

**Assessing the Impact of Information Technology in Higher Education at  
China's Universities Pre/Post COVID**

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**by**

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## **Abstract**

WPI students and a student team from Beijing University of Chemical Technology (BUCT) worked with BUCT to create a framework for online education in universities pre and post the Covid-19 pandemic. Keyword analyses were used to research opinions on remote learning and its future implementation in higher education. To justify the results, qualitative and quantitative data collection in the form of interviews and surveys was performed. This report outlines the background, methodology, and the findings of this study. With this information, a conclusion and several recommendations were developed for the sponsor as a guideline for the continued use of online platforms in universities after the pandemic.

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## **Executive Summary**

This project report is divided into 5 main sections: the introduction; the background; the methodology; the findings & analysis; and the conclusion plus recommendations. The overall goal of this project is to study the impact and role of online education during the pandemic and how it will impact the future beyond the pandemic.

## **Background**

The background section of this report covers the contextual information surrounding the project sponsor, Beijing University of Chemical Technology (BUCT) and the implementation of education during the pandemic. Firstly, it addresses the background of the sponsor, discussing the purpose of the study, as well as the sponsor's intentions. BUCT is a higher education organization located in Beijing, China, focusing on the study of sciences, technology, engineering, and mathematics. The BUCT, along with every other educational institution, was forced to entertain remote learning due to the dangers of the pandemic. Following the recognition of the COVID-19 virus, all schools were forced to cease teaching, making all students take a two-week break. The Chinese Ministry of Education underwent a series of changes during this time, particularly ensuring that all students were capable of learning remotely. During this time there were a series of infrastructural changes and improvements to make remote learning viable. The new mode of teaching was never before seen on such a large scale, causing transitional issues for both students and professors adjusting to the new platforms.

## **Methodology**

The team's methodology for this project consisted of three objectives as presented below:

1. Identify protocols and technologies used during the pandemic to determine the presence and quality of online education in Chinese Universities.
2. Synthesize the necessary analysis of the technologies and resources involved during the pandemic and how they may be implemented past the pandemic.

3. Compose recommendations for our liaison, BUCT, including an in-depth analysis of online education and its role in the future of higher education.

Objective one encompasses gathering quantitative data from BUCT students through an online web-based survey. This online survey consisted of 14 questions that elicited student opinions on online education during the pandemic and their recommendations for future use of online platforms after the pandemic. The survey was spread through a snowballing effect and the final number of respondents tallied 104 students. Statistical results from this survey were collected and graphed into significant categories to be analyzed. Students that were still interested in the project signed up for one-on-one interviews for further questioning.

Objective two consisted of one-on-one interviews between our team and students and staff from BUCT. These interviews were short conversations regarding qualitative experiences and opinions on personal findings of online education during the pandemic. Professors and students harped on the multiple advantages and disadvantages of online platforms. The results were compiled into keyword analyses and graphed into bar charts to portray findings.

Objective three concluded the team's findings from the previous two objectives into a visual format of bar graphs, pie charts, and a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis table. The SWOT analysis table provided a concise visual acknowledging the strengths, weaknesses, opportunities, and threats to online education. Statistical data was graphed and inputted into a final PowerPoint presentation that succinctly showcased important correlations and findings between our survey question results and one-on-one interviews. Ultimately, a conclusion and several recommendations to implement online education after the pandemic were drawn from this objective.

The project's data analysis was done for both the survey questionnaire and one-on-one interviews following the plan detailed in the methodology. The survey questions focused on a series of closed-ended analyses for the majority of the questions. The data analysis shows that the majority of students believe BUCT implemented remote learning at an above-average level. Furthermore, grades during the time spent remote mostly either remained the same or improved

by some margin, which is a major positive for remote learning. Some students even indicated that they would be willing to take other online fully remote courses, and most students encouraged hybrid courses. Specific questions were selected and compared against other questions to draw more in-depth conclusions. For example, a question ascertaining if student grades increased or decreased was commonly plotted against other questions since it can be used as a reference of success. This method was used to note any correlations between different impacting factors, such as mental health or network issues.

## **Data Analysis**

The data analysis for the individual interviews with students and professors was more open-ended responses. The team used a series of different analysis methods to analyze this data, such as word frequency analysis and categorization. Student participants often noted the benefits of remote learning in these interviews. The most prominent feature mentioned by students was the ability to join meetings online and via content digitally. These can be major benefits for students since digital content allows the student to review the lecture material as often as they desire. The individual professor interviews focused on the role of technology in their classroom, and if they will continue remote learning to any capacity. Most professors noted that online information technology can play a major role in advancing and improving the educational system. The tools that remote learning provides to students and professors can exhibit major benefits if the challenges of remote learning can be overcome. The analyses for these professor responses were mostly done via the categorization of the responses.

## **Conclusion**

After analyzing our findings, we derived two key takeaways:

- Most students surveyed were willing to learn remotely. Many students claimed that their learning experience was unaltered or even improved by remote learning. Remote learning going forward is likely to have a high adoption rate amongst students.

- Professors largely viewed the opportunities that remote education brought positively. While they expressed difficulty with some technical aspects, remote learning paired with proper training is likely to be endorsed by professors/staff.

## **Recommendations**

Based on our conclusions and data collection, we've compiled a set of recommendations about what to look for in remote learning technology and when to implement it. The full recommendation report can be found in the recommendation section of this paper. We found that four main features are important to ensuring the quality of remote education:

- A communication network between students, classes, and schools is important especially now. Communication is important to share new developments in a constantly changing academic landscape and to share experiences to improve the still rapidly developing field of online education.
- The standardization of platforms will help with accessibility. Features such as asynchronous access to course material, timed modules, and common file types should become standard to benefit everyone and make the usage of remote platforms easier to learn.
- Improvements to networking infrastructure are a major sticking point. High-speed internet access must become more common before remote learning is standard.
- The integration of different remote learning technologies is also very important. The ability to take data from forums, real-time polls, and assignments and use them between different pieces of software is a capability that wasn't possible in the traditional classroom setting and could greatly increase the overall quality of education.

We also recommend that further study be conducted on remote learning. Our research is limited to students of the STEM field, so a diversified sampling would provide a more holistic picture.

## **I . Introduction**

The COVID-19 pandemic has highlighted the need for robust remote learning technologies within Chinese universities. Before the pandemic, Chinese universities normally incorporated online aspects to their style of teaching in addition to traditional paper handouts, but this minimum reliance on virtual platforms soon changed with the rise of the COVID pandemic. The escalation of the COVID-19 virus on December 31<sup>st</sup> 2019, (Hoseinpour et al, 2020) has caused significant implications on school systems throughout the world. Countries such as the United States, Italy, and China had the most confirmed fatalities, and it was becoming more and more apparent that the virus would not simply disappear (Hoseinpour et al, 2020). These countries were required to adapt to this new landscape, transforming all aspects of life. Specifically, all events that involved in-person activities were required to be drastically altered. This was no exception for China since the Chinese government enacted national policies that bound each University to the new stipulations proposed on education which prompted universities to quickly transition to fully online learning.

However, each University responded differently to the potential danger of COVID-19, and the policies implemented by the government. In response to this sudden conversion in technology and schooling, Chinese students have adapted to the new norm of learning online and relying on hybrid virtual programs where the instructor can both synchronously and asynchronously interact with their students. Notably, educators found that simply following and relaying a similar school schedule online was impractical. To combat distractions and stipulated learning, teachers redesigned their classes by shortening pre-recorded lectures and live classes. The solution to this chaotic learning environment was managing and maintaining a good system for online learning, which proved to be a challenging task as teachers strived to provide newer means to learning through the internet.

One particular institution of interest in this research is the Beijing University of Chemical Technology (BUCT). BUCT is a highly renowned multidisciplinary university directly under the Ministry of Education specializing in chemical technology. Like the majority of universities in China, BUCT's transition to fully online courses proved to be a struggle. However, as time passed, China's unprecedented experience in online education provided wider lessons about how

best to structure remote learning. Online learning has also awakened an interest in teachers, parents, and students, as well as tech giants, to further improve technology.

Despite a heightened focus on primary education, universities in China face the same problem of not being able to effectively teach students to the standard of in-person learning. The goal of our research paper is to recommend ways to improve current online learning platforms for both students and faculty to establish a new understanding of higher education technology in China. By understanding how the learning and management systems in China were created and built, people can begin to understand the issues and concerns with the current systems, and solutions going forward. Students and faculty were required to adjust to these new systems, while still maintaining the integrity required in higher education. Furthermore, reviewing the assisting technology instituted during the pandemic to further education will provide insight into used technologies during the education atmosphere.

## II. Background

This background presents an overview of the components necessary to understand online education in China as a direct result of the COVID-19 pandemic. This background is split into seven different sections. The first section introduces the sponsor for this research assignment and addresses their involvement in Chinese education. The second section covers the government policies and actions that led to the online education platform in China. The third section delves into specific implementations that universities implemented for students and faculty remote learning. The fourth section analyzes the response from faculty members as a result of being required to shift to the online platform. The fifth section encompasses the difficulties and opinions of students adjusting to the online system. The sixth component addresses the future of education in China and addresses how technology can be built upon. The seventh section focuses on the gaps in the current literature on the topic.

### 2.1 Beijing University of Chemical Technology



Figure 1: Image of BUCT Campus (AdmissionPool, 2006).

Beijing University of Chemical Technology (BUCT) is a high-education university located in Chaoyang, China, and was founded in 1958. BUCT is a highly respected university responsible for basic and applied scientific research including, high-tech development, innovative talent, original research, and the training of professional students into the workforce. Beijing University of Chemical Technology is also a national key university directly affiliated with the Ministry of Education of the People's Republic of China and is one of the Project 211

universities and 985 Project Innovation Platforms (BUCT.edu, 2021). As a multi-disciplinary university based on a solid foundation in engineering and science, BUCT strives to produce top-grade students on an exceptional level that will impact not only China's economy but that of the entire globe. BUCT has a total of 14 colleges with 25,739 active full-time students. The university provides an enhanced education with a fully staffed faculty equipped with a vast knowledge of chemical technology. BUCT is also ranked #538 in Best Global Universities (U.S.News.com, 2021). The university has made considerable strides in the fields of science and technology as well as integrating academic disciplines of economics, law, liberal arts, education, and medicine into its curriculum. As a comprehensive outlook, BUCT has its foundation firmly planted on the national and global stage. The university is a key contributor in both the national '211 Project' and the '985 Advantage Subject Innovation Platform,' while also pursuing its original goal of advanced scientific research. BUCT continues to build upon its reputation as the dedicated University of cutting-edge innovativeness within an ever-changing environment.

## **2.2 Transition to Online Learning due to the Pandemic**

Online education in China was practiced before the pandemic, although not extensively as it is being utilized today. It was first instituted in 1999 in a series of conventional universities, such as Tsinghua University, Zhejiang University, and Peking University, and the goal of this was to establish an open education system focused on learning (Ding, Niu & Han, 2020). By April 2002, a total of 67 conventional universities had been approved to carry out e-learning pilot projects, and the Ministry of Education established guidelines for the development of online learning, with a focus on active development for students and standardized administration by the universities. Over time the number of students enrolled in online educational classes provided by universities increased drastically, however, the number of students was small compared to enrolled students in 2020 (Ding, Niu & Han, 2020).





Figure 2: COVID-19 Cases as of 4/13/2020 (Wahab, 2020).

Despite the advancements in online learning in years prior the current system was not sufficient for the pandemic, causing the Chinese Ministry of Education to enact the policy initiative “Suspending Classes Without Stopping Learning”, with the primary purpose of continuing education during the pandemic (Huang, Liu, et al., 2020). To accomplish this enormous task, the Ministry of Education called upon several education specialists and university community members to begin collecting and analyzing information and communication technology. To give context to the scenario that the Chinese Ministry of Education faced, in 2019 the Chinese Ministry of Education conducted a study that concluded that there were about 518,800 schools at all levels, with about 276 million students, and 16,728,500 full-time teachers, meaning about 300 million individuals were required to adapt to the new system (Huang, Liu, et al., 2020).

