided high quality education and engaged students with the material, even if issues occurred [9]. They experienced frustration, lack of motivation due to changing academic and personal schedules, and anxiety about missing deadlines [9]. Further, they missed in-person interactions [9].

In offering advice to professors and mentors, students mentioned multiple things they wanted known. These related to difficulty focusing, unstable mental health, lack of designated study areas and uninterrupted study time, computer exhaustion, the disruption of the move to online, stress and anxiety, family challenges, and generally how hard online learning was [52]. These desires are consistent with the research findings of Kimble-Hill et al. [53] that found students had to overcome hurdles of technology access, environmental disruptions, and cultural pressures. They wanted empathy, understanding of the abnormal situation, advice about future academic goals, less emphasis on exams and more on course material, motivation and guidance, creation of a strong and collective atmosphere of participation, patience and understanding, lighter workload, and value for the individual [52]. They recommended that peer mentors [14, 24], advisers, and professors offer emotional support and cheer for their success [9].

2.6 Services and Factors Impacting Student Success

Beyond the instructional course features and tools implemented by faculty, academic institutions invested heavily in time and resources to support students. Pre-pandemic, foundation for the value of support services for student success was codified in several quality frameworks. Indicators within these frameworks for quality programs included the "student support dimension" of [54], Quality Matters' "learner support" [55], and Institute for Higher Education Policy's "student support" benchmark [56], During the pandemic, 69% of students reported that campus administrators had been supportive [17]. Programs developed, enhanced, and extended included technology support, for example laptop and Wi-Fi access [1, 7, 17, 18, 25, 57]; financial assistance including scholarships [1], grants and financial aid [13, 14, 17, 58], elimination of account balances [17], free summer classes [17, 24], reduced payment plans [17], and extending job resources to family members [16]; food assistance including food banks and pantries [13, 18], gift cards for groceries [18] , and food delivery services [16]; housing and study space programs [18, 59]; and counseling and advising services including social services advising and referrals [13], mental health counseling [16, 60], mentoring programs [14, 24, 61], academic advising [62], telehealth [16], and increased communications [24, 62].

3 Methodology

The research questions that guided this work about COVID-19 impacts on learning for technology students include:

1. How did technology students perceive their potential for success during COVID-19?
2. What course features or tools did technology students value during COVID-19?
3. What factors enabled technology students' course completion?

Survey methodology was selected for this study. Questionnaires were distributed to 925 technology students enrolled in a Carnegie-designated research university in the United States. The doctoral-granting university, located in a large urban setting, serves 47,000 undergraduate and graduate students, and has one of the most diverse student populations in the U.S. Students enrolled in classes in the College of Technology were selected for this study and almost all were majors in a technology degree program. The survey feature of the Blackboard educational platform was used for students to access and respond to the survey. Blackboard was the platform used by the university and, by the time the survey was administered, all courses had transitioned to online formats.

The questionnaire was designed by the research team and included some items that were adapted from previous research instruments developed and used by the team to investigate student perceptions of course tools and features. (See Appendix A for the full survey.) Items 1 through 12 related to student background included classification, number of previously completed online courses, normal course format, age, GPA, employment status, gender, major, video conferencing tool used in courses, video conferencing tool preferred, number of courses enrolled in spring 2020, and number of classes originally in face-to-face or hybrid formats for spring 2020.

Specific to this investigation, students were then asked in items 13 through 16 to rate the following:

- First reactions to the decision to complete the semester with all online classes
- How well they were able to adapt to a semester in a total online format
- How they believed the change to a total online format affected their overall semester grades
- How they believed the change to a total online format affected their overall learning of content.

Then followed items 17 through 27 asking students to indicate their preference for the use of specific course features. A scale of 1 (no use) to 9 (high use) was used for responses. For items 29 and 30 which were questions asking students to indicate how important a course feature was to their success in a class, a scale of 1 (not important) to 9 (very important) was used.

The questionnaire's item 31 recorded impacts of the pandemic students had experienced including job loss, income decrease, anxiety, difficulty studying at home, contraction of COVID-19, increased job workload, and other or none. The concluding item 32 was an open-ended question asking for comments on factors that enabled successful course completion after the transition to an online format.

For analysis, the survey data from 511 technology student participants were extracted from Blackboard. To complete the survey, students logged into the online learning management system that housed course materials and other course elements for their enrolled courses. Completion of the survey was voluntary, and all responses were anonymous. Using this system, responses were downloaded for analysis into a spreadsheet, with each response record identified by a number assigned to the response record by the learning management system's assessment module. Survey response rate was 55%. Descriptive measures were computed and tables and graphs were created to present the data. These were used to examine and analyze the data for meaning. The open-ended responses were coded and analyzed using the standard text analysis method of keyword extraction followed by tabulation.

4 Findings

4.1 Demographics

As background to interpretation of the findings of this study, Table 1 presents the demographic characteristics of the survey participants.

