



Factors influencing undergraduate education in an expanding virtual world during COVID-19

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Abstract

Moving to a virtual platform can introduce barriers beyond access and stability of technology, which may influence students' academic performance. The aim of this study was to identify factors, both personal and technology-related, that students and faculty perceived as contributors to academic performance. Enrolled students and teaching faculty in the Bachelor of Science programs at Rush University were surveyed. Analysis of survey results indicated that mental health and finances hindered students' performance, whereas faculty reported that technology accessibility and stability was the greatest contributor to students' performance. Both groups reported that at-home learning environment contributed to students' academic performance. These results provided insight into factors that impact student academic performance, allowing for appropriate changes to courses and overall curriculum to ensure undergraduates' learning and retention of course material.

Keywords Undergraduate · Virtual platform · Education · Educational challenges · COVID-19

1 Introduction

As COVID-19 continues to surge, subside and resurge, many universities are re-evaluating their use of the virtual platform. The virtual world has expanded in use, pattern of use, and availability of tools as the number of online users has spiked since the start of the pandemic (Beech, 2020; De et al., 2020). More users shop online for food, medications, and other necessities that they may normally do

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in-person. There has also been an increase in digital methods of communication and streaming (De et al., 2020). With initial responses to controlling the spread of COVID-19, universities also moved to a virtual platform. The change in the delivery of education can hinder student learning, particularly without consistent evaluation of content delivery, learning and retention.

The change in the mode of instruction struck university students in many ways, both positive and negative, and continue to do so. The transition of academic coursework to a virtual platform allowed for flexibility and greater access of learning materials; on the other hand, the transition reduced social and learning interactions, and created a greater gap between those unable to access or afford technology and technology services. The unequal access to technology for underrepresented minorities (URM) occurs early in education and continues throughout their academic career with school districts lacking resources, and subsequently resulting in lack of development of technical skills (Margolis et al., 2008). The change to primarily online learning enhanced the inequity in access to technology (Romm, 2020).

The secondary effects of the pandemic (e.g., economic hardship) disproportionately affected URM students, some of whom reported to be struggling with food and technology insecurities (Finkel, 2020). Hispanic and Black/African American undergraduate students were two times and 1.7 times, respectively, more likely to delay graduation relative to Whites (Saw et al., 2020). Students across the country were accepting emergency funds, lowering their coursework credit hours, and overall, missing in-person academic opportunities (Aguilera-Hermida, 2020). Furthermore, enrollment of Hispanic and Black/African American students is down (INSIGHT Staff, 2022; Finkel, 2020). Even though students feel supported, many URM students are struggling with managing school along with taking care of family, financial instability, and struggling with a lack of technology (Finkel, 2020).

While the rapid shift to online learning posed pragmatic challenges, the secondary effects of the pandemic presented additional stressors that impacted learning for students. Stressors regarding financial stability, the health and well-being of loved ones, and the implications that these stressors had on a students' education has not subsided (Cohen et al., 2020). A study suggests that the increase in mental health concerns is linked to the prolonged endurance of anxiety college students face (Son et al., 2020). This study of 195 public university students showed that 71% of students reported increased stress and anxiety due to the COVID-19 pandemic (Son et al., 2020). Additionally, the primary challenges and concerns reported to contribute to students' stress and anxiety included health concern for themselves and family, academic performance, diet, increase workload, financial difficulties, and changes in living environment (Son et al., 2020). An increasing number of studies support such findings related to students' concerns and outline the severity of depression, isolation, and suicidal thoughts, amongst college students (Rodriguez-Hidalgo et al., 2020; Wang et al., 2020; Wilson et al., 2021).