The “Suspending Classes Without Stopping Learning” initiative during the pandemic would provide millions of faculty and students with the ability to continue their education in the virtual setting, however, there were some immediate challenges the Ministry of Education faced. One major issue was the national resources around the country that supported online learning were unequally distributed. Network services are different from region to region, with more developed regions, such as cities, having more advanced network services. This produced an unbalanced learning experience for students since those in more developed regions had a technological advantage. The integration of national resources for online learning around the

country became a top priority for the Ministry of Education as they attempted to guarantee the provision of network service resources. To accomplish this task of distribution the Ministry of Education partnered with several companies to improve and maintain public service platforms and school networks. The companies, including the China Education and Scientific Research Computer Network, China Mobile, China Telecom, China Unicom, and China Satellite Communication, focused on increasing the internet bandwidth in the country to ensure that learners can access the resources and technologies for online learning (Zhang et al, 2020).

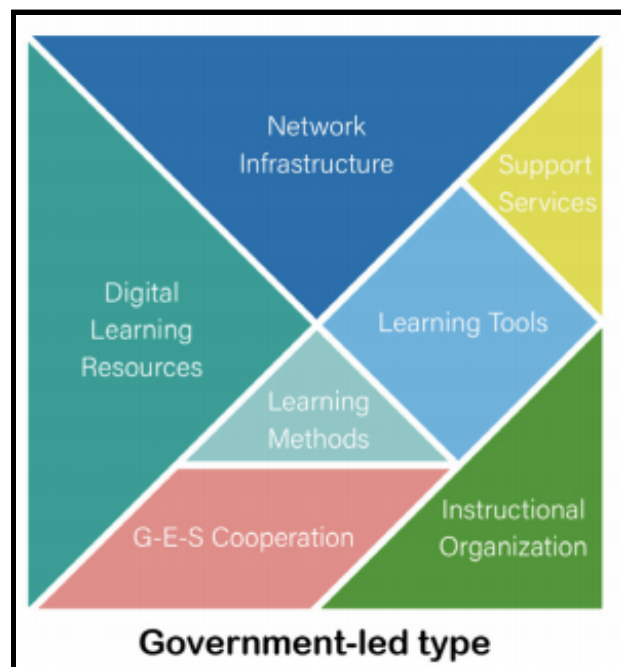


Figure 3: Government Led Improvements (Huang, Liu, et al., 2020)

### 2.3 Current Online/Virtual Learning Platforms

\_\_\_\_\_Universities both in China and worldwide were forced to entertain online lectures with each university implementing the strategies and methods differently. Factors such as resources, money, and faculty numbers impacted these universities' ability to implement different tactics. For example, universities with more income can get better and more useful supplies for their students. However, despite these individual factors, each university had similar implementation systems and techniques. The majority of universities implement three types of educational platforms, leaving it to the discretion of the professor to decide which to implement.

Live synchronous lectures are the main mode of education for professors across China, and this consists of streaming the lecture to students via streaming platforms. Students would join the lecture on the streaming service and be joined by their fellow students and the professor. This approach is quite popular due to it resembling the traditional teaching model in that it is easy to communicate with students and allows professors to continue lecturing to students. Multiple different simulcast platforms are viable resources for the synchronous platform, with each resource having advantages and disadvantages, different platforms are chosen depending on the demands of the professor, be they interaction, network quality, or convenience. Common streaming platforms include, but are not limited to, Rain-classroom, Tencent Classroom, ClassIn, CCtalk, TencentQQ, Wechat, DingTalk, ZOOM (Huang, Liu, et al., 2020). Learning tools such as Tencent Classroom and Rain-classroom have the capabilities of live lecturing and lecture recording, allowing students to have greater freedom of choice in online activities (Bai et al, 2020). Overall, this method provides teachers and students with a time structure, interaction between parties, and a sense of presence in the classroom (Xue, Li, Li, & Shang, 2020).



Figure 4: Common remote learning tools/software.

Pre-recorded asynchronous lectures are another popular form of the educational method utilized during the pandemic. Typically, professors record and upload the prepared teaching resources to the online learning platform, during the week, and students have the freedom to

review and watch the lecture on their own time. Asynchronous video recordings allow the learning behavior for the student to be freely adjusted since they can watch the recording whenever they desire. Professors using this model forgo an open model of educational resources, meaning that “teaching resources are not limited to professors' lectures, and can be linked and interacted with online educational resources” (Bai et al, 2020). For example, PowerPoint presentations can supplement material by providing students with notes on what the professor will be covering. The disadvantage of asynchronous lectures is that they limit student-teacher interactions by not opening a line of dialog between the student and the professor. (Xue, Li, & Xu, 2020).

A unique form of education particularly due to the pandemic is the flipped classroom structure that many professors have implemented during the academic year. For this strategy, professors would post asynchronous lectures, and students would be required to watch the lecture before class time. During class time professors would host office hours, where the students are free to ask questions and interact with the professor and their peers, attendance is not always mandatory. The flipped classroom structure implements "blended learning" since it incorporates multiple educational strategies, which helps to build a relationship between teacher and student and promotes the development of teaching resources and time (Xue, Li, & Xu, 2020).

A series of invaluable studies have been conducted on the impact of Covid-19 on education, especially in terms of online education. One study called “Strategies, methods, and problems of online education in China during the epidemic” analyzed the online education strategy of “ Undisrupted Learning ” in 22 provinces of China. The paper noted five main issues with online education, with them being, participation, network and technology stability, teacher’s familiarity with technology, lack of progress in the classroom, and lack of interaction in the classroom. These issues are identified showing the difficulties of online learning, and present challenges that must be overcome for the future of remote learning. For example, network stability and technology accessibility must be improved before remote learning can become a valid teaching platform in the future.

One study, “Covid - 19 and online teaching in higher education: A case study of Peking university” analyzed the different methods of remote learning implemented at Peking University,

and how they can be applied at other universities. Among the different methods implemented the study noted a few as crucial. Firstly, emergency preparedness plans for unexpected problems were integral to a system capable of responding to issues. The school required faculty to prepare different plans of action if one failed. For example, if synchronous lecturing failed, then the professor should have a recorded lecture (Bao, 2020). Secondly, Peking university divided the content into subunits to help students focus. Many Chinese college students have shown weak persistence in online learning, which increases learning effectiveness (Li, Wu, Yao, & Zhu, 2013). To ensure that students concentrate on online study, the faculty broke down the content into different topics (Bao, 2020). Lastly, the paper concluded that universities need to combine online learning and offline self-learning effectively. Faculty should consider two phases of teaching, the offline self-learning phase and the online teaching phase (Bao, 2020).

#### **2.4 Implications of Online Teaching on Professors**

The transition to online learning came with a slew of new challenges not only for students and policymakers but also for school faculty. Professors were forced to adapt to using online tools in place of their typical in-person workflow. Over the course of the first wave of the pandemic, the number of daily active users in most online education apps went up by an average of 47% (Cen & Sun, 2020). Faculty were forced to virtually demonstrate course material, restructure courses towards a more online nature, deal with student access to technology, keep student attention, and much more. Specifically, older Professors with little technological experience had a hard time adjusting to an online setting, since they have less exposure to video conferencing and other online platforms used during the pandemic.

Faculty did not have the training needed for remote learning, for such, they were required to undergo specific training and workshops to prepare to teach and structure their in-person classes. Unfortunately, in a crisis like COVID-19, there is very little time to get professors adjusted to a new teaching style. A case study of Peking University revealed that the vast majority of teachers were evaluated to have insufficient training to use and provide online resources to their students (Bao, 2020). One proposed suggestion for smoothing out the learning curve was the increased use of Open Educational Practices (OEP) to supplement material made by the professor. OEPs are already a common staple in classrooms around the world,

characterized by a problem-set, reading, or other educational resources accessible to many professors at no cost with active contribution to the material encouraged (Huang and Tlili, 2020). Figure 2 outlines the principles behind OEPs and how they can contribute to making online education easier, such as by opening up resources to be assessed and validated by multiple professors. This research shows that a very simple way of assisting University faculty would be to educate them on the existence of such resources. The Chinese Ministry of Education posts resources of this nature specifically for the use of their universities.

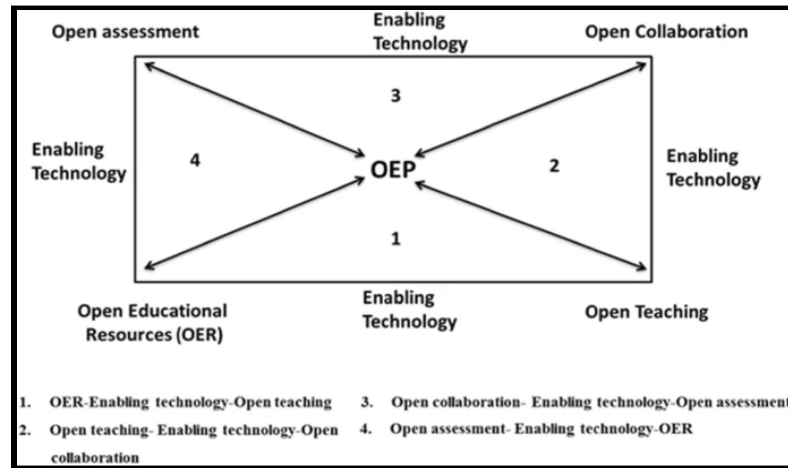


Figure 5: OEP Framework for Open Education (Huang and Tlili, 2020).

Despite struggles in the transition to online learning, many professors still see the OEP framework as a viable learning method of teaching according to a case study of Chinese Universities (Weixin He, John Xiao, 2020). This suggests that a more permanent switch to remote learning may be in the best interests of some students and faculty.

School faculty also encountered issues retaining the attention of students for long periods of time in an online environment. A proposed solution to this was to shorten course modules to brief, 20-25 minute, sessions in order to maximize retention (Bao, 2020). Shortening modules also allows professors to take advantage of the online nature of remote classes and organize class resources more comprehensively. These tools and methods can provide professors with valuable resources to more effectively utilize remote learning in the future.

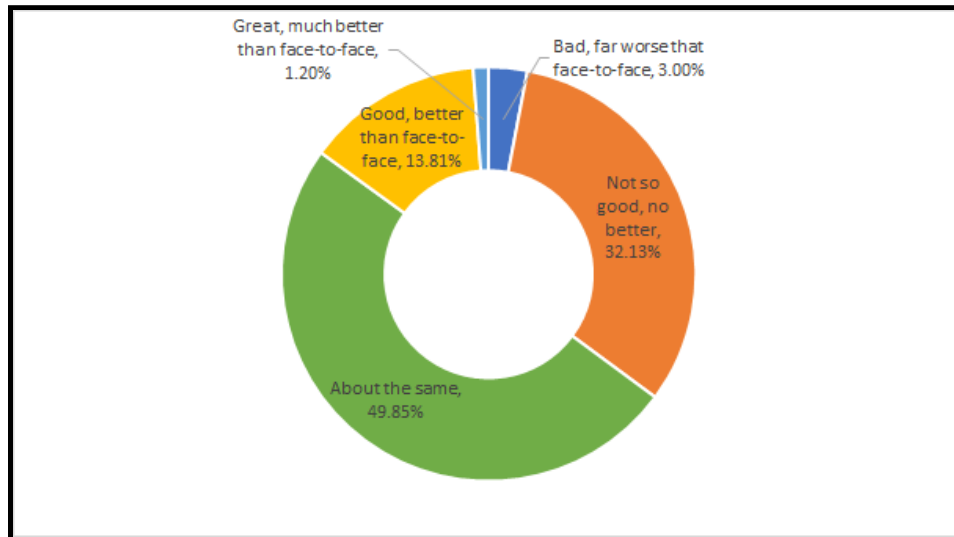


Figure 6: Views of Online vs. In-person Effectiveness (Weixin He, John Xiao, 2020).

Lastly, professors could no longer rely on in-person means of displaying course material, such as chalkboards and whiteboards. This caused great difficulty for professors that would typically rely heavily on visualizing their material. To counteract this, professors spent time developing many different forms of visual aids for the course, such as PowerPoint or videos (Bao, 2020). PowerPoint presentations can provide students with visual notes on what the professor will be covering (Bai et al, 2020). Furthermore, professors that opted to teach remote courses asynchronously needed to record lectures on their own time, and upload them for students to view. This caused professors to spend hours recording lectures that would otherwise be taught live. Other factors such as internet speed caused difficulty for professors in terms of disconnection when uploading lectures online, and presenting live lectures (Bao, 2020).