Table 1. Participant Demographics (N=51)

Age (years)		Gender		Employment	
≤ 30	93%	Female	44%	Full-time	24%
> 30	7%	Male	56%	Part-time	44%
				Student only	32%
GPA				**Classification**	
<2.0	2%			Freshman	21%
2.0-2.5	11%			Sophomore	41%
>2.5-3.0	30%			Junior	28%
>3.0-3.5	32%			Senior	5%
>3.5	25%			Post-baccalaureate/Graduate	5%

Student participants were predominately under 30 years of age (93%), Just over half (56%) were male and just under half (44%) were female. More students worked part-time (44%) than full-time (24%); 57% reported a GPA of 3.0 or higher; and 73% were junior or higher classification.

4.2 Research Question 1

Data related to research question #1 "How did technology students perceive their potential for success during COVID-19?" included attributes related to initial reaction, adaptation, expected impact on semester grades, and anticipation of content learning. Extended investigation of relationships between demographic variables (classification, normal course format, age, and GPA) and expected grades and learning is also reported to enhance understanding.

4.2.1 Reaction to Class Format Change

While many students (41%) were indifferent to the change, 25% showed varying levels of concern and 33% showed levels of relief. From this data it is not possible to infer the reasons for student concern nor relief, but the data does show that 74% of students were either indifferent or relieved by the move to totally online course formats. It is possible that the technology base of the students may have been an influence on their reaction to class format change. In contrast, the 25% of students who expressed concerns provides reason for educators to take notice (see Figure 1).

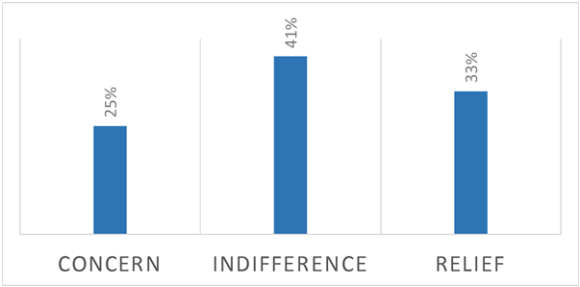


Figure 1. First reaction to the decision to complete the semester with all online classes. (N=511)

4.2.2 Adaptation to Change to Total Online

Student perceptions of adaptation to the change to online course formats indicated both agility in adapting and concerns with 41% of students reporting that they were adapting well, 20% not

adapting well, and 39% noting no difference (see Figure 2). Again, while 80% of students were either adapting well or noting no difference, the 20% of students who were not adapting well is of concern.

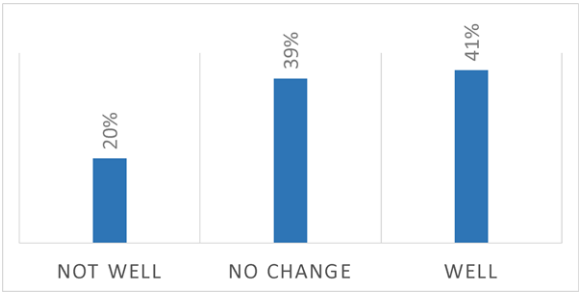


Figure 2. Student Perception of Adaptation to Online Change. (N=511)

4.2.3 Grade Impact

In addition to overall adaptation, technology student responses showed that while a range of perceptions existed, a substantial 60% of students who rated the effect of the change on their semester grades indicated they were not overly concerned about the effect the change had on their grades (see Figure 3). Of particular interest is the finding that 23% of the students expressed their perception that the change to online formats would result in higher semester grades.

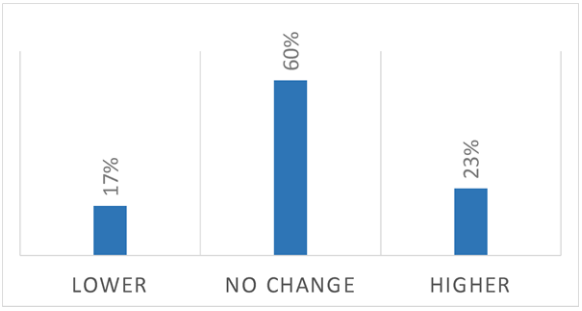


Figure 3. Student Perception of Effect of Change to Online Format on Semester Grades (N=511)

4.2.4 Learning Impact

Additionally, students were given the opportunity to record how they felt the change to a total online format affected their overall learning of course content. While 56% of technology students selected a score between "learned much less" and "learned much more", 30% of the technology students indicated varying levels of less learning (see Figure 4). Since the goal of courses and instruction is to facilitate student learning, the 30% of students whose responses indicated that they learned less is noteworthy. Another factor to consider is how well the applied content and hands-on learning and laboratory activities of technology courses transferred to the online environment.

To further understand technology student perceptions of impacts on grades and learning, analysis was extended to investigation of relationships between demographic variables (classification, normal course format, age, and GPA) and expected grades and learning (see Table 2).

