Technological Momentum of Online Education: How Student Experiences Have Evolved Over Time Through Online Instruction

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

The COVID-19 pandemic is currently affecting the lives of millions worldwide and is forcing the members of society to make changes to multiple aspects of their daily lifestyles. One element that has changed significantly is education; in order to limit the spread of the virus, many schools and universities have adopted online instruction. *The Chronicle of Higher education* evaluated almost 3000 universities' plans for their Fall 2020 semesters, and only 4% of them decided to operate as usual, with all courses being taught in person ("Here's Our List of Colleges' Reopening Models", 2020). In order to ensure the success of the transitions to online education that the pandemic has forced many institutions into, it is vital to research how students are able to navigate their new learning environments.

The University of Virginia is one instance of an institution where instruction has been moved to an online format for many classes. For the course Program and Data Representation, known as CS 2150, the ability to efficiently provide support to students remains a priority. The technical project that is being completed consists of the continuation of previous work on an online platform that will host course tools. One feature of this system is the office hours queue, where students are able to request assistance during scheduled times and Teaching Assistants (TA's) have the ability to assign and unassign students to themselves. A ticketing system to help instructors and TA's respond to student requests is being implemented and added to the course management system.

Education plays an important role in the development of a society, deemed as "the foundation of society" (Idris et al., 2012, p. 443). Making sure everyone has the proper opportunity to receive the best education they can will help facilitate growth and advancement. However, online instruction can create barriers to learning that students must face. Research into

student opinions and experiences with online education and their development over time is being conducted to investigate the relationship between education and technology utilized in online learning and gain information to help facilitate future progression of online education. This relationship between society and technology is being analyzed through the lens of technological momentum in order to provide insight into mitigating existing problems as well as preventing the formation of new ones. The research that is being completed will be framed by the following question: How has the relationship between education and instructional tools influenced students' opinions and experiences pertaining to online learning over time?

Literature Review

Technological Framework

In order to answer the research question posed above, the role of education in society is being evaluated in the context of the theoretical framework, technological momentum. Technological momentum, coined by Thomas P. Hughes, "infers that social development shapes and is shaped by technology" (1994, p. 102). Technological determinism is another idea that instead claims "technical forces determine social and cultural changes" (Hughes, 1994, p. 102). Social constructivists assert that the opposite is true, where "social and cultural forces determine technical change" (Hughes, 1994, p. 102). Technological momentum takes characteristics of both social construction as well as technological determinism without restricting the relationship between technology and society to one resembling cause and effect (Hughes, 1994); it can fill the gap that exists between technological determinism and social construction. This view on technology and society also allows for complexity with the include of the element of time that drives momentum (Hughes, 1994). Opponents of technological momentum argue that it is at its

root technological determinism because technology is still placed at a central position, but Hughes argues that society and technology are equally influential to each other (1994).

Technological Momentum between Education and Technology

Analyzing student opinions and experiences over time using technological momentum as a lens can help identify trends within online education and create the potential to solve problems that currently exist within the field. Existing literature provides evidence of the link between online education and the relationship between technology and society. Hoadley (2016) claims that "learning is more of a social process than a mental one" (p. 31). Idris et al. (2012) writes that the "Main purpose of education is to educate individuals within society, to prepare and qualify them for work in economy as well as to integrate people into society and teach them values and morals of society" (p. 444). These statements reaffirm the idea that education is an important component of a society, so showing how education and technology influence each other is used to reinforce the idea that the relationship between society and technology can be described using technological momentum.

There are many arguments that display the influences technology and education have on each other. Cloete (2017) identifies technological development as the "most important factor in initiating and expanding distance, online and blended learning" (p. 2). Alalshaikh (2015) defines globalization as the "phenomenon in which rapid advancements in information and communication technologies have led to dynamic, real-time communication across different time zones, the breaking down of barriers so that global trade may prosper as well as increasing diversity as waves of people cross borders in order to seek opportunities in different lands" (p. 68). Globalization has also led to increased specializations in careers, so people who are looking for targeted education are willing to take part in distance learning in order to obtain it

(Alalshaikh, 2015). The increasing number of professions that exist in different societies require technologies used in education to adapt to the changing demands of future professionals. Distance learning also can allow students to learn from universities in other countries, and so cultural differences also need to be accounted for when educators are designing their instruction plans (Alalshaikh, 2015). When incorporating technology into their teaching, educators must do so in a way that does not hinder the learning of those students who come from diverse backgrounds. Another piece of evidence that supports the intertwined relationship of technology and society comes from Dabbagh (2004), who claims that "the compatible bonding of telecommunication technologies and social constructivist learning principles premised a pedagogical ecology" (pp. 27-28). Advances in technology have allowed instruction to become more flexible and have provided alternative methods of communication between educators and students, but different aspects of society must still be accounted for when integrating these technologies into educational purposes.