## 2.5 Social/Technical Impacts on Students

Transition to virtual learning has numerous effects on the student community. For most higher-education students' careers, in-person learning has provided hands-on experience and a multitude of tools for students to succeed. However, with the rise of the pandemic, all universities and schools in China have turned to online teaching as their main platform of educational learning. These virtual systems are complex and often challenging for students to manage. Not only is the transition to working on assignments online and scanning in documents a hassle, but students are also subjected to the negative consequences of self-management.

Without the need for in-person meetings and synchronous class schedules, students often feel discouraged to work on their assignments promptly.

One study at the Beijing Normal University called “China’s Internationalized Higher Education During Covid-19: Collective Student Autoethnography” addressed the specific opinions and concerns of the students attending the university. The student testimonies offer reflections on Chinese education, experiences of online teaching and learning, reflections on university mechanisms, and discussions on coping strategies in Chinese international higher education (Peters, Wang, et al., 2020). These experiences provide important inputs to global discussions about the future of the world, after Covid-19, and the potential impacts of information technology in education. One student stated “To make matters worse, the university imposed a lockdown on students living on campus. This move drowned my hope and academic energy and replaced them with fear and stress.” (Peters, Wang, et al., 2020) The reports in this paper are a valuable source of student opinions and emotions on the controversial and serious changes due to the pandemic. For example, students felt that remote education was not adequate, yet it was necessary and provided potential benefits, such as asynchronous lectures.

### **2.5.1 Mental Health Impacts on Students**

In other situations, students can be influenced and distracted from outside sources like the internet and social media (Huang, Tlili, et al., 2020). Other health studies on online education showcase how these negative influences hinder the effectiveness of online teaching sites like Zoom and Voov. Besides, most virtual teaching sites are not secure and equipped with the right preventive measures to block out external distractions. An example of this would be “Zoom bombings”. Zoom bombings are incidents when unauthorized individuals get access to structured course calls to simply disrupt students from learning. Students are often overwhelmed with the tasks given at hand and the stress of not being able to directly confront the instructor or have easy access to resources builds up over time. This can lead to substandard results as 56.8 percent of students are experiencing depression-like symptoms (Yu, Tian, Cui, & Wu, 2021). Online learning systems focused on just specifically learning cause physiological damage to students in this process. Although this research on depression addressed how students were affected by the seclusive aspects of virtual learning, it did not address potential recommendations to mitigate



issues. All in all, these interferences play critical roles in hindering the effectiveness of virtual learning, and these consequences shape how students are affected by online education.

Variables	N (%)	Depressive symptoms		$\chi^2$ or Z	P-value
		No, n (%)	Yes, n (%)		
Perceived more stress				-4.911	< 0.001
Disagree	486 (28.9)	255 (52.5)	231 (47.5)		
Equal	684 (40.7)	282 (41.2)	402 (58.8)		
Agree	511 (30.4)	189 (37.0)	322 (63.0)		
Overall satisfaction				20.720	< 0.001
Satisfaction	1071 (63.7)	507 (47.3)	564 (52.7)		
Dissatisfaction	610 (36.3)	219 (35.9)	391 (64.1)		

Figure 7: Relationship between online education and depression (Yu, Tian, Cui, & Wu, 2021)

## 2.6 The Future of Online Education

One field of study in terms of online learning is the potential remote learning holds in terms of the future. A research paper called “[Education in and After Covid-19: Immediate Responses and Long-Term Visions](#)”, was written about a case study at Beijing Normal University (BNU). The paper addresses the impacts that the Covid-19 virus had on education, including long-term impacts, specifically the Beijing Normal University’s opinions on continuing online learning. (Zhu & Liu, 2020). It notes that post-pandemic national teaching could be composed of face-to-face teacher education, and online teacher education, creating a more diverse system for students. This urges an advocate for the development of a holistic teacher education system, which could support present and future teachers in becoming more resilient to crises similar to the Covid-19 pandemic. Overall, these discuss how the pandemic can lead to a shift from traditional, teacher-centered, and lecture-based activities towards more student-centered activities including group activities, discussions, and hands-on learning activities, which were common during the pandemic (Zhu & Liu, 2020). The paper noted the need for developing staff–teachers’ online teaching skills, encouraging cooperation between universities to promote high-quality online learning, and quantitative and qualitative research evaluating current models of online teaching and learning. However, the paper mostly focuses on if students are likely to continue to attend these online courses post-pandemic. A potential way to

further the paper is to analyze how online learning can be implemented across multiple Chinese universities, as well as ascertain opinions on the potential benefits of remote classes.

## **2.7 Gaps in the Research and Summary**

To build off the many studies completed by other researchers in this field, studies must further analyze the future of education after the pandemic is over, for example, by studying if professors will continue to implement asynchronous lectures. The research must be conducted on a large scale to assure accurate results and reflect the opinions of multiple students. The majority of the current studies only analyze the means and methods of the present, not looking into the future of education. The pandemic has clearly shown that online education can be a major success, although it does have some concerns. Questions such as, do the technologies used currently have any role in the future, will asynchronous lectures continue to be a benefit past the pandemic, and what safety protocols could be instituted to prevent such an educational disaster in the future, are all valid research topics. Furthermore, online education should continue to be a relevant education method, especially since it provides a valid means of decentralizing local educational differences, and making an equal education system, due to the increased access to resources (Huang, Tlili, et al., 2020). The technologies that have had major success and should continue to be implemented and developed for future use. All potential recommendations about the continuation of online learning must be supported by positive students' opinions. Our proposal aimed to address the future of remote education in the Chinese Educational system.

### III. Methodology

The goal of our research is to establish a new understanding of the effects of the COVID-19 pandemic on higher education in China and analyze the role of technology in the new online landscape. By understanding how remote learning technologies were created and built, we can begin to understand the issues and concerns with current methods of online teaching and explore new solutions going forward. The goals of the project were accomplished by implementing the following research objectives:

1. Identify protocols and technologies used during the pandemic to determine the presence and quality of online education in Chinese universities.
  - A. Document the opinions of students on how remote learning was handled by BUCT.
2. Synthesize the necessary analysis of the technologies and resources involved during the pandemic and how they may be implemented past the pandemic.
3. Compose recommendations for our liaison, Beijing University of Chemical Engineering, including an in-depth analysis of online education and its role in the future of higher education.

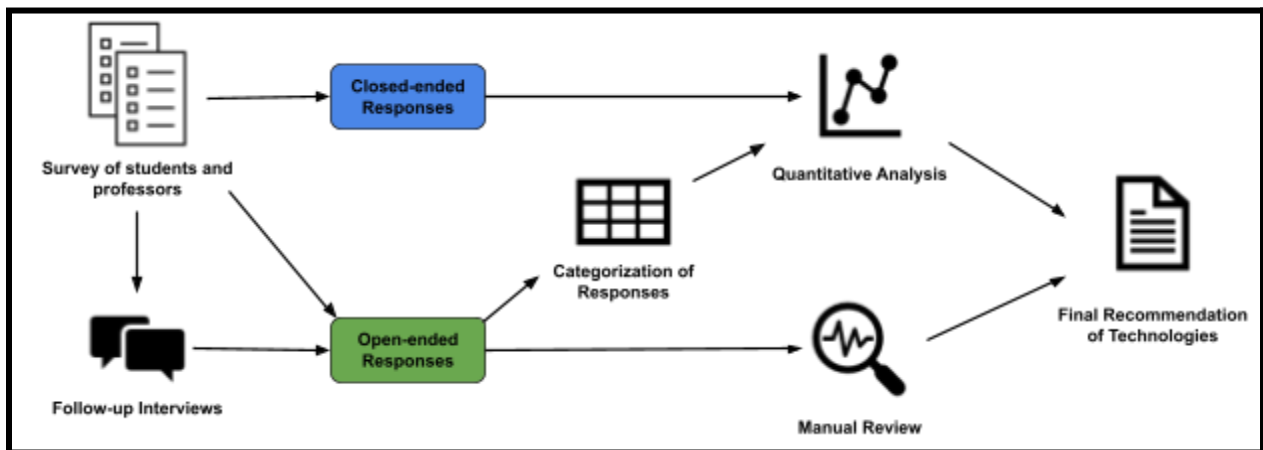


Figure 8: Flow-chart outlining our data-collection process

### **3.1 Identify protocols and technologies used during the pandemic to determine the presence and quality of online education in Chinese universities.**

To gather information pertaining to this objective, an online web-based survey was distributed to students and faculty. The demographic of potential respondents were Chinese students enrolled as Undergraduates and Graduates. The economic background of students varied greatly between low-class and high-class individuals since wealthier students have more resources at their disposal to adapt to education during the pandemic, such as better access to technology (Zhang et al, 2020). The questions in Appendix A were provided on the survey, and all questions were translated into Mandarin. Since our group members are not completely fluent in writing Chinese characters, we utilized the BUCT student team provided by the university to assist with translation and analysis in Mandarin. All translations were assessed by the team for accuracy to the best of our abilities.

Non-probability sampling was used to help determine the sample size of the survey, and provide a means on how we accessed the sample population. Both convenience and snowballing methods were used to reach students and faculty. Snowballing is a non-probability sampling technique that involves a primary data source nominating other potential data sources that will be able to participate in the research studies. Convenience sampling is a type of nonprobability sampling in which people are sampled simply because they are convenient sources of data for researchers. This will be discussed in further detail pertaining to our survey in section 3.1.2. The collection of data was accomplished within the first three weeks of the study, view Appendix C.

#### **3.1.1 Questionnaire Design**

The survey consisted of 11 optional questions. It begins with an evaluation of the current sentiment of the respondent on online education. Students were asked to rate on a scale from strongly agree to strongly disagree about how they feel their University has handled remote education, how their professors have handled it, and how satisfied they were with their experience. These questions provided quantitative data points to analyze. The data was used to determine which areas of the subjects' education have been most impacted by remote learning. The next section collects open-ended anecdotes on the subject's experience. Information such as

which technologies were used and how learning has impacted their academic performance. This information was used to ascertain which technologies should be explored as solutions. The final section covers prospects about the future of remote learning. Questions in this section included an open-ended request for suggestions and takeaways from remote classes that may benefit traditional classes, and if the subject would opt to continue learning remotely.

### **3.1.2 The Data Sampling and Limitations**

To create an effective questionnaire, we targeted the accessible population, that is, the whole student body that consists of about 25,000 students at this university was our sample population. We aimed for an ideal sample size of 100 students. To ensure that the survey reaches the student public, we promoted our project through the school's website and online forums (Stead, 2016). The survey is purely optional, so we did not force responses.

The type of sampling that the IQP group chose for this survey is non-probability, as we tried to survey the opinions of students that actually care about their experiences with online education. Both convenience and snowballing methods were used to reach students and faculty. To try to reach other university students that do not attend BUCT, a snowballing approach was used by reaching out to friends from their network. The Snowball sampling method is purely based on referrals and that is how a researcher is able to generate a sample. For one, convenience sampling the university administration played a key role in distributing the survey to their students and faculty members. Reaching out to club organizations, such as Student Government, can help convenience sampling. WeChat, a Chinese multi-purpose social media platform, was also used to distribute the survey to students. The advantage of this data collection strategy is that it provides an easy means of gathering student feedback as most students are required to have this application installed already. Due to the web-based nature of the survey, students can complete the survey at their leisure. Furthermore, the results can easily be interpreted by data analyzing tools, such as Excel and Matlab. This provides a much more condensed platform of analysis, making the data more representative.