4.2.5 Extended Analysis: Variable Effects on Semester Grades

Students' classification, normal course format, age, and GPA were considered in relation to students' grade impact responses. In general, class standing, or classification did not seem to show

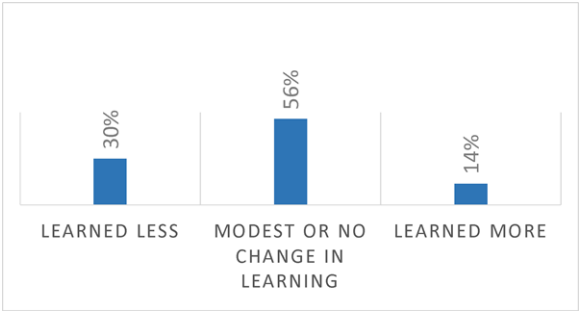


Figure 4. Student Perception of Effect of Change to Online Format on Their Learning. (N=511)

any strong relationship to students' perception of effect on semester grades. For normal course format, it was not surprising that students who had historically taken most of their courses online expected no change in grades. Yet, 31% of students who usually took about half of their courses online anticipated higher grades. This was higher than the 20% of students who anticipated higher grades, but had taken most of their courses in either format. GPA showed an interesting result in that students at the opposite ends of the GPA continuum (less than 2.0 and 3.5 to 4.0) both had higher levels of expectation of "no change" in semester grades (78% and 73% respectively). Additionally, age did not appear to be highly influential in grade perception, with the exception that students aged 30-32 years appeared less inclined to expect higher grades as a result of the pandemic changes than their peers. The results are shown in Table 2.

Table 2. Grade Effect (N=511)

		Grades Lower	No Chg.	Higher
Classification	Fr	15%	54%	31%
	So	13%	70%	17%
	Jr	18%	55%	27%
	Sr	14%	58%	25%
	PB_GR	18%	77%	5%
Normal Class Format	F2F	19%	61%	20%
	Half OL/Half F2F	15%	54%	31%
	OL	10%	71%	20%
GPA	2.0 or less	0%	78%	22%
	2.0 to 2.5	13%	54%	33%
	2.5 to 3.0	19%	54%	27%
	3.0 to 3.5	18%	58%	24%
	3.5 to 4.0	15%	73%	12%
Age	18 - 20	21%	61%	18%
	21 - 23	15%	58%	27%
	24 - 26	15%	60%	24%
	27 - 29	15%	65%	21%
	30 - 32	17%	75%	8%
	33 or older	18%	61%	21%

4.2.6 Extended Analysis: Variable Effects on Learning

Similarly, deeper understanding was sought by analyzing students' perceptions of the influence of the transition to online course formats on their learning of course content in relation to classification, normal course format, GPA, age, and number of hybrids. While it is good to note that about 55% of the students expected "no change" in their learning of course content, it is also alarming that about 30% anticipated lower levels of learning. This split was fairly consistent across

classifications. Not surprising is the finding that the percentage of students expecting to learn less is highest for students who typically enroll in traditional face-to-face classes (35% compared to 26% for mixed and 12% for online formats). Most notable of the age-related findings with regard to learning is that students aged 30-32 years showed more concern that they would learn less in the new online formats than other age groups. It is interesting that students with less than a 2.0 GPA were more likely to think they would learn more in online courses than their peers. The results are in Table 3.

Table 3. Demographic Categories versus Learning Effect (N=511)

		Learning		
		Lower	No Chg.	Higher
Classification	Fr	27%	58%	15%
	So	28%	58%	12%
	Jr	31%	54%	14%
	Sr	28%	58%	14%
	PB_GR	36%	50%	14%
Normal Class Format	F2F	35%	52%	12%
	Half OL/Half F2F	26%	60%	14%
	OL	12%	67%	22%
GPA	2.0 or less	11%	44%	44%
	2.0 to 2.5	17%	61%	22%
	2.5 to 3.0	34%	53%	13%
	3.0 to 3.5	31%	56%	13%
	3.5 to 4.0	32%	59%	9%
Age	18 - 20	32%	54%	14%
	21 - 23	34%	52%	13%
	24 - 26	20%	61%	17%
	27 - 29	18%	74%	9%
	30 - 32	42%	58%	0%
	33 or older	32%	50%	18%
OL/Hybrid	0	5%	89%	5%
	1	23%	70%	7%
	2	21%	56%	22%
	3	39%	51%	10%
	4	34%	51%	13%
	5	37%	39%	20%
	6	40%	40%	20%

4.3 Research Question 2

Findings related to research question #2 "What course features or tools did technology students value during COVID-19?" were designed to provide input for course improvement. Student success during the pandemic-driven transition to online courses was possibly related to the course tools applied. Data was collected to ascertain which tools and course features students valued. Calculated mean scores for 11 course tools or features indicated that most students preferred course materials (e.g. slides, examples, etc.) that were developed by the instructor. The least valued tools were student online presentations and lectures with clickers. Table 4 shows the technology students' summary response values (mean and standard deviation) for eleven course tools or features derived from individual responses about each tool ranging from "No Use", which corresponded to a score of 1, to "High Use", which corresponding to a score of 9. The eleven course tools or features were instructor course materials, asynchronous instructor videos, e-text content, asynchronous discussion boards, non instructor created videos, computer simulations, online collaborative assignments, online synchronous discussions, computer games, student online

presentations, and lectures with clickers. Results are in Table 4, presented in order from the highest mean score to lowest.