The effect of the COVID-19 pandemic on upper-level undergraduate bachelor's degree seeking population is largely unknown. Initially, academic institutions had little time for reflection or evaluation of new methods of teaching and learning. Students and professors had little time to convert content normally given in-person, immediately to an online format with little training, introducing additional

challenges (Crews et al., 2009; for review see Pokhrel & Chhetri, 2021). The rapid transition to online learning posed challenges for allied health undergraduate programs, including questions about how to teach delivery of patient care and patient assessment as well as teach students how to use medical equipment in a virtual format effectively. As academic institutions begin to evaluate the repercussions of pivoting to online learning platforms and continued shifting methods of implementing curricula, research is needed to understand perceptions of how the secondary effects of COVID-19 influenced students and faculty within undergraduate programs.

This study evaluated the student and faculty perception of how the COVID-19 pandemic influenced access to technology and academic performance within the three undergraduate programs at Rush University during an academic year. These three programs are unique in that the enrolled students are completing their final two years in undergraduate studies to obtain their bachelor's degree. Many of the students work, full time or part time, to manage household finances, and may also have families to care for and/or support. The student composition of each undergraduate programs is diverse, as defined by race, ethnicity, zip code, gender, and age. This study provides valuable insight on the impact of converting course work to a virtual platform among a diverse undergraduate population. Faculty and students must endure a pedagogical shift from traditional, in-person learning to learning in an expanded virtual platform. By understanding factors that contribute to students' academic success, we can innovate and implement alternative teaching and assessment strategies for learning engagement for URM, women and all students alike. Furthermore, without assessment, and re-assessment, of external factors that impact academic performance, long-term learning and retention of information affect a students' academic outcome and future career goals.

2 Methods

2.1 Cohort

For the purposes of this study, students from the Vascular Ultrasound (VU), Imaging Sciences (IS), and Health Sciences (HS) bachelor programs were surveyed. At the time of the survey, the students who matriculated into each of these programs were completing the last two years of their bachelor degree coursework, equating to their junior and senior years of college. Following successful completion of their coursework, they would be granted a bachelor's degree from Rush University. The VU curriculum, prior to the COVID-19 pandemic, was 100% in-person, with in-person labs, patient contact, and stimulations. The IS and HS curriculums are hybrid, with a mix of in-person and online instruction. The HS program has approximately 70% of their classes formatted as online courses. All instruction was virtual in the Spring of 2020. All didactic content remained online for Summer and Fall 2020 and into Spring 2021, with patient contact and lab content moving to in-person format again, which applied primarily to the VU students. All of the online courses, prior to the COVID-19 pandemic, were given in an asynchronous virtual format. All courses

are during regular business hours of 9:00 a.m. to 5:00 p.m., no weekend or evening classes are available for any of the programs. All programs use Blackboard as the learning management system.

2.2 Survey

Active students who registered for coursework in the summer of 2020, fall of 2020, and spring of 2021 from the three bachelor of science programs, listed above, within the College of Health Sciences at Rush University were anonymously surveyed. Active VU, IS and HS faculty who taught in the summer of 2020, fall of 2020, and spring of 2021 were also surveyed. These surveys were not anonymous. The authors of this paper, though teachers, were not included in the survey.

The surveys were designed to address the technology and academic issues as perceived by students and faculty. The student and faculty were asked survey questions regarding online teaching and learning, mental health and academics prior to and during the COVID-19 pandemic. Survey questions were based on student and faculty concerns brought up during formative and summative sessions. Since all students enrolled in courses and active faculty between summer 2020 and spring 2021 were included in the survey, only students that were enrolled in courses prior to and faculty teaching prior to COVID-19 pandemic were asked the additional questions to allow for comparison and evaluate changes in learning and mental health prior to and during the COVID-19 pandemic. Survey questions included ranked, yes/no, and open-ended questions. Students were asked ranked questions on technology stability, accessibility, and impact of finances. Yes/no and open-ended questions were regarding mental health, financial hardships, teaching environment, and additional support needed. Faculty were asked yes/no and open-ended questions regarding technology, student mental health, performance on coursework, and online teaching skills. Faculty were asked to rank supports needed for students and themselves. The number of incompletes and withdrawals were also evaluated from the three bachelor programs during the COVID-19 pandemic using data collected from the University registrar's office. Data is shown as percentage of respondents.