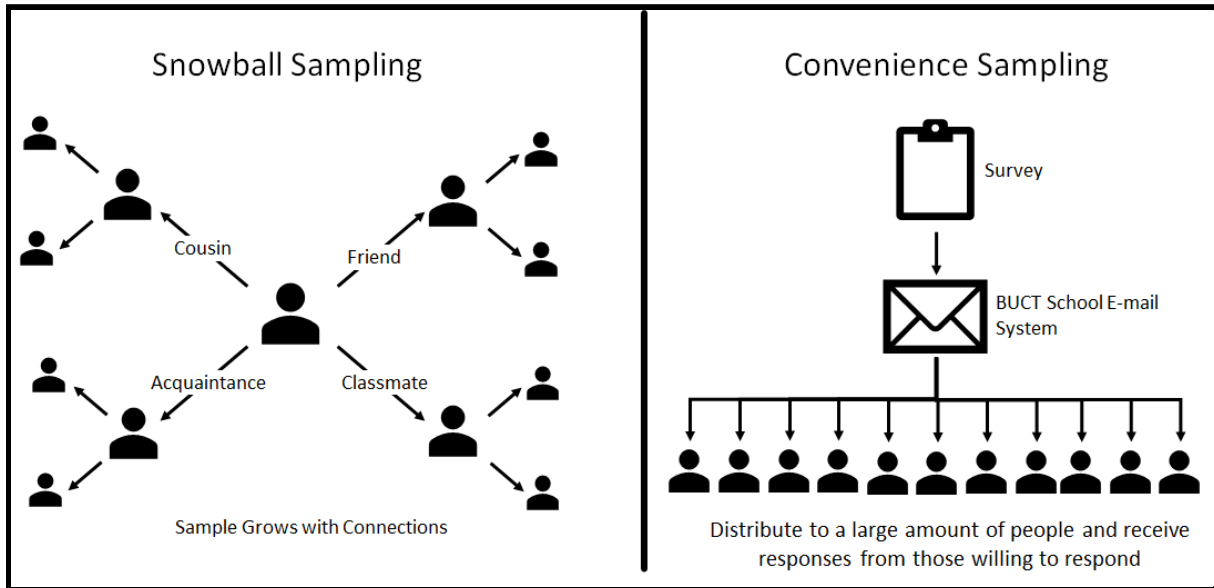


Figure 9: Snowball vs Convenience Sampling

### 3.1.3 Data Analysis

The majority of the questionnaire questions were recorded with the online survey tools provided by WeChat. The questions were automatically inputted into a data analysis tool, such as Google Sheets and Microsoft Word, for review. Questions two to five collected answers on a scale of one to five, with one being strongly disagreed and five being strongly agreed. The responses from each of these questions were plotted on a scatter plot compared to age and college year. The results of this comparison provided insight into whether students will take another remote course in the future and whether this preference is impacted by their age or how close they are to graduation.

Question 2 was plotted against each section of question 3 as well. The goal of this comparison was to determine if there is a correlation between the student's confidence in their university's handling of remote education to their confidence in the idea of remote education. This provided a better image of the sentiment regarding each aspect of online education better than an independent analysis of any individual question would. The responses to question 3 were also plotted against question 6 to question 10. These questions offer a set of options to the respondent to express things such as what aspects of remote teaching have given them trouble

and what online platforms they used. This comparison provided insight on which difficulties caused students to lose confidence in online education and which tools have worked.

Many of the questions allowed students to input another option of their writing, and these responses were reviewed by hand and grouped into specific categories depending on their nature. This type of analysis is well within the capabilities of a program such as Excel, so it was used to perform analysis. The other open-ended questions on the questionnaire will be written in text, which allows students to give more personal feedback on the topic. For these questions, the responses were used to create a word map of valuable opinions, noting the most common action words in responses. Further details on the categorization of open-ended responses are very similar to the procedure found in section 3.2.3.

#### **3.1.4 Deliverables**

The results of the web-based survey were used to learn student opinions on the specifics of online education. We provide a graphical analysis to represent the data collected from the survey, as well as provide the information in an easily accessible format, such as a chart. The individual correlations made are paired with the conclusions we came to along with our confidence in the responses. Since we collected from a limited data set in a limited amount of time, we also prepared a set of recommendations for the next steps to take in order to paint a complete picture of this issue.

### **3.2 Synthesizing the necessary analysis of technologies and resources and how they may be implemented past the pandemic**

After collecting opinions and anecdotes about implementing remote learning technology at BUCT, we began identifying which remote learning technologies have worked, which have not, and which could work with improvement. This was accomplished with a combination of qualitative and quantitative analysis of the staff's responses in one-on-one and key informant interviews following a structured set of predetermined questions, [Appendix B](#).

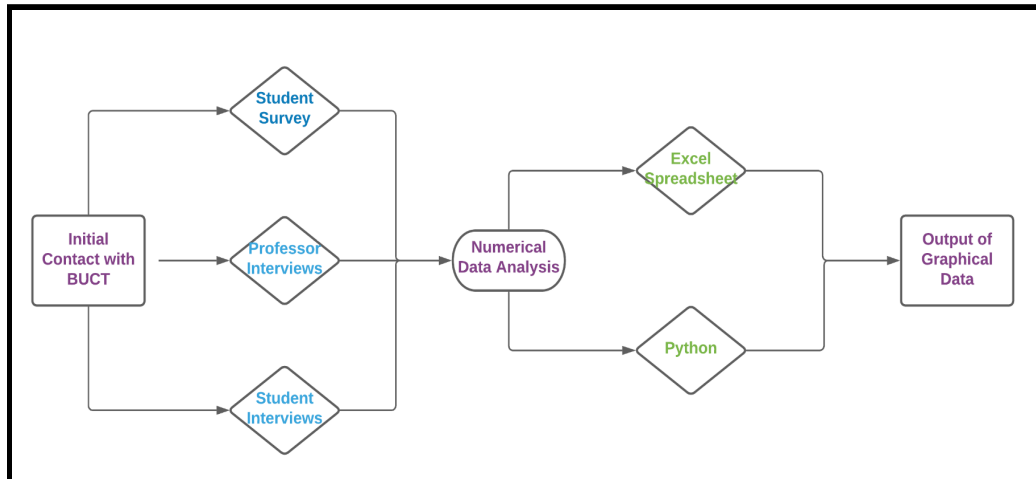


Figure 10: Process of One-on-One Interviews

### 3.2.1 One-on-one Interview Data Collection

Following the web-based survey, one-on-one interviews were conducted focusing on gathering opinions from faculty, specifically professors. These individuals were asked if they would like to participate in the interview as a means of getting data on the administrative end of online education in China. We interviewed 7 professors and students to gather a wide range of opinions for administrative staff. The interviews covered more in-depth and open-ended questions about the topic, with the interview being no longer than 30 minutes at the time the interviewee selects, between 9 pm-2 am EST. All members of the research group were present, and one member led each interview. The interviews were recorded via Zoom with the participant's permission and minutes were taken from a member of the team, along with a transcript for data collection provided via Zoom's built-in transcript system. For more information about the questions that were asked view [Appendix B](#). The purpose of these interviews was to gather more personal opinions of the higher education system in China from the view of professors and specific students that choose to undergo an interview. The interviewees gave feedback about whether professors are likely to continue practices for online learning.



### **3.2.2 Interview Design**

The questions in the interview (as seen in Appendix B) were original and created solely for the express purposes of this research. This is necessary because we are covering the current state of remote education and the prospects of a wide variety of potential solutions. Many other papers on this subject focus on a specific technology or set of technologies and their effects, or a case study in the issues being faced by a community in light of the COVID-19 pandemic. This paper seeks to take a more integrated approach: we started with a case study of the issues faced by BUCT and proceeded to explore the technologies that could remedy those issues.

Interviews were completed at the time selected by the interviewee, with the purpose of additional data collection from professors and students. Each of these questions was asked in private. The recordings via Zoom were also kept private from members not on the research team. Individuals on the research team were responsible for taking minutes during the interview and writing a transcript during the meeting. Minutes provided valuable records of the discussion during the meeting and provided context on the opinions of the interviewee. The results from each interview were managed by naming each file “ Faculty Interviewee 1 or Student Interviewee 1” and safely stored on WPI’s OneDrive.

### **3.2.3 Analysis of Open-Ended Responses**

If Zoom was used, the transcription tool via Zoom easily allowed the audio to be transcribed to text for our analysis. The analysis of open-ended responses was performed through a mixture of qualitative review and word-frequency analysis. Each question was reviewed by all researchers to compile the most relevant technological solutions for each question posed. A question response was deemed to conform to a specific category of answers, allowing for the categorization of responses. The number of responses that fall into each category was factored into the determination of how viable that aspect of remote learning will be going forward. Word-frequency analysis was done using Python to calculate the number of usages of each word in the responses. Using these techniques to break down the results of the interviews, we formulated suggestions for potential changes to technology in education.

### **3.2.4 Additional Information for Data Collection**

Secondly, content analysis was performed by reviewing a series of scholarly written articles, analyzing a similar situation. For example, articles such as [China's Internationalized Higher Education During Covid-19: Collective Student Autoethnography](#), [Parents' experiences with remote education during Covid-19 school closures](#), and [Education in and After Covid-19: Immediate Responses and Long-Term Visions](#), helped provide secondary data collection methods for analysis. The group drew conclusions from these scholarly articles addressing technology in education that helped build the overall analysis. The articles provided insight into the additional specifics about online education that the interview does not cover, as well as providing further opinions from additional surveys conducted at different Chinese universities.

### **3.2.5 Deliverables**

We utilized the result of the interviews to learn the opinions of the professors and administrative staff on the use of technology in education. A graphical analysis to represent the data, as well as a provided consensus is included in a summary. We sent the results to our liaison for them to learn from the information and improve the implementation of learning.

### **3.3 Recommendations for our liaison, Beijing University of Chemical Engineering**

The objective of our project was to provide recommendations to improve current online platforms and their functionalities to help Chinese Universities prepare and respond to potential future situations like the COVID pandemic. We provided suggestions and feedback on how higher education technologies will be implemented hand-in-hand with in-person teaching. The current systems used by BUCT all stem from aspects of communications apps. This includes platforms such as WeComm, Zoom, and WeChat. These current platforms have strong foundations, but the technical aspects of the programs can be improved upon to create a more efficient learning environment for students and teachers alike. Upon further research with key informant interviews, we can improve the functionality of teaching platforms to a more efficient standard. The analysis of the student questionnaire and key informant interviews are presented in this order. First, results from objective one were presented in an MS PowerPoint slide deck

presentation that includes an analysis of various findings from the questionnaire. Then, results from the second objective were composed into a colorful report that summarized all critical points of data from one-on-one interviews with faculty and administration. This includes a graphical representation of the analyzed findings from the interviews, such as a bar graph or a pie chart, and a SWOT analysis chart.

In addition to the following deliverables, a SWOT analysis of our recommendations to improve higher education online platforms were conducted. This was included in the MS PowerPoint presentation mentioned above, to report our findings from the previous two objectives, and not as a new method of analysis. This diagram helps determine the relevance and quality of the recommendations provided. SWOT stands for strengths, weaknesses, opportunities, and threats, and is a technique for assessing these four aspects of our recommendations. In weighing the costs and benefits of these technical aspects, we built a list of possible actions for the university to take.



Figure 11: SWOT Analysis Format Chart (Worldstream, 2017).

By looking for potential connections between the strengths and weaknesses of multiple online learning platform apps, we utilized informed suggestions to create new opportunities. For instance, we chose to keep the strong aspects of WeComm’s secure firewall-protected online classrooms and attendance tracking function, while further building upon it with the inclusion of a better recording option for lectures and a screen locking feature to keep students engaged. By

playing to the strengths of current online education platforms, we have eliminated certain weaknesses that may affect the effectiveness of virtual teaching. Overall, this SWOT diagram benefited our group's research and narrowed down on aspects of higher education online strategies to be implemented in future suggestions platforms.

### **3.4 Ethical Implications**

This research study questionnaire is purely optional, and the participants were fully informed about the purpose of the study regarding online higher education technology and its effectiveness in teaching students. For specifics on the consent agreement view Appendix D for more information. This form presented information about the study so that participants can make a fully informed decision regarding their participation. Official records were kept by the study investigators for the duration of the research period, which is approximately seven weeks, after which the data was destroyed. The survey responses of your participation in this study are held confidential so far as permitted by law. However, the study investigators, the sponsor or its designer under certain circumstances, and the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) were able to inspect and have access to confidential data. Any publication or presentation of the data did not identify participants. This survey is purely optional, and participants could stop at any point in the questionnaire if they are uncomfortable in answering any questions. This occurred without any loss of benefits or result in any form of penalty. The project investigators retained the right to cancel or postpone the questionnaire at any time they see fit. This proposal was approved by the WPI IRB review department.

## **IV. Findings and Analysis**

The information collected for the data analysis of the research project was collected from the survey of Chinese university students and one-on-one interviews with BUCT professors. The analysis of the data was then split into subsections of analysis based on the goals of the project. For objective 1, the student survey, there are a total of six sections of analysis, which will be compared and contrasted with one another. Each section focuses on a different line of questioning in the survey questions. For objective 2, the one-on-one interviews focused on the opinions and beliefs of professors that were taught during the pandemic. The subsections of the interviews dive deeper into the suggestions and current implementation of remote learning. Finally, the group implemented an in-depth analysis of many of the common remote learning platforms mentioned in the student and professor interviews.