Table 4. Student Preferences for Course Tools and Features

Tool	Mean Score (High Use 9 to No Use 1)	SD
Instructor Course Materials	7.3	1.9
Asynchronous Videos	6.3	2.2
e-Text Content	6.2	2.3
Asynchronous Discussion Boards	5.7	2.3
Non Instructor Created Videos	5.7	2.2
Computer Simulations	5.5	2.4
OL Collaborative Activities	5.3	2.4
OL Synchronous Discussions	5.2	2.3
Computer Games	4.6	2.6
Student OL Presentations	4.5	2.4
Lectures w/ Clickers	4.1	2.5

4.3.1 Student Perception of Learning and Value for Course Tools and Features

To further investigate possible interplay between students' anticipated learning and value for course tools and features, cross-tabulations were conducted with results for course tools shown in Table 5.

To understand what the cross tabulated data shows, compare the following summary statements about the course element perceived overall to be most useful (instructor-authored content) versus the course element perceived overall to be the least useful (lectures with clickers).

- Of the students who found instructor-authored content not useful, 73% of them expected to learn about the same (64%) or more (9%). 27% of them expected to learn less.
- Of the students who found instructor-authored content somewhat useful, 69% of them expected to learn about the same (55%) or more (14%). 31% of them expected to learn less.
- Of the students who found instructor-authored content very useful, 70% of them expected to learn about the same (56%) or more (14%). 29% of them expected to learn less.
- Of the students who found lectures with clickers not useful, 63% of them expected to learn about the same (53%) or more (10%). 36% of them expected to learn less.
- Of the students who found lectures with clickers somewhat useful, 76% of them expected to learn about the same (62%) or more (14%). 25% of them expected to learn less.
- Of the students who found lectures with clickers very useful, 74% of them expected to learn about the same (50%) or more (24%). 26% of them expected to learn less.

Thus, when focusing on the tool, not much impact on the tendency to believe learning will increase, decrease, or stay the same is perceptible. However, if focus is placed on the rightmost column, representing students who believe they will learn more, the percent who believe they will learn more increases as the perception of the usefulness of the tool increases. It appears to the authors that students who tend to believe they will learn more, more readily see the usefulness of tools, in general, to aid them.

Results for course features (which were relationship or human interaction based) cross-tabulated with learning perception are presented in Table 6.

Table 5. Relationships Course Tool Preferences and Learning Perception (N=511)

Tool	Learning	Less	Same	More
Instructor Course Material	Not Useful	27%	64%	9%
	Moderate	31%	55%	14%
	Useful	29%	56%	14%
Asynchronous Videos	Not Useful	39%	50%	11%
	Moderate	32%	56%	11%
	Useful	26%	56%	17%
e-text Content	Not Useful	46%	46%	6%
	Moderate	29%	60%	10%
	Useful	27%	54%	19%
Asynchronous Discussion	Not Useful	44%	49%	6%
	Moderate	29%	56%	14%
	Useful	25%	60%	16%
Non Instructor Created Videos	Not Useful	41%	50%	7%
	Moderate	27%	61%	11%
	Useful	30%	50%	19%
Computer Simulations	Not Useful	40%	52%	8%
	Moderate	26%	63%	11%
	Useful	30%	50%	19%
OL Collaborative Activities	Not Useful	36%	53%	11%
	Moderate	28%	60%	10%
	Useful	27%	51%	21%
OL Synchronous Discussions	Not Useful	38%	54%	8%
	Moderate	30%	55%	13%
	Useful	22%	59%	19%
Computer Games	Not Useful	33%	55%	10%
	Moderate	26%	62%	13%
	Useful	32%	48%	19%
Student OL Presentations	Not Useful	32%	57%	11%
	Moderate	30%	57%	12%
	Useful	26%	50%	23%
Lectures w/ Clickers	Not Useful	36%	53%	10%
	Moderate	25%	62%	14%
	Useful	26%	50%	24%

Table 6. Relationships - Instructor Use of Tool and Learning Perception (N=511)

Tool	Use	Learn Less	Same	More
e-mail Response	Less	67%	33%	0%
	Same	19%	71%	9%
	More	31%	53%	15%
Assignment Return in 1 Week	Less	50%	50%	0%
	Same	25%	66%	9%
	More	31%	53%	16%
Technical Support	Less	9%	35%	54%
	Same	4%	44%	53%
	More	1%	26%	73%

From these results, it is interesting to note that those students who less preferred prompt e-mail responses also perceived learning less (67%). Another category, assignment grades returned within one week, also experienced a similar type of result. It is possible that those students who used the feature less also expected to learn less (see Table 6).