Online Learning and the COVID-19 Pandemic

Technological innovations have become integrated into almost every aspect of people's everyday lives. The way people communicate with each other has become digitized, transportation now relies heavily on technology, and technology provides tools in education (Alalshaikh, 2015). In 2020, a new virus, COVID-19, has created a global pandemic that has forced people to adapt to new changes. In order to limit the spread of the disease, people must limit their interactions with others, and this has led to many school closures. Teachers and students are now forced to adapt to these new changes, with many institutions moving to a virtual format, so education can continue without risking the lives of their students and employees.

Online learning existed prior to COVID-19, but it has not been used to the same degree that was necessary to respond to the global pandemic. Alalshaikh (2015) discusses different forms of distance education, with online learning being one of them. He describes online learning as the "more contemporary version of distance learning that enhances access to educational opportunities for nontraditional and even unprivileged learners" (Alalshaikh, 2015, p. 71). Online learning has allowed students to continue learning and developing skills that will help them face society's demands (Schneider & Meirovich, 2020). However, students face many barriers to learning that are created or facilitated by online instruction. The exclusion of interactions between students with their peers as well as with their instructors can lead to students easily getting bored or distracted, which will affect the effectiveness of their learning (Chang, 2020). Students who grew up in different societal backgrounds also have to face different challenges; for example, some households may have limited access to the Internet (Silva, 2020), and international students have to navigate different time zones (Eidt, 2020). Combatting students' challenges and responding to their opinions is important to the success of online education.

Case Studies and Discourse Analysis

In order to investigate students' experiences with online tools and educational technologies, three case studies were examined. The first was a survey conducted in 2004 at the Open University of Hong Kong by Shin and Chan. The University had developed an Online Learning Environment (OLE) for courses taught in Chinese and English. Questions were created that included wordings like "'I believe' or 'I feel' in order to capture a respondent's subjective state of mind" (Shin & Chan, 2004, p. 279). Factors that were measured were students' engagements in the OLE, which measured how often students logged in to the course site,

institutional presence, which allowed students to communicate how supported they felt by the university, learning outcomes, which were the "gains" students thought they received from OLE courses, satisfaction with the course and their overall experience, and intent-to-persist, which showed how likely a student was to remain at their university (Shin & Chan, 2004). They received 285 responses out of 746 students that were enrolled who consisted of both undergraduate and postgraduate students. Through analysis of the responses, it was found that "students active in logging in to their course web site tended to report greater gains from the course than students less active in the same course" (Shin & Chan, 2004, p. 284) for courses with an optional OLE. This suggests that for students who have the option to use online tools and choose to utilize it may get more out of the course than those who do not. For students in courses with compulsory OLE, "their involvement in the OLE was significantly linked to their perceptions of institutional presence" (Shin & Chan, 2004, pp. 284-285). This indicates that when students feel more connected to their instructors and their institution, they may be more active in using the tools provided to them. In this study, it was also found that variances in student backgrounds also influenced their interactions with online learning; self-assessed internet skill was the variable that most affected students in this study (Shin & Chan, 2004). This shows that making sure students have the ability to receive guidance and instruction when becoming accustomed to new online learning environments is important.

Another study was done in 2016 by Gemmell and Harrison, who surveyed 64 students taking courses for an online master's degree in public health in the United Kingdom (UK). The demographics that were available to analyze were "age, gender, previous online study, full- or part-time status, fee-paying status, year of study, region of residence and region of

origin" (Gemmell & Harrison, 2016, p. 70). Many of the results were separated in order to explore differences between students who were from the UK or Europe and those who were not. They found that students whose regions of origin were not in Europe accessed on average, 7.3 out of 14 learning support resources, while the average for students whose regions of origin were in Europe was only 5.7. This was surprising to the study organizers as the students whose regions of residence were outside of Europe also faced more technical difficulties (Gemmell & Harrison, 2016). However, there was no statistically significant difference, "the direction of the correlations implied a positive association between self-efficacy for e-learning and help-seeking behaviours and a negative association between self-efficacy for e-learning and experience of technical difficulties" (Gemmell & Harrison, 2016, p. 74). Students in this study were also able to present barriers they faced when attempting to access support materials, such as internet connectivity issues, time differences and technical skills.

The last study that was looked at was the most recent one, taking place in 2020 during the COVID-19 pandemic (Ana et al.). Students who studied in various universities in Malaysia and Indonesia were surveyed about their experiences after their education was transitioned to an online format. 136 students responded, with most (88%) of them being between 17 and 22 years old. Over half of the students agreed that preparation for their e-learning was quite easy, but more students had negative perceptions of "the aspects of conducting lectures through e-learning" (Ana et al., 2020, p. 21) than positive; however, the largest percentage was made up of students who were held neutral opinions. Other notable results from this study were that 41% of respondents disagreed that e-learning can increase students' motivations to learn, 39% of respondents were dissatisfied with their e-learning usage, and 50% of respondents felt that e-learning was more passive than normal instruction (Ana et al., 2020). However, for many of the

questions about their e-learning experiences, many students stayed neutral in their responses. Ana et al. (2020) also discusses advantages and disadvantages of online education, with the main advantage being that learning can be done anytime, anywhere, while its disadvantages include the reliance on internet quality and the need for students' self-discipline.