### **4.1 Objective 1: Student Survey Analysis**

Overall the survey reached a total of 104 students that attended a Chinese University during the pandemic. These individuals provided their views and feedback on their time in academia during these unique circumstances. The total population of Chinese students attending college during the pandemic was 30.3 million students, and the sample size of students at BUCT is 25,739 actively enrolled students. These numbers do not take into account students not from BUCT that completed the survey, however, the majority of the focus for the student is on BUCT students. The margin of error for the survey, calculated using the standard margin of error formula and a confidence interval of 95%, was 10%. This margin of error shows that the results for the survey are an accurate representation of the student body by a range of 10%.

#### **4.1.1 Participant Demographics**

One of the goals for the survey was to gather information from a wide range of subjects differing in multiple different aspects, specifically age, gender, grade, currently enrolled university, and designated major. These specific aspects of an individual can provide context to which groups of students were impacted by remote learning, why they were impacted, and how to change and improve remote education for these individuals in the future.

Based on the results collected from Question 1, a total of 61% of females completed the survey, as opposed to 49% of males. Female participants comprised the majority of the data collection for the survey. From the data 5% of participants were freshmen, 16% were Sophomores, 64% were Juniors, and 10% were Seniors. The Other option, 5% of participants, includes those that did not specify or graduated from university during the pandemic. The most likely reason for these proportions is due to snowball sampling. This type of sampling was heavily relied upon for distribution, and it is likely the individuals in one grade will send the study to others in the same grade level. The same logic can be applied to gender disproportionality since female students likely have female friends they recommend the survey to.

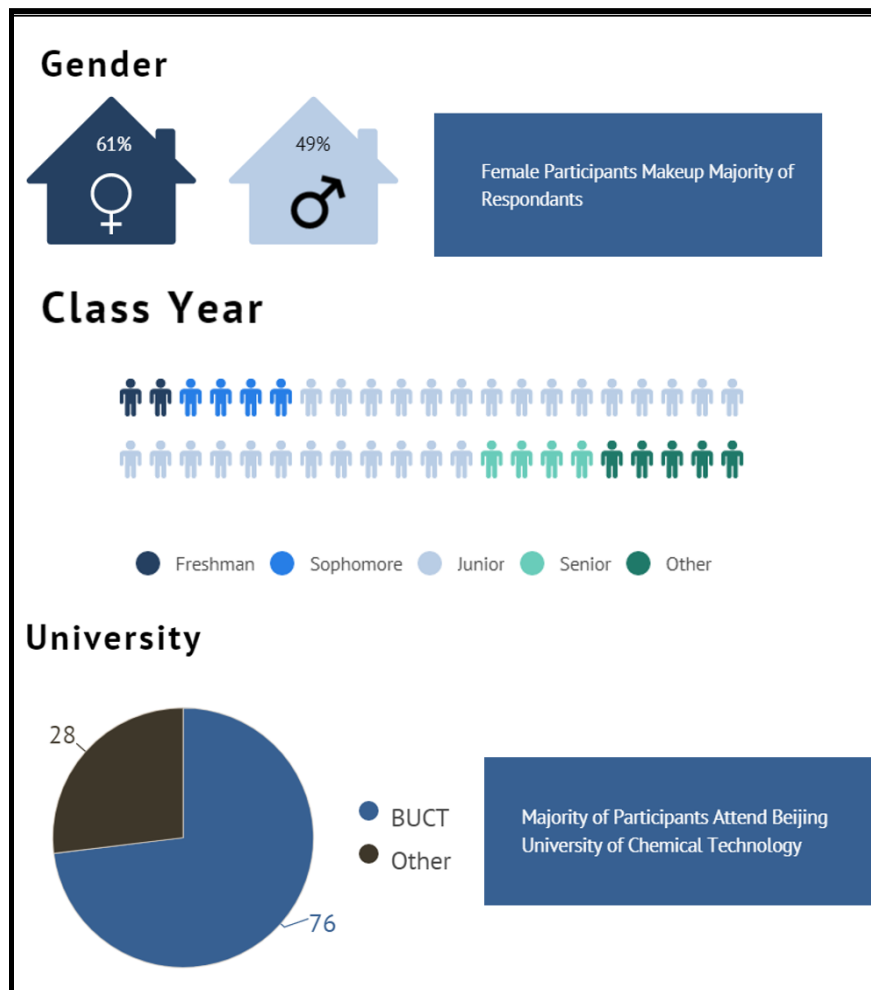


Figure 12: Demographic Data Collected from Survey for Gender, Year, and University

As mentioned previously, students enrolled in other universities besides BUCT were able to fill out the survey, however, the majority of awareness and sponsorship for the survey were displayed at BUCT. The sponsor at BUCT increased awareness by stressing students complete the survey, and then recommend the survey to at least one other individual. This caused the majority of the survey participants to be students enrolled at BUCT, a total of 73%, comprising 76 students, as opposed to other universities. Overall, based on the results of the survey, the main participants were majoring in Mechanical Engineering, Computer Science, and Financial Mathematics. There were a total of 60 participants that were majoring in a S.T.E.M. focused major. This is possibly due to the majority of respondents attending BUCT, most students were members of a S.T.E.M. major. S.T.E.M. stands for science, technology, engineering, and mathematics, which describes the majority of the majors offered at BUCT. A continuation of the study might distribute the survey to a larger pool of Chinese universities, such as ones with more expansive and diverse major offerings that are not only S.T.E.M focused.

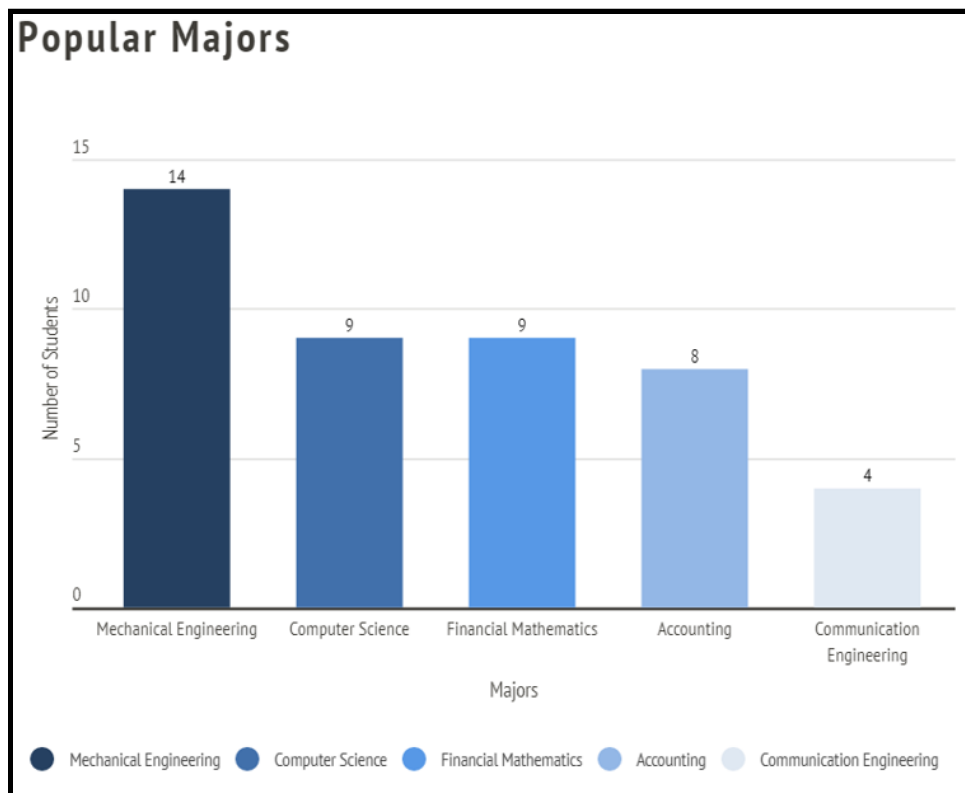


Figure 13: Popular Major Demographic

#### 4.1.2 Remote Learning Tools Implemented

The goal of this study is to compare the effectiveness of different remote learning technologies and ultimately recommend which would be most viable in the future. Questions 7 and 8 cover both open-source platforms and show what remote learning tools were used during and before the pandemic. Figure 13 shows the popularity of different platforms before and during the pandemic.

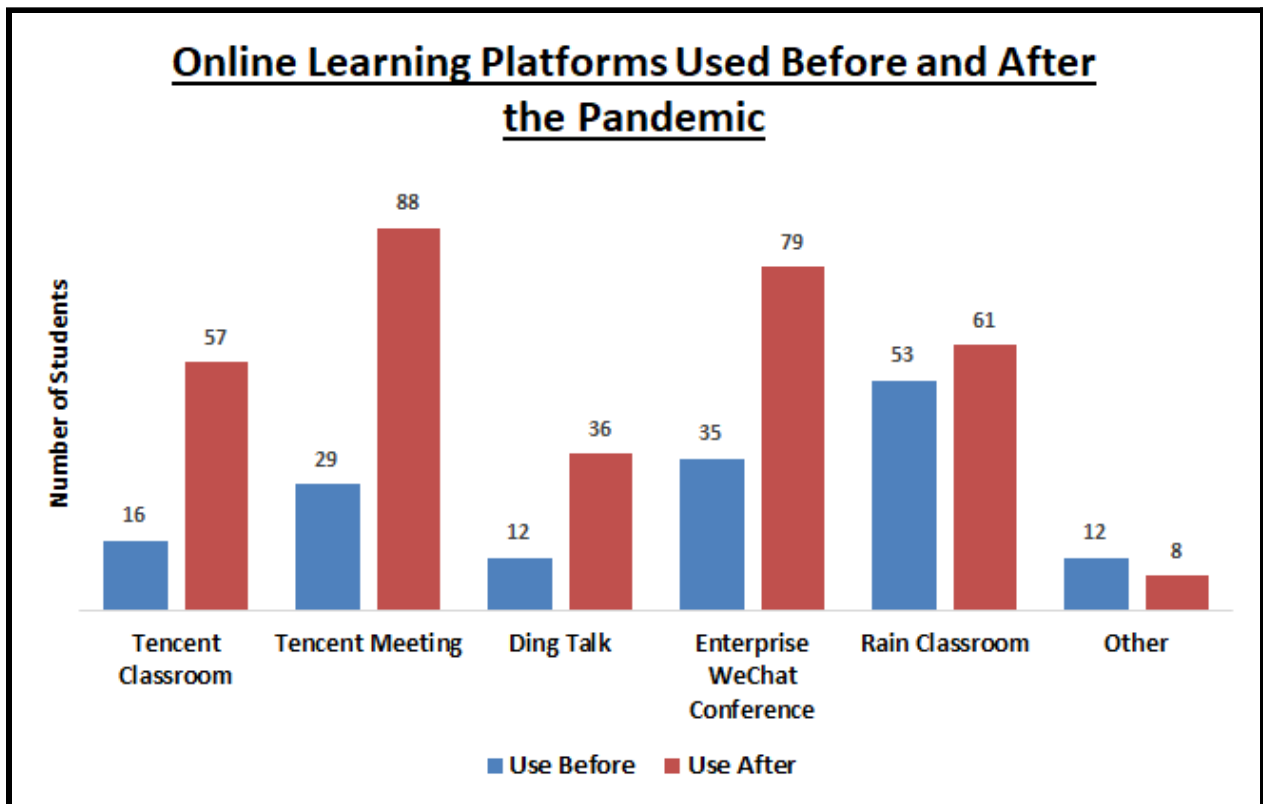


Figure 14: Online Platforms Sorted From Highest to Lowest % Change

Overall, there was a 109.6% increase in usage of remote learning platforms after the pandemic began. This comes as no surprise, however, the question remains on whether this effect will continue now that social distancing policies are being lifted. The consistent increase in the usage of each platform demonstrates a clear influence of the popularity of the platform before the pandemic on its popularity during and after the pandemic. A possible measure of the effectiveness of learning tools before and after the pandemic would be the percent increase in usage as shown in Figure 14.