4.4 Research Question 3

For analysis of research question 3, "What factors enabled technology students' course completion?", it is first useful to consider the impacts of the COVID-19 pandemic on student's lives. Figure 5 shows the percent of students who experienced each of multiple impacts they were asked about by the survey. Table 7 shows summary statistics for the number of impacts suffered by individual students. Noteworthy is the critical nature of the impacts and the number of impacts affecting students' lives. More than 40% of students experienced household income decreases, anxiety, or increased difficulty in study from home Fewer than 40% of students experienced increased job workload or hours, job loss, or other. Substantially fewer experienced no impacts or a household member having contracted COVID-19. The summary statistics for number of impacts indicate that, on average, students experienced multiple impacts, with the median number of impacts being 3.

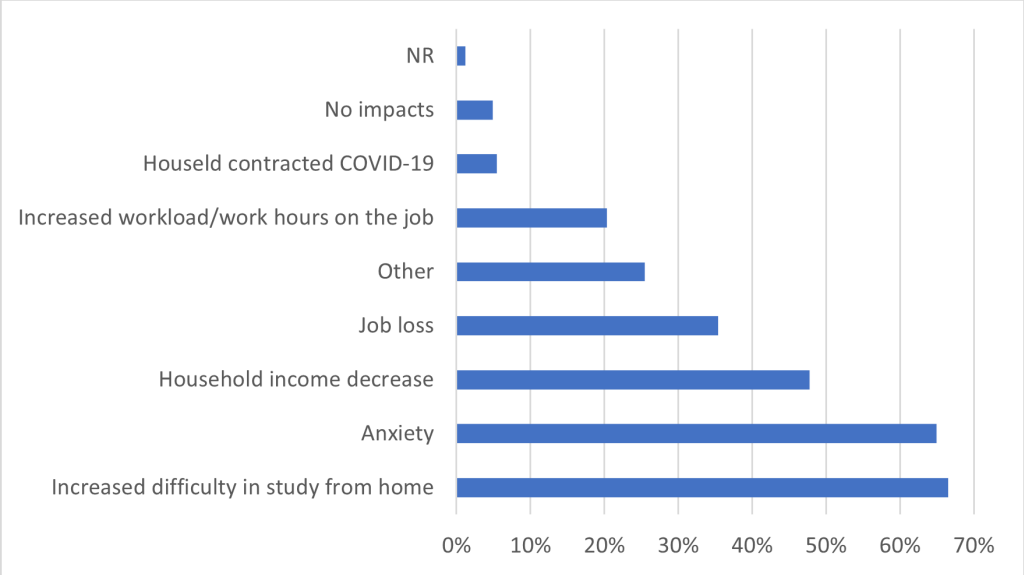


Figure 5. Student Impacts as a Result of the Pandemic (N=511)

Table 7. Number of Impacts per Student

Mean	2.7
Median	3.0
Standard Deviation	1.3
Skewness	-0.07

4.5 Factors to Enable Success

Finally, to illuminate opportunities for faculty and administrators to create improved learning environments for students, they were asked, in an open ended inquiry, to comment briefly on factors that enabled them to successfully complete courses after the transition to online formats. These comments were in addition to the data gathered about course tools and features and already discussed. Most commonly mentioned items were communication and understanding from the

instructor, flexible due dates, and support from a partner or advisor (see Table 8). Recommendations from the students for improvements included increased training for faculty in online delivery and more online resources.

Table 8. Factors that Affected Course Completion

Category	Description	Responses
Communication	instructor communication and understanding	27%
Same	no change, most courses were online already	23%
Extra Time	flexible due dates	20%
Support	support from partner or advisor	7%
Not Successful	transition was not successful for the student	13%
Improvement	student recommended improvement	10%

5 Discussion and Conclusions

The massive transition from on-campus to online course formats, forced by mandated school facility closures, radically changed educational practice both in the short-term during spring of 2020 and, likely, more permanently. Short-term, the exodus from physical campuses meant that both students and faculties accelerated their experiences with online instruction. While some faculty members and students were well-versed and experienced with online learning, others had to rapidly adapt. Long-term, the expectation was that as campuses re-opened, in-class instruction would again be available. Yet, both students and instructors learned to use new computer-based learning tools. Their skills and capabilities grew. Many tried online formats and liked them. This leaves a legacy where both technology students and instructors of technology can build upon newly acquired computer-centric skills and tools to engender continued student learning. While eventually a productive balance will ensue between courses taught on-campus and online, it is likely that even on-campus courses will apply increased levels of computer-based techniques to enhance face-to-face instruction. The application of computer grounded tools and techniques learned during COVID-19 will have lasting impacts on technology education.

This study explored students' perceptions of their potential for success during COVID-19 (research question #1) and provided evidence that initial reaction, adaptation, impact on semester grades, and anticipation of content learning were factors. In general, students showed indifference to the change (41%), concern (25%), and relief (33%); adaptability (41%); and little effect on grades (60%) and learning (56%). While these findings are worthwhile, more important are applications for future online course development to address student concerns that they would learn less with online instruction (30%). This critical study finding has implications for course design as well as computer-based tool selection and use.