Advances in technology have helped to make online instruction easier for students and educators to navigate. Recorded – or pre-recorded – lectures can be paused so students can work at their own paces; many of these recordings also have subtitles available, which helps students who may not fully understand what professors are saying (Eidt, 2020). However, the sudden shifts to online instruction due to the COVID-19 pandemic have also brought to light weaknesses that still exist in online learning. Yuwen Wan is a student at Ohio State University who chose to stay at home in China for her fall semester (Eidt, 2020). She had to adjust her schedule in extreme ways, with her synchronous courses taking place at midnight and 5:30 in the morning. Time differences have been an issue, as mentioned in the 2016 study conducted by Gemmell and Harrison, and continue to inconvenience students whose universities are not in the same time zone as their residences. Recognizing and figuring out ways to combat this is important if online learning is to become a prominent means of education in the future. Another student, Yutong Guo, who also stayed in China for the fall, faced challenges due to her internet connection in China, making uploading homework assignments take a long time (Eidt, 2020). In both the 2016 and 2020 cases mentioned above, internet connectivity issues have also been barriers to learning for students around the world. In 2020, the National Education Association reported that before the pandemic, "one quarter of households with children ages 5 to 17 lacked either high-speed Wi-Fi, a computer or both" (Kamanetz, 2020). The percentage was greater for students with homes near the poverty line. Technical competency was another factor presented in the 2004 and

2016 cases, and remains to be an issue to students of different ages. The director of the Center for Technology Innovation at the Brookings Institution, Nicol Turner Lee, has said "Eight months after schools first shut down, how many students still can't sign on? We don't really know, and that's a problem" (Kamanetz, 2020). Students should know or be told how to operate the technologies they are required to use in order to learn. The existence of these issues may prevent online education from being seen as an equivalent alternative to standard face-to-face education. Through a survey conducted in 2006, it was found that employers preferred "applicants who received traditional training instead of an online degree" (Cloete, 2017, p. 3). By mitigating these problems, the reputation of online learning may increase. Even though technology has continued to advance, the improvements that have been made have not solved the present issues, hindering student success.

Satori and the Student Experience

The technical project that is being worked on alongside this research paper is a new course management system, designated as "Satori." Currently, CS 2150 employs "Course Tools," a platform made in the early 2000s. The class size continues to grow, with the Spring 2021 roster containing more than 500 students, but the initial office hours queue was not created to handle this volume of students during busy sessions. The system becomes glitchy, with problems including students being kicked off the queue randomly, the queue freezing at inconsistent times, and having a slow response time during busy office hour times. In addition, the support request tool also has a slow response time when there is a large amount of student request tickets in the system and is not compatible with Gradescope, a system that the instructors have begun to use for automatic assignment grading and feedback.

Last year, another group began work on the new platform, designated as "Satori." The current team is making additions to this system. This project will be directed by Professor Aaron Bloomfield in the Computer Science department in the School of Engineering and Applied Sciences. The project consists on building onto the office hours queue that was created by the previous group where students add themselves to when they need help on assignments, as well as creating a ticketing system for student requests if they need an extension on an assignment or need to reach out to the course staff directly. These features are adaptations of similar existing tools used in CS 2150. Improvement on these features will help large courses be able to manage students and allow the course staff to interact with and help as many students as possible, as studies have shown that going to office hours increases students' overall learnings and scores in the course (Guerrero & Rod, 2013). The team hopes that by using this system, instructors and students will be able to have an easier-to-use and more cohesive course management system, especially with the course being completely online due to the COVID-19 global pandemic. Another goal of the project is to advance the student experience in order to improve their opinions on online learning as well as their academic performance.

Conclusion

This research paper aims to prove that there are many barriers to the success of online learning as well as identify some of these issues. The technical project described in this paper hopes to improve the experiences of students taking CS 2150. By providing an intuitive platform, the team hopes to encourage students to take advantage of the assistance that is being made available to them. However, this project alone cannot solve all of the issues the course has with online learning.

Through examining the case studies and other instances of students' opinions, some long-lasting issues were identified. Many of these issues do not just have one cause and cannot be solved easily. Cloete (2017) states that "access to technology and technological literacy are a part of the challenges faced in a developing country" (p. 4), so these problems need more than just technological advancement. As shown above, technological momentum can be used to describe the relationship between education and technology, so resolving challenges in online learning needs to account for both societal and technological influences.

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