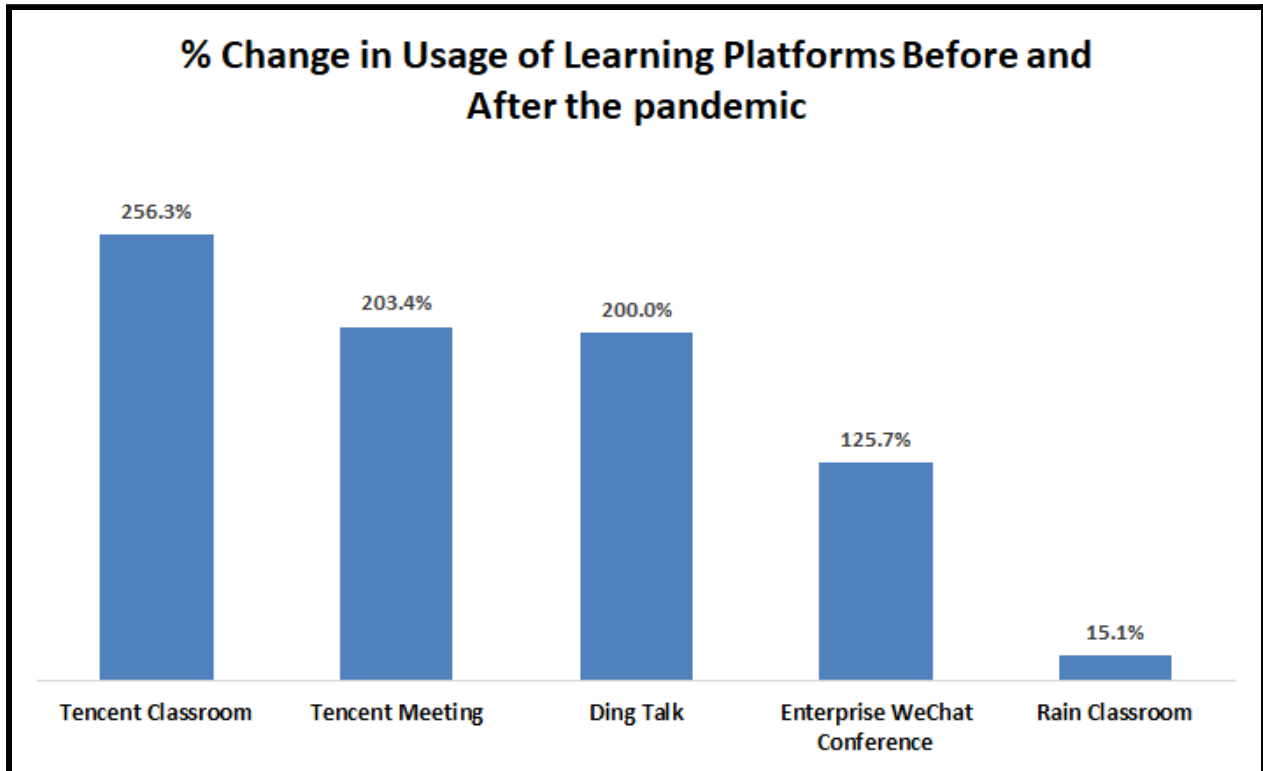


Figure 15: Percent Change in Remote Learning Platforms Used

The outlier here is Rain Classroom, which only saw a 15.1% increase in usage, a full 1.13 standard deviations separated from the average. This would, at face value, suggest that Rain Classroom is less suited to a remote learning environment. It is, however, worth noting that Rain Classroom was by far the most popular learning platform before the pandemic began. This might suggest that Rain Classroom is more suited to a hybrid environment rather than the fully online ones seen during the lockdown. The discrepancy may also be explained by preexisting relationships and training between Rain Classroom and the universities using it. More information about this platform is needed to draw more accurate conclusions and is discussed in more detail in the One-on-one interview section of this paper.

#### 4.1.3 Student Grades during Remote Learning

Question 5 ascertains the educational impact of online teaching during the pandemic on the student, be it positive or negative. Students on the survey input information relating to their grades and the educational value of the material they learned in the form of a decreasing to

increasing scale. The linear regression for Question 5 is 0.8458, which is used to model the relationship between two variables by fitting a linear equation to observed data, and the standard deviation is 0.86 with a margin of error of 0.08. The large majority 42% believed their grades were unchanged by online education. The average response for this question was 2.92, which is well within the range of neutrality for grade changes. The statistic gathered for the “Unchanged” option is positive, because these data points show that remote learning can perform on par with the typical in-person setting. One major concern with online education was that it would impact the grades of students due to a decrease in educational normality, however, that is not the case (D’Orville, 2020). Students can perform to the standard of the university while undergoing online education.

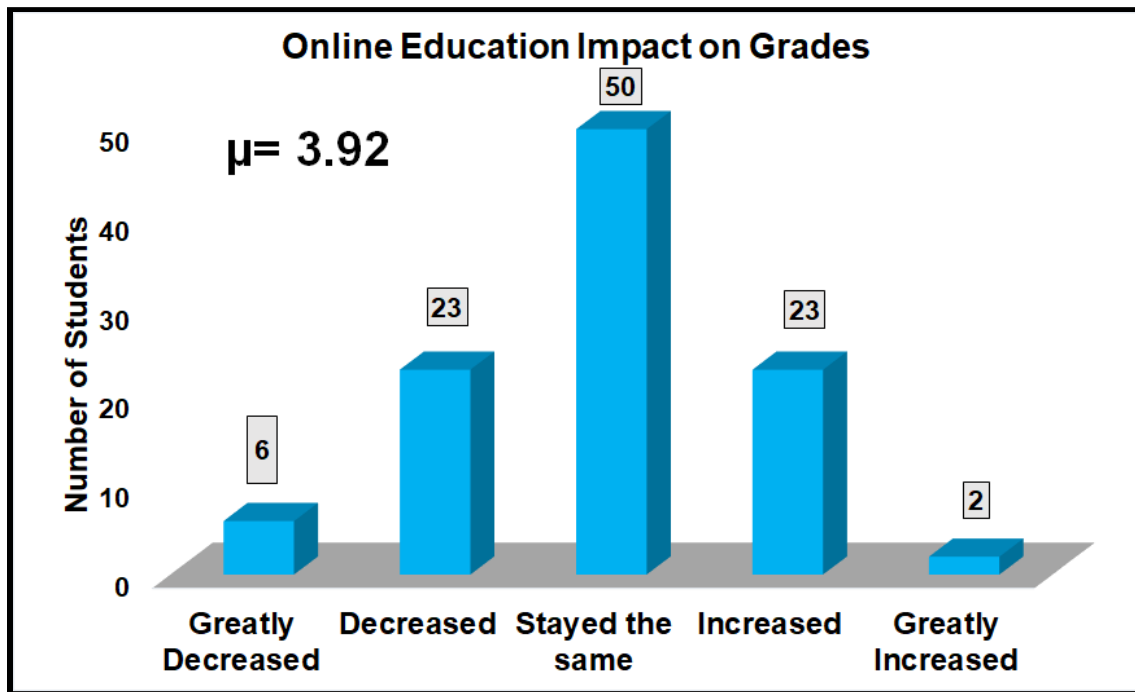


Figure 16: The Impact of Remote Learning on Student Grades

Overall the results show that 14% believed their grades increased during the pandemic, and 19% believed their grades decreased by some margin. The individuals that noted the decrease could have suffered that decrease due to the transitional phase of remote learning that occurred at the beginning of the pandemic since everyone takes different amounts of time to adjust to the new setting. The data shows 56% of students were unimpacted due to remote

learning or had their grades improved by the education. The result of this data is that online education is a valid form of teaching at the higher education level. Despite the difficulties of online learning, these results display that students were capable of adjusting and adapting to the new setting efficiently.

Different majors can potentially be impacted in different respects to remote learning since access to supplies and professors can differ depending on the major. Courses are taught by a professor that is within the major’s department, and the department can impact the resources and adjustment to online learning. For example, if the one department receives more income or has professors that have already undergone remote training, then the professors within that one department will be better equipped for educating during the pandemic.

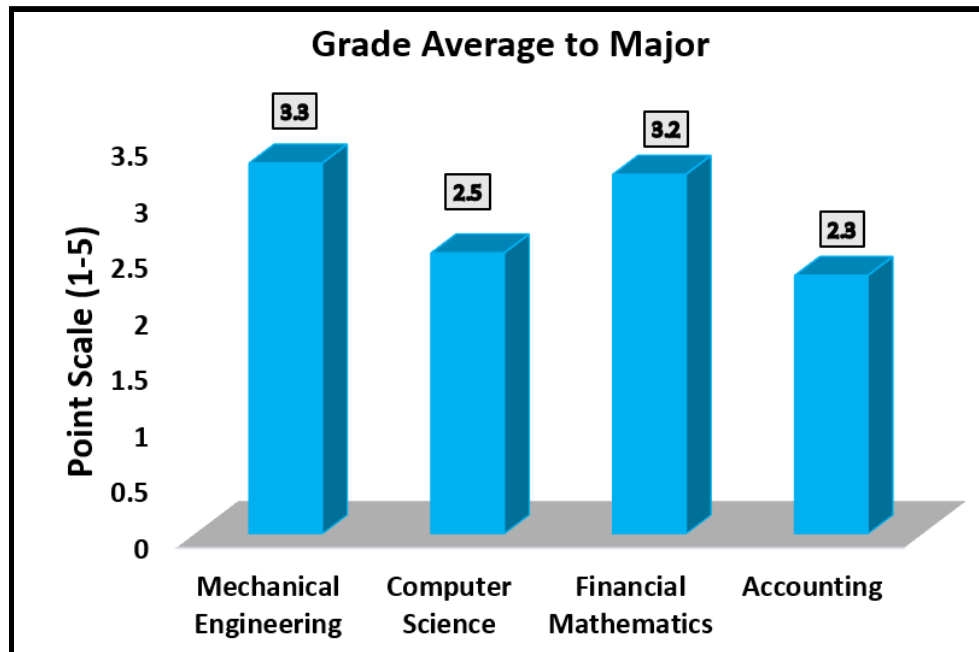


Figure 17: Average Grade Scores from Significant Decrease to Significant Increase

Based on the data collected and the graphical depiction in Figure 17, out of the 4 most popular majors entered on the survey the overall grade progression differed during remote learning. Mechanical engineering (ME) majors averaged a score of 3.3, which is well within the line of grade progression. Individually, ME majors received a score of 1 “Significant Progress”, 4 votes for “Progress”, 6 votes for “Stayed the Same” and 3 votes for “Decreased”. Overall, 78% of ME majors noted either neutrality in grades or an increase to some degree, which is

impressive due to the required adaptation to remote learning. One conclusion to be drawn from this data is that the Mechanical Engineering department at BUCT adjusted to the remote learning format quite well, and it reflects in the student grades.

Similarly, the Financial majors at BUCT also input a general scale of progression in terms of their remote learning experiences. Financial majors averaged a score of 3.2, which shows that remote learning if properly implemented can cause a standard level of progression compared to in-person learning. Individually, Financial majors received a score of 2 votes for “Progress”, 7 votes for “Stayed the Same” and 1 vote for “Decreased”. It should be taken into account that the Financial majors totaled only 9 students, which is less than the total of ME majors, which was 14 students. In terms of percentages, 88% of students believed their grades did not falter due to the new setting, with 22% of the Financial major participants believing their grades not only maintained the same degree but even improved during remote learning.

Lastly, majors such as Computer Science (CS), and Accounting noted a decrease in their grades and their educational experience. The average Computer Science grade progression score was 2.5 and for Accounting the average score was 2.3. Similar to the Financial majors, the CS majors and Accounting majors were not as common to respond to the survey, and their total number of respondents was only 9 and 8 respectively, compared to ME majors. The results gathered could be born from the fact that there is not enough data specific to major departments at BUCT. A more in-depth department could study student satisfaction with each major department. Overall, these average scores show that some students within these majors are struggling to adjust to the new virtual setting with remote learning. There are multiple different reasons that this drop in scale might occur for the CS and Accounting majors and they will be addressed in the latter portion of this research paper.