Regarding the course features and tools valued by students during COVID-19 (research question #2), greatest value was expressed for instructor created course materials, asynchronous lectures captured as videos, and e-text content. Least value was shown for student online presentations, synchronous online discussions, and online collaboration. This appreciation for instructor-created course materials, including asynchronous video lectures, as well as e-texts indicates that students seek solid content sources and instructor input in their learning tools.

From analysis related to inquiry of question #3 "What factors enabled technology students' course completion?", this research revealed that students had multiple (mean 2.7) personal impacts from COVID-19 including increased difficulty studying from home, anxiety, decreased income, job loss, increased workload, and contraction of COVID-19. Even while attempting to master new technologies themselves, instructors were dealing with students experiencing multiple personal challenges. This finding has substantial implications for recognition that technology faculty have added responsibility to recognize the personal needs of students as they impact learning capabilities. This can be assisted by incorporating the factors given by students to enable course completion including

instructor communication and understanding, flexible due dates, and support from others. Hence, these finding can inform faculty approaches to effective course delivery and student interactions.

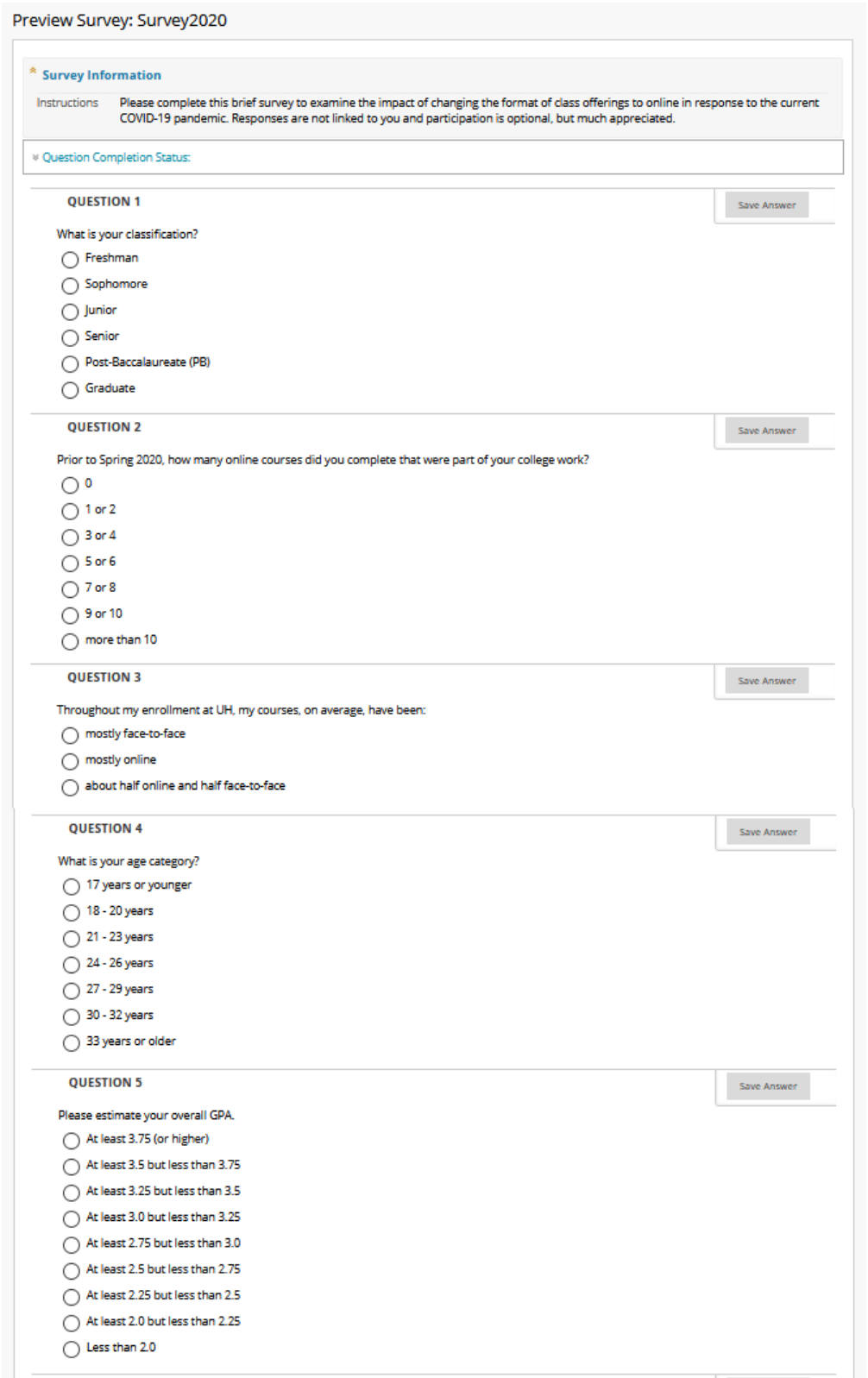
In summary, the findings of this study both collaborate and provides contrast to the existing literature on student adaptation. In contrast, [7] reported that students did not find online classes as effective as in-person ones and Binkley [8] found students to be unimpressed by the caliber of education they were receiving. Yet, in this study, students (70%) reported moderate and even higher levels of learning online. In collaboration, this study mirrors concerns for the upheaval caused by COVID-19 to students' personal lives. [11], [16], [20], [8], [1], [12], [13], [18], [19], [14], [21], [15], [17], and this study all reported on pandemic related influences that created challenges and turmoil for students. Additionally, the findings of this study offer solution input to concerns for academic persistence expressed by [24], [29], and [27].