3 Results

3.1 Surveys

Within the College of Health Sciences, three bachelor programs, IS, VU and HS, were assessed using surveys to determine the impact COVID-19 had on technology accessibility, use and overall academics. Though the mission is the programs are different, in general, the programs have students that have not obtained their bachelor's degree. The survey was conducted during a four-week period at the end of the Spring 2021 semester to ensure completion of survey without school obligation of completing coursework or final exams. There were 111 total students enrolled in

the bachelor programs from summer of 2020 onward. Of those students, 49 students responded to the anonymous survey, for a 44% response rate.

Though all programs are diverse, the IS and HS programs have the greatest diversity in that more than 50% of the students are self-identified as URM. URM in health care is currently defined as Black/African American, Hispanic/Latin, Native American, and Hawaiian/Pacific Islander. For example, of the students enrolled in the HS program in Spring 2020, approximately 83% were self-reported URM and 80% were women. Further, 34.7% of students from all program live in zip codes associated with low life expectancy (77.0 years, the US life expectancy (Murphy et al., 2021)) and unemployment rates greater than 10%.

There was a total of 27 active faculty teaching coursework to bachelor students in summer of 2020, fall of 2020 and spring of 2021. Of those active faculty members, 15 responded to the survey, for a 56% response rate. Prior to the COVID-19 pandemic, faculty primarily used the learning management system Blackboard to provide course content to the students for both the virtual and in-person platform. Of the surveyed faculty, 80% have six or more years of teaching experience, with 47% of the faculty with online teaching experience prior to the COVID-19 pandemic.

3.2 Perception of online accessibility

Technology accessibility, as determined by computer and internet availability and stability, is a determining factor in a student's ability to learn material in a virtual format. This is particularly important during the COVID-19 pandemic as all courses were moved to an online format. More than half (67%) of the responding students had taken a course online prior to COVID-19 pandemic, suggesting that students may be versed on the virtual platform. Prior to the COVID-19 pandemic, 88% of students felt that their personal internet stability was excellent, good or adequate to support online learning (Table 1). The perception of stable technology reduced approximately 10% or less throughout the 2020/2021 academic year. Though an average of 12.6% of responding students reported instability in technology throughout the 2020/2021 academic year, more than half of the responding faculty (53%) perceived issues with at home technology, and 27% of the faculty believed it was more academic terms prior to the COVID-19 pandemic.

Table 1 Students' perception of technology stability

	Excellent, Good or adequate	Slow/unstable
Prior to COVID-19	88%	12%
During COVID-19		
Summer 2020	78%	10%
Fall 2020	82%	12%
Spring 2021	83%	16%

Table 2 Students' perception of COVID-19 pandemic contribution to slow/unstable technology

Reduced bandwidth	51%
Lack of funds	29%
Unable to install software	27%
Lack of software on computer	24%
Unable to pay for internet	8%

When asked, students assessed that the reduction of technology stability was largely attributed to reduced internet bandwidth (Table 2).

3.3 Other factors that impacted online learning

Learning can be affected by the students' engagement level, whether in a virtual platform or in-person in the classroom. The ability to learn online can be further impacted due to the home environment, faculty ability, and student perception of online learning. In order to determine mental health, finances and other factors that affected online learning during the COVID-19 pandemic, we surveyed students who had completed coursework in the any of the undergraduate programs prior to and during the COVID-19 pandemic.

Of the students who were eligible to respond to this portion of the survey, 88% felt comfortable with online coursework and 73% felt that faculty were adapting to online teaching. Aligned with student perception, 67% of responding faculty believe that they improved on their teaching skills during the COVID-19 pandemic. Faculty attributed their improvement to practice, increased availability of teaching resources and online tools, and increased comfort with online teaching. Faculty identified that additional support was needed in the areas of course scheduling, communication, more faculty members, increased university budgets for technology, and more training and modules on technology and education.