#### 4.1.4 Technical Impacts of Remote Learning

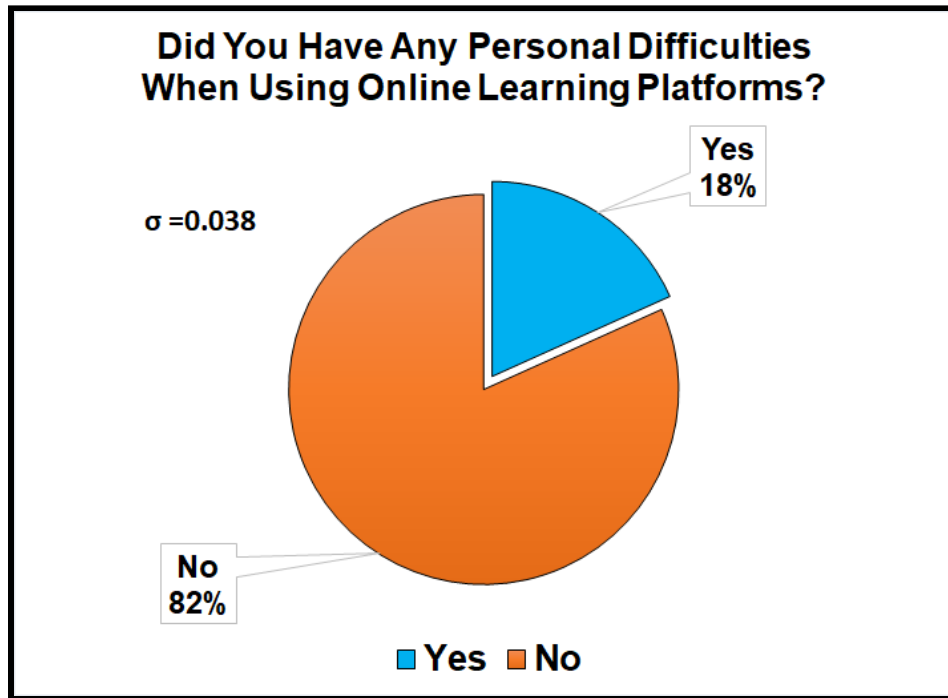


Figure 18: Representation of Question 10, Personal Difficulties in Remote Learning

Question 10 and Question 11 on the survey seek to address those concerns and ascertain why students might be decreasing in academic performance. Question 10 and 11 are closely related to one another, and both address the challenges and difficulties of online learning, which would not be present in a more in-person setting. Remote learning brought with it more difficulties for students, such as focusing issues, network issues, technology issues, and more. Question 10 asks the participant if they experienced any difficulties from online learning during the pandemic, be they emotional, physical, or technological. 82% of students noted that they experienced no difficulties during their experience with remote learning with a standard deviation of 3.8%. Should a follow-up study be conducted that demonstrates a difference in these results of more than 6.8%, it would point towards a potential source of bias in our data. These statistics show that with proper preparation and implementation remote learning can be a great source of education. Even with the forced usage due to the pandemic students were still capable of learning. Reasoning as to why the percentage of students with no difficulties is so high is that

many students probably did not experience major network or technological issues with remote learning, causing them to lean towards no difficulties.

Specifically, in regards to CS majors and Accounting major's responses to Question 2, only 11% of CS majors, which correlates to 1 CS major, selected "Yes" to Question 10, and 0% of Accounting majors selected "Yes". This shows that the decreasing grades that students are experiencing are not due to technical issues and difficulties that are common with remote learning. These students may be suffering from personal issues with the pandemic in general, as opposed to just remote learning. For example, maybe these students' emotional states are low due to the quarantine that corresponds with remote learning implementation, or they are having difficulty motivating themselves to work during these difficult times.

Question 12 could further provide insight into the decreasing grade progression because the question specifically asks about the participants' mental concerns during the pandemic. For the 9 participants that were CS majors 66% of them inputted a type of mental concern, which is shown in-depth that they faced health issues like depression and loneliness during the pandemic. Most notably these individuals noted a decrease in concentration and self-control in the online setting. These concerns seem to be more related to students motivating and controlling their actions as opposed to the implementation of online learning. Similar concerns were noted among the Accounting majors that inputted a mental health concern.

If a student mentions that they experienced difficulties in Question 10 then they are required to complete question 11, which asks specifically which challenges they faced. Participants can select from a preset list of options, as well as enter their unique difficulties. As mentioned previously, 18% of participants answered yes to question 10 and inputted their opinions on the difficulties they faced. One keynote is all the options besides the outlier option "Other" received very similar rankings in terms of votes. This is likely due to students experiencing more than one type of issue due to the remote setting. For example, network issues that existed for professor communication likely persisted for classmate communication, and vice versa. Similarly, the lack of a learning environment and lack of in-person contact likely correlate with one another. Specifically, the survey notes that network difficulties between themselves and professors comprised 72% of student votes and network difficulties with other classmates

comprised 66% of students votes out of 18 total students. Furthermore, 66% of participants had a lack of learning atmosphere which impacted their learning capabilities. This is likely due to students living at home or other locations that differ from the typical learning environment during the year. Lastly, 72% said that they experienced issues with remote learning due to them lacking required materials that are accessible in a non-remote setting. Online learning can impact the ability of courses to perform on-hand experiences such as labs and demonstrations.

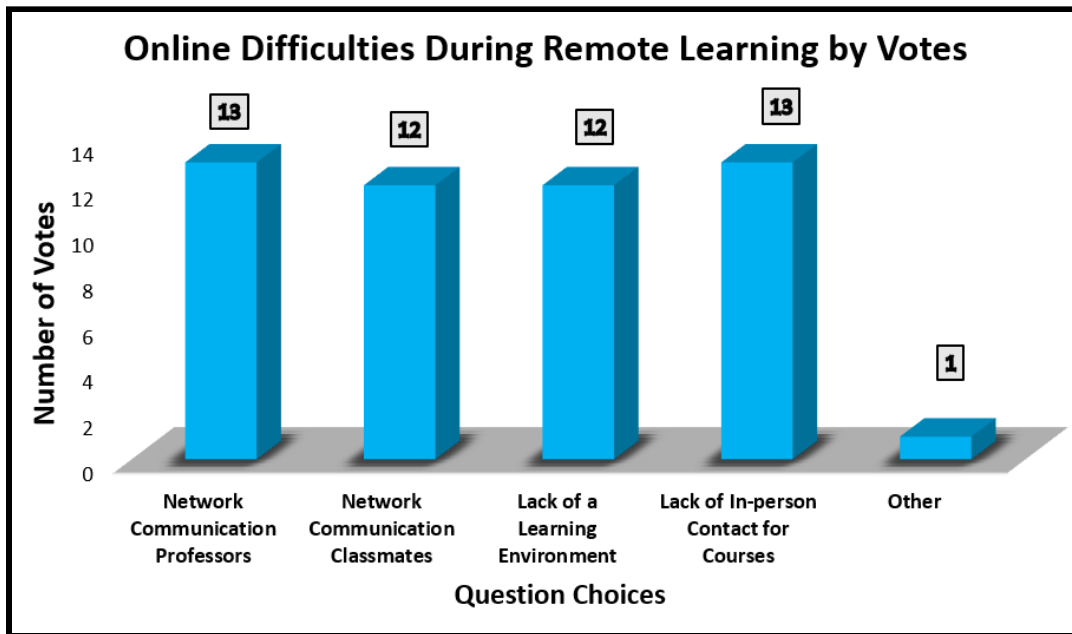


Figure 19: Question 11 Responses By Total Votes, Specific Difficulties Faced

An in-depth analysis of grade proportionality to remote learning difficulties could be valuable to understanding the challenges students faced. Specifically, Question 5 in reference to Question 10 and 11 could perform this analysis. Out of the 29 students that selected their grades decreased to some margin on the survey, only 8 noted that they experienced difficulties online on Question 10. This could lead to the conclusion that the decrease in grades was not due to the infrastructure of remote learning, such as network connectivity, but rather due to other external challenges. Particularly, students would have faced other difficulties such as mental focus challenges or other general difficulties due to the pandemic. In regards to question 12, of the 29 students that decreased in grades the most common concern was becoming lazy and less focused due to personal issues during the pandemic that impacted their remote learning experience.

#### **4.1.5 Positive Impacts of Remote Learning on Students**

Question 6 requires participants to select from a series of advantages of remote learning, asking them if they have experienced any of these positives. Options include, but are not limited to, “Online submissions”, “More time at home”, “Remote access to professors” and more. These positives are only possible due to the remote nature of education during the pandemic. These benefits help show why and what benefits remote learning brings to higher education. Positives, such as “More time at home” can have major impacts on a student’s emotional state, either increasing or decreasing their positive emotional feelings. Other positives, such as “Online submissions” and “Online course material” create an easy atmosphere for students to submit work, and interact with the course material. Online course material allows students to re-watch and re-use lecture content from class. Remote access to professors can increase the interactions between professors and students, increasing the bond and learning experience for the student, overall improving the educational experience.

All students noted that they experienced benefits from remote learning. Each of the options presented to participants was almost evenly ranked, with some ranking a little higher than others. Specifically, “Not commuting”, which had 74% of participants vote for this option, and “More time at home”, which received 67% of participants' votes, were applied to students on a large scale. These results are likely due to the emotional and physical benefits. The time spent commuting can be spent doing other vital activities, such as homework or relaxation. One student survey conducted by the National Survey of Student Engagement noted that college students spend 17.8 hours commuting to school and class(McCormick, 2011).

The next major benefits students experienced during the pandemic were “Course material being available online”, with 63% of students voting for this option, and “Online submissions” which gathered over 58% of votes from students. Online course material can present a major advantage to students since they are capable of accessing the information online and at any time. This means that students could rewatch lectures, and review the professor's notes, as opposed to only the notes they take in a lecture. Having the ability to rewatch a recorded lecture allows students to disseminate the information at their time frame, instead of adjusting to the professor's pacing. The online submission provides an easy means of submitting work versus the typical



in-person paper submissions since students need not visit the class to submit assignments. This method can also reduce waste, as the assignments are stored and submitted entirely digitally, removing the paper aspect.

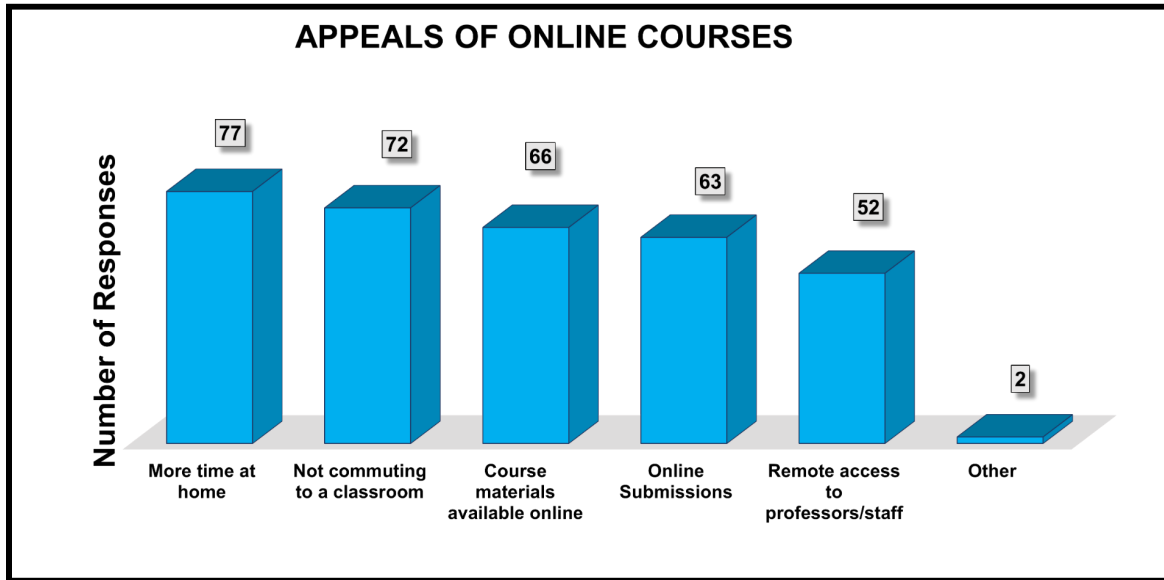


Figure 20: Survey Responses to Question 6 by Number of Votes

Lastly, 50% of students voted for the “Remote access to professors” option on the survey. This means that many students interacted with their professors remotely and took advantage of the online setting. Remote access to professors allows students to freely access the professors during a set time frame. This removes the transportation, and confrontational barriers from the meeting with a professor, as students can be at home with a webcam turned off. One possible reason as to why this option has a low percentage compared to the other options is that students did not take advantage of these remote office hours, hence the option did not apply to them. Even in the in-person classroom setting students might lack the desire to visit professors during office hours, and this could be reflected in the remote learning setting as well. One follow-up study would be to analyze if students attended more office hours before the pandemic, or during the pandemic. Two students chose the optional “Other” choice which allowed a student to write in a response. The responses related to the online capabilities of WeChat to connect the participants with friends and family. However, this application of WeChat is not directly related to Online Education in China.