Importantly, this study also offers student reactions to course features, both technology-based and human-based, extending the research work of [46, 53, 63], [50], [49], and [51]. These perceived impacts of transition to online instruction collaborate and respond to the opinions of [24, 48], [19], [52], [14] [47], and [9]. Finally, the results shared herein reinforce and offer avenues for extended investigation for multiple types of support [1, 7, 13, 14, 17, 24, 25, 57–59, 61, 62].

While this study offered student perceptions of tools and course features that can now be applied to the enhancement of both on-campus and online course design and delivery in the wake of the pandemic, the authors recognize study limitations that should be noted. First, the survey population included only students enrolled in College of Technology courses and, thereby, has limited generalizability to a broader student audience. Similarly, the non-random sampling techniques, self-selection of students who responded, general response rate (55%), and single study institution, while within respected parameters of acceptance, present limitations to generalization and require readers to evaluate, as with any study, the merits of the results for their own use.

In sum, COVID-19 forced rapid expansion of online learning formats. Faculty and students exhibited agility and flexibility in coping. This study offers insight into technology students' perceptions of their potential for success, including reactions to class format change, adaptation to totally online instruction, and impact on grades and learning. It highlights student values for specific course features and tools, and shares factors that enabled students' course completion. These are offered as background and reference to aid in the perpetual drive of ASEE members and others to create effective learning environments for students.

A Appendix A Survey Instrument



Preview Survey: Survey2020

Survey Information

Instructions: Please complete this brief survey to examine the impact of changing the format of class offerings to online in response to the current COVID-19 pandemic. Responses are not linked to you and participation is optional, but much appreciated.

Question Completion Status:

QUESTION 1 — Save Answer

What is your classification?

- ◯ Freshman
- ◯ Sophomore
- ◯ Junior
- ◯ Senior
- ◯ Post-Baccalaureate (PB)
- ◯ Graduate

QUESTION 2 — Save Answer

Prior to Spring 2020, how many online courses did you complete that were part of your college work?

- ◯ 0
- ◯ 1 or 2
- ◯ 3 or 4
- ◯ 5 or 6
- ◯ 7 or 8
- ◯ 9 or 10
- ◯ more than 10

QUESTION 3 — Save Answer

Throughout my enrollment at UH, my courses, on average, have been:

- ◯ mostly face-to-face
- ◯ mostly online
- ◯ about half online and half face-to-face

QUESTION 4 — Save Answer

What is your age category?

- ◯ 17 years or younger
- ◯ 18 - 20 years
- ◯ 21 - 23 years
- ◯ 24 - 26 years
- ◯ 27 - 29 years
- ◯ 30 - 32 years
- ◯ 33 years or older

QUESTION 5 — Save Answer

Please estimate your overall GPA.

- ◯ At least 3.75 (or higher)
- ◯ At least 3.5 but less than 3.75
- ◯ At least 3.25 but less than 3.5
- ◯ At least 3.0 but less than 3.25
- ◯ At least 2.75 but less than 3.0
- ◯ At least 2.5 but less than 2.75
- ◯ At least 2.25 but less than 2.5
- ◯ At least 2.0 but less than 2.25
- ◯ Less than 2.0

QUESTION 6

Save Answer

What is your employment status?

- ◯ Student only, not employed
- ◯ Employed part-time
- ◯ Employed full-time

QUESTION 7

Save Answer

What is your gender?

- ◯ male
- ◯ female

QUESTION 8

Save Answer

My major is:

- ◯ Biotechnology (BTEC)
- ◯ Computer Information Systems (CIS)
- ◯ Computer Engineering Technology (CETE)
- ◯ Construction Management (CMT)
- ◯ Digital Media (DIGM)
- ◯ Electrical Power Engineering Technology (EPET)
- ◯ Human Resource Development (HRD)
- ◯ Mechanical Engineering Technology (MECT)
- ◯ Organizational Leadership and Supervision (TELS) or Technology Leadership and Innovation Management (TLIM)
- ◯ Retailing and Consumer Science (RCS)
- ◯ Supply Chain and Logistics (SCLT)
- ◯ Other

QUESTION 9

Save Answer

The video conferencing tool used in classes that were moved to an online format in Spring 2020 was:

- ◯ MS Teams (only)
- ◯ Zoom (only)
- ◯ Combination (Zoom and/or MS Teams and/or other)
- ◯ Other (Neither Zoom nor MS Teams)

QUESTION 10

Save Answer

What video conferencing tool do you prefer for class, that is, for academic use?