Of the students who had taken courses within their respective programs prior to the COVID-19 pandemic, 81% of students felt that it was harder to focus on classwork due to the COVID-19 pandemic. The students perceived the hardship was not due to the coursework and content delivery being in a virtual format or faculty adaption to online teaching, as those parameters showed adequate resilience. In fact, 40% of students had someone in their immediate household suffer from financial hardship (Table 3). A high percentage of students also attributed personal and family health as major contributing factor to lack of focus and poor course grades. This can contribute to stress and anxiety, making it more difficult

Table 3 Students' perception on external contribution for lack of focus and/or poor course grades

Learning environment	51%
Personal health	49%
Family health	43%
Finances	40%
Internet stability	30%
Lack of technology	11%

Table 4 Students' perception of improvements that helped during the COVID-19 pandemic

Emergency student funds	41%
Reducing school to increase employment	20%
Borrowed technology from the University technology center	14%
None of these options	39%

Table 5 Needed support during the COVID-19 pandemic

	Student response	Faculty response
Financial Aid	51%	6%
Overall wellness	47%	40%
Flexibility with schedule	43%	53%
Technology	29%	67%
Information about the pandemic	2%	13%

to concentrate on coursework. Interestingly, 51% students expressed learning environment made it hard to focus, however, based on the high percentage of comfort of taking online classes, student may have chosen learning environment in reference to the physical location of taking online classes and the related disturbances/interruptions.

Interestingly, when faculty were asked an opened ended question regarding why students were finding it difficult to focus and doing poor in coursework, faculty reported it was because students did not attend online as frequently as in the classroom, students were not prepared for class and were trying to multi-task during online classes. These data suggest that the learning environment, as perceived by both faculty and students, made it difficult for students to focus on coursework during the COVID-19 pandemic.

Aligned with the external contributors of poor academic performance, faculty reported more students in need of academic extensions, incompletes, or withdrawals from the course and/or program. Twenty percent reported that these student needs increased from previous terms prior to the pandemic. Between Summer 2020 and Spring 2021, 34% students dropped at least one course during one semester, all being either enrolled in the IS or HS program. Of those, 38% dropped more than one class, many taking a leave of absence for a semester or withdrawing from the program.

In an effort to help students and faculty during the COVID-19 pandemic, colleges and universities throughout the country tried to incorporate technology support and improve finances. In fact, the emergency students' funds, supplied by Rush University, had the greatest positive impact on students surveyed. Interestingly, 39% of students who responded did not think that finance and technology support supplied by the university helped ease the negative effects of the pandemic (Table 4c). Furthermore, even with financial support from the university, 20% of students still felt they

had to reduce coursework and increase employment to mitigate the financial impact of the pandemic (Table 4).

In fact, students were interested in having more technology and financial aid support (Table 5). Overall, university focus on student wellness and mental health as well as flexibility with schedule were also important to students during the COVID-19 pandemic (Table 5), suggesting that these two areas should be a focus of improvement.

Interestingly, 67% of the responding faculty believed that students needed more technology support versus 29% of responding students (Table 5). Though a need more student wellness tools and support systems, and flexibility with schedule was identified by both faculty and students, the importance placed on each of these parameters ranked in the opposite direction (Table 5).

4 Discussion

This study surveyed a unique cohort of diverse undergraduate students and provided insight into barriers that students experience that influence their academic performance, beyond access to technology. While some research has shown that technology accessibility and stability was impacted negatively during the COVID-19 pandemic (Asgari et al., 2021), the students in this study did not have a perception that the technology was affected due to COVID-19. By looking semester to semester, the data may not reflect the ebb-and-flow of internet stability, as circumstances may change throughout the semester and students may only be reflecting on the internet situation at the end of the semester. It is also possible that many of the students' experience internet issues prior to COVID-19, and therefore did not see a difference in their accessibility or stability when comparing before and after the pandemic.