Question 12 on the survey relates to question Question 6 in that it asked participants to input any mental health concerns or developments they experienced over their remote learning experience. Question 12 received around only 50% of responses with any concerns, meaning that many students did not suffer mental fatigue or concerns due to remote learning. Of that 50%, many concerns were surrounding loneliness due to the remote learning atmosphere, and more time spent at home, which directly relates to Question 6’s option for “More time at home”. This might cause students to view the time they spent at home as a crutch, rather than a benefit. This leads to the hypothesis that remote education and student loneliness are directly correlated, and such a conclusion cannot be claimed due to the extreme circumstances of the pandemic. In the typical remote setting, students won't be forced to quarantine in their homes, removing the loneliness of remote learning.

#### 4.1.6 Confidence in Remote Learning

Questions 2 and 3 address how well students believe their schools have handled remote learning and how likely they are to take another online course.

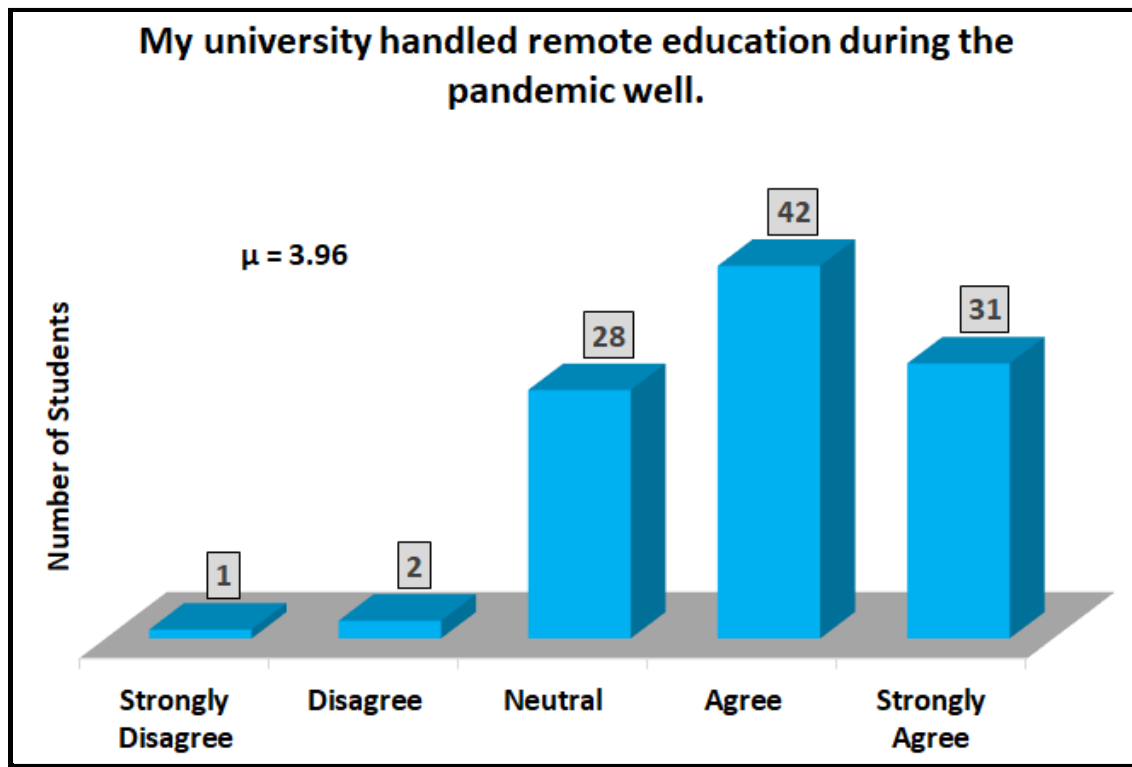


Figure 21: Student Rating of Universities’ Performance in Remote Learning

Question 2 specifically requires students to rate their experience on a scale of one to five, with five being that BUCT handled online learning well. The responses to question 2 (i.e. how well the participants' university handled remote learning) reflected a high opinion of their universities' performance. The average response to Question 2 was 3.96, which is within the range of agreement that the university handled remote learning. For question 3 the distribution was as follows:

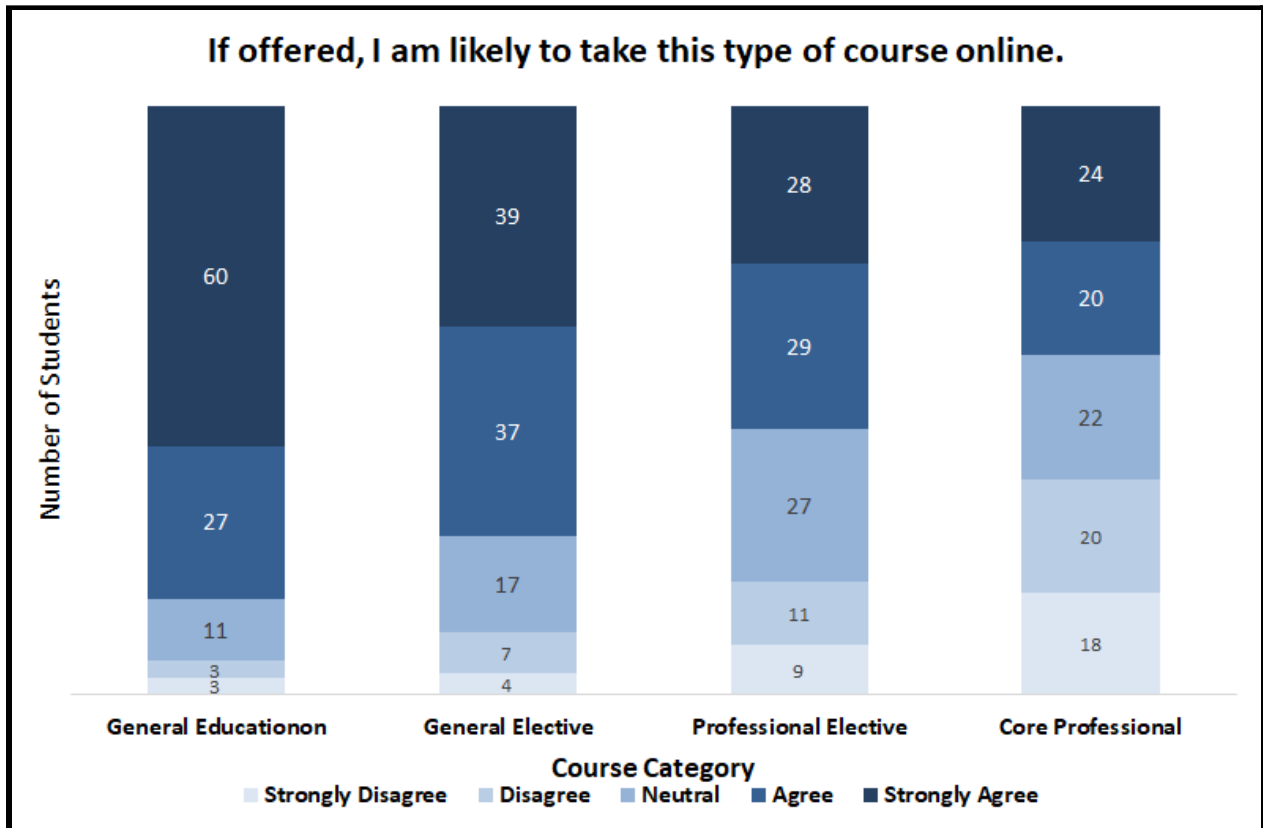


Figure 22: Likelihood of Taking Courses Online by Type

The responses to this question reflected varying levels of willingness to take courses online. More interest in taking courses online was expressed for taking General Education courses with 57.7% of students responding that they would be very likely to take these courses online. The average rating for this group was 4.33. General Elective courses were next with 37.5% of students expressing a high likelihood of taking them and an average score of 3.96. Professional Elective Courses were third with a 3.54 average rating, and Core Professional courses were last with a 3.12 average rating. Note that Core Professional courses, despite being

the least desired online course, still received a moderate rating. This coincides with students' rating of their university's handling of remote learning.

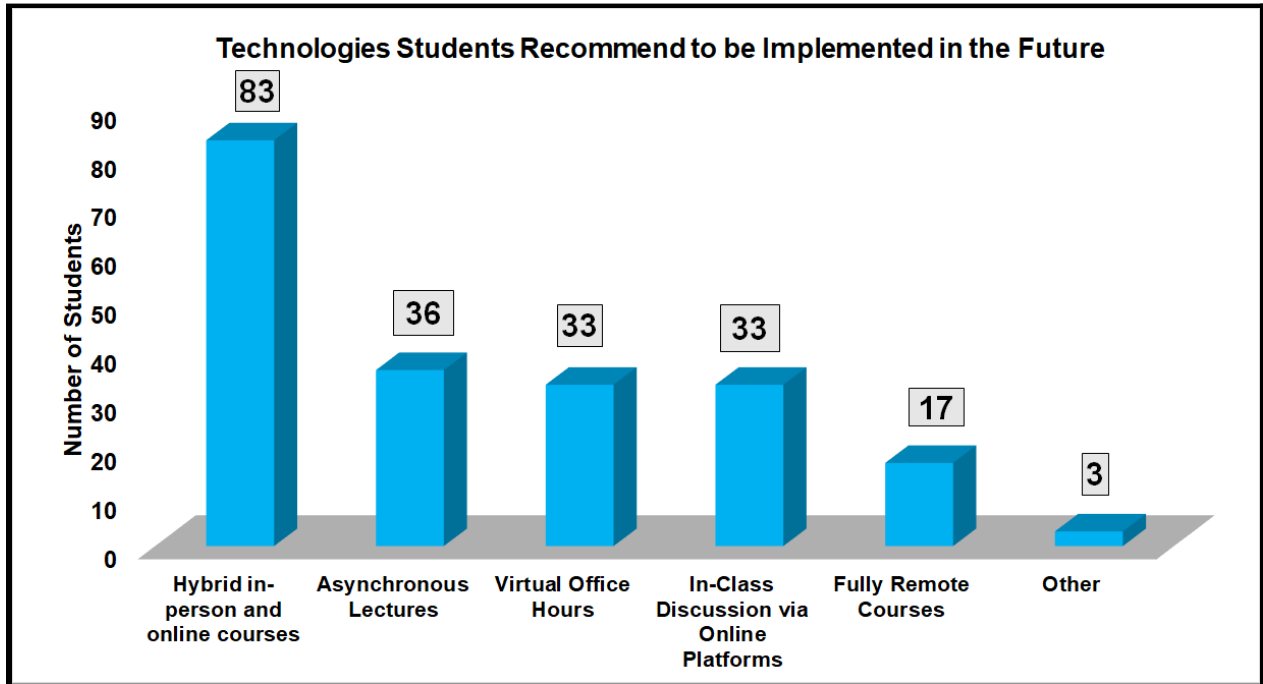


Figure 23: Recommended Technologies in the Future

Question 9 asked students to select which aspects of remote learning could be used in the future. Figure 23 represents the distribution of the responses. With 83 out of 104 positive responses, hybrid lectures were by far the most desired feature. Asynchronous Lectures, Virtual Office Hours, and Online Discussions all nearly tied for second place. Aside from the 'other' category, fully remote courses rested squarely in the last place. These responses highlight a very negative sentiment around fully remote courses with a small amount of interest. Since Question 9 did not provide a breakdown based on types of courses, students may have been discouraged from making a sweeping statement about remote learning. The responses shown in Figure 21 demonstrate differences in opinion based on the nature of the course. A switch to a mix of hybrid and fully online lectures may serve to fulfill both the desire for in-person learning and capitalize on the advantages of online courses.

#### 4.1.7 Additional Suggestions Posed by Participants

This section addresses one of the final overarching open-ended remarks in the student questionnaire. Students input any suggestions that they had in mind on improving the online education system and any takeaways from online learning that they would like to be implemented in the future. By performing a frequency keyword analysis, the top four suggestions were documented. In this graph, the frequency and percentage of students that mentioned these recommendations are shown in labeled categories.