- ◯ No Preference
- ◯ Zoom
- ◯ Prefer Not to Use
- ◯ Other
- ◯ MS Teams

QUESTION 11

Save Answer

What is the total number of classes for which you were enrolled in Spring 2020?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6

QUESTION 12

Save Answer

For Spring 2020, how many of your classes were originally in a face-to-face or hybrid (partially face-to-face) format?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6

QUESTION 13

Save Answer

Rate your first reaction to the decision to complete the semester with all online classes.

- ◯ 1 - Great concern
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 - Indifference
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9 - Great reflief

QUESTION 14

Save Answer

Rate how well you were able to adapt to a semester in a total online format.

- ◯ 1 - Not well
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 - No change
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9 - Very well

QUESTION 15

Save Answer

Rate how you believe the change to a total online format affected your overall semester grades.

- ◯ 1 - Much lower
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 - No change
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9 - Much higher

QUESTION 16

Save Answer

Rate how you believe the change to a total online format affected your overall learning of content.

- ◯ 1 - Learned much less
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 - No change
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9 - Learned much more

QUESTION 17

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

instructor lectures captured as videos for viewing by students on their own schedule (asynchronous)

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 18

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

content-related videos from YouTube (or another free online source), not created by the instructor (asynchronous)

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 19

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

computer games

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 20

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

computer simulations

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 21

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

student online presentations of content related to the course

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 22

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

e-text content (e-books, online articles, online content to be read)

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 23

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

activities (such as assignments) that involve online collaboration

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 24

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

online discussions among course participants (students and instructor) using discussion board tool (asynchronous)

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 25

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

online discussions among course participants (students and instructor) using video conferencing tool (synchronous)

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 26

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

lectures with clickers (these allow students listening to live lectures to respond to questions posed by the lecturer to check for student comprehension of concepts) (synchronous)

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 27

Save Answer

Indicate your preference for the use of the following course feature for classes, in general.

course materials (e.g. presentation slides, detailed examples, templates, etc.) created by the instructor and available for download

- ◯ 9 - high use
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - moderate use
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - no use

QUESTION 28

Save Answer

How important is the following course feature to your success in a class?

Contact information for technical support

- ◯ 9 - very important
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - neutral
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - not important

QUESTION 29

Save Answer

How important is the following course feature to your success in a class?

Prompt response to e-mail by instructor

- ◯ 9 - very important
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - neutral
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - not important

QUESTION 30

Save Answer

How important is the following course feature to your success in the class?

Assignment grades within a week

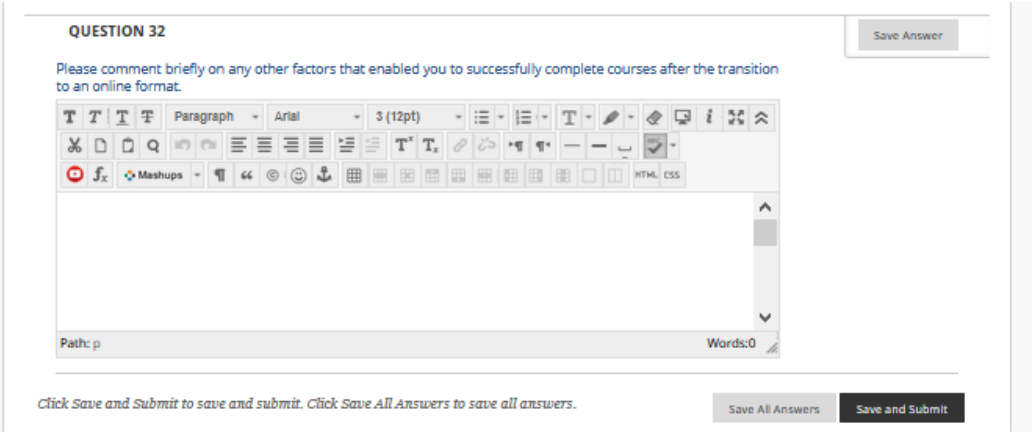
- ◯ 9 - very important
- ◯ 8
- ◯ 7
- ◯ 6
- ◯ 5 - neutral
- ◯ 4
- ◯ 3
- ◯ 2
- ◯ 1 - not important

QUESTION 31

Save Answer

Which of the following impacts have you experienced as a result of the pandemic (mark all impacts that apply or choose 'No impacts')?

- ☐ Job loss
- ☐ Household income decrease
- ☐ Anxiety
- ☐ Increased difficulty in study from home
- ☐ A family or household member or I contracted COVID-19
- ☐ Increased workload/work hours on the job
- ☐ Other
- ☐ No impacts


QUESTION 32
Save Answer
Please comment briefly on any other factors that enabled you to successfully complete courses after the transition to an online format.
Paragraph
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3 (12pt)
Mashups
HTML
CSS
Path: p
Words:0
Click Save and Submit to save and submit. Click Save All Answers to save all answers.
Save All Answers
Save and Submit

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