It was quite interesting that the overall results show the misperception of faculty for more technology needs for students compared to prior to the pandemic. The access and stability to technology, from the student perception, was slightly reduced during the pandemic (academic year 2020–2021). It is possible that the faculty perception of technology need was based on the shift of contributing factors to technology. Prior to the COVID-19 pandemic, if technology was unreliable, students had access to on-campus computers and wi-fi. Moreover, students were more often on campus due to in-person classes, that at-home technology rarely affected academic performance. The COVID-19 pandemic further exposed the inequity in access to technology (Romm, 2020). Many URM may have adapted to unequal access prior to the pandemic by utilizing technology on campus and not taking online courses. These adjustments were not adequate enough during the pandemic, as access to campus technology is limited and, potentially, still lagging behind. With more courses offering virtual learning, students had to rely on at-home technology more than prior to the COVID-19 pandemic. With more individuals than normal relying on at home technology, reduced bandwidth was a new factor contributing to poor academic performance that was not affected prior to the pandemic.

Since all students, including those in standard grades, were online, along with adults working remotely, the actual network bandwidth was, most likely, reduced.

This would interrupt online learning, particularly if students are required to synchronous participate in lecture using Zoom, or the like. Students can also experience issues with lagging and poor connection. Online testing can also be affected, potentially affected a students' grade. With reduced bandwidth, as students may not get to complete, or may be completing faster in order to avoid disconnection, and the grade is not a true reflection of student academic ability. These issues may not be present if the bandwidth was larger, and therefore may not have been identified by the student as a stability issue.

It is also important to note that bandwidth can have other meanings. The survey asked students to reflect on bandwidth regarding technology, however, the results can be confounded due to its multiple meanings. Bandwidth has also been used to describe the students' ability to obtain and retain information, in other words, a students' cognitive capacity in the brain. When students are experiencing high levels of stress and anxiety, that may or may not manifest clinically, cognitive functions can decline and may be diverted to deal with the stress or anxious event (Verschelden, 2017; Scott et al., 2015). This leaves less bandwidth for learning. Cognitive capacity or bandwidth can be influenced by gender, race, ethnicity, and other insecurities (Verschelden, 2017). The greatest reduced in technology stability was observed in Spring of 2021, one year after the start of the pandemic (Table 1). During this time, more and more classes were being reinstated as in-person, reducing the need for at-home technology. It is possible that students taking the survey may be considering cognitive capacity as a contributor to the perception of technology, not necessarily information transfer (Tables 1 and 2).

The idea of reduced cognitive bandwidth is further validated when students were asked on what factors may have contributed to lack of focus and poor course grades. Lack of technology and stability of technology were the two of lowest concern. Moreover, most students were comfortable with online learning and faculty's ability to adapt to a virtual platform. Student attributed their inability to concentration to personal and family health, learning environment and finances (Table 3). All of these factors can contribute to stress and anxiety, limiting cognitive capacity. With limited bandwidth, students would be unable to focus on the coursework, complete assignments to the best of their cognitive ability, and ultimately their grade would suffer. Interestingly, faculty did not perceive finances and overall mental health/wellness as needed support for students in the same capacity as students perceived the need (Table 5).

The shift of bandwidth to concerns of health, environment, and finances from schoolwork coincides with Maslow's hierarchy of needs. It is usually presented as a five-tier pyramid model of human needs with basic needs, such as security, food, water, warmth, at the bottom of the pyramid. Maslow believed that individuals must satisfy the lower level of need on the pyramid, prior to progression up to psychological and self-fulfillment needs (Maslow, 1943). Due to concerns about health, environment (security and safety), and finances, COVID-19 has shifted student needs so that they must focus on meeting basic needs (bottom of the pyramid) before considering school work. The focus on basic needs has limited cognitive capacity for school work.

A similar bandwidth issue may have affected faculty. The switch from in-person teaching to online teaching requires a lot of attention, additional faculty, technology learning support and training. Though faculty perceived that the greatest student needs was resources in technology, it may be that the limited bandwidth faculty was experiencing was being projected as a student need. Though faculty may have had concern about personal and family health, financially, faculty tend to be more secure. Since lower needs, are for the most part, being met, faculty are able to shift a greater attention to work. As such, faculty and students believe that online teaching improved throughout the course of the COVID-19 pandemic.

The data from this study allowed our program to develop recommendations for faculty to improve student learning, engagement and retention. Wellness/mental health was identified as an area for improvement, and self-care should be incorporated into both the program/department and university wellness programs. Monthly workshops facilitated by psychologists or social workers help with not only providing students with tools to handle stress and anxiety but can also provide a sense of community or belongingness during a time of physical quarantine. These workshops or forums can provide a safe space for students to ask questions and express needs, as many may not feel comfortable going to program faculty.

Changes that can be made to address the importance of flexibility to students include faculty offering alternative assignments, considering the limited bandwidth or cognitive capacity, as long as the lecture and course objectives are being met. Faculty can also offer flexibility in due date, if it does not hinder progression of the course. Instead of offering one day as the due date, provide a range, maybe even during a weekend. The faculty can base the range of dates on when he/she will be grading the assessment. Many times, faculty may have a Friday due date, but will not grade until Monday. Those additional days during the weekend can be given to the students to complete the assignment or assessment.

Having different options for assessment (ex. a reflection paper or a short answer test) allows for flexibility and takes into consideration different learning styles and cognitive capacity. For example, faculty can offer

- reflection papers or journaling
- discussion boards where a student serves as a discussion leader
- writing or answering case studies
- working through or creating a game
- creating a brochure or information packet for a patient population
- having students assess each other's class notes
- have students writing test/quiz questions

These alternative methods may also better engage a student to the course. Continuous feedback is also critical with online learning. Without consistent and constant communication between faculty and student, a student can disengage. Faculty tend to ask students to ask questions, without the consideration that students may not know how to ask the question or even what to ask. Instead, having mandatory meetings where the faculty can engage with the student allows for faculty to determine level of learning and what may need to be re-explained. Development of an

information bank within a program, department or college can help faculty change content quickly, or gain an assessment tool to help students engage and learn.

The data collected from this survey provided a lens to factors that contributed to poor student performance, beyond technological concerns. Continual assessment using surveys such as this can provide faculty insight allowing them to become more aware of student needs, allowing for appropriate course adjustments. As the pandemic continues, programs need to continue assessing the faculty and students to determine the factors that are influencing academics. These factors may change, or may have greater impact, as the pandemic continues to surge, subside and resurge. Understanding the pattern of factors, such as wellness/mental health, that are influencing poor academic outcome by consistent and regular assessment can allow faculty and programs to mitigate poor grades, low graduation rates, or withdrawal from education. Furthermore, the insight can force faculty to innovate the learning and assessment material, overall improving the course, student engagement, academic performance, and retention of information. Though these may not be new problems, in light of the pandemic, we do have to look for new solutions. The solutions that were available prior to the pandemic are either no longer guaranteed or stable solutions as we continue to maneuver through additional variants.

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Author contributions Brinda Desai Bradaric analyzed and interpreted all student and faculty data and was a major contributor in writing and editing of the manuscript. Dina Batlivala Tresselt interpreted student and faculty data results and was a major contributor in writing and editing of the manuscript. All authors have read and approved the final manuscript.

Data availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Data will be de-identified when shared.

Code availability The surveys used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval None of the data presented in this manuscript is misrepresented and authors have maintained integrity of the research and presentation as outlined by the rules of the journal.

Consent Study-specific approval by the appropriate committee was not required for this study.

Competing interests The authors have no competing interest to declare that are relevant to the content of this article.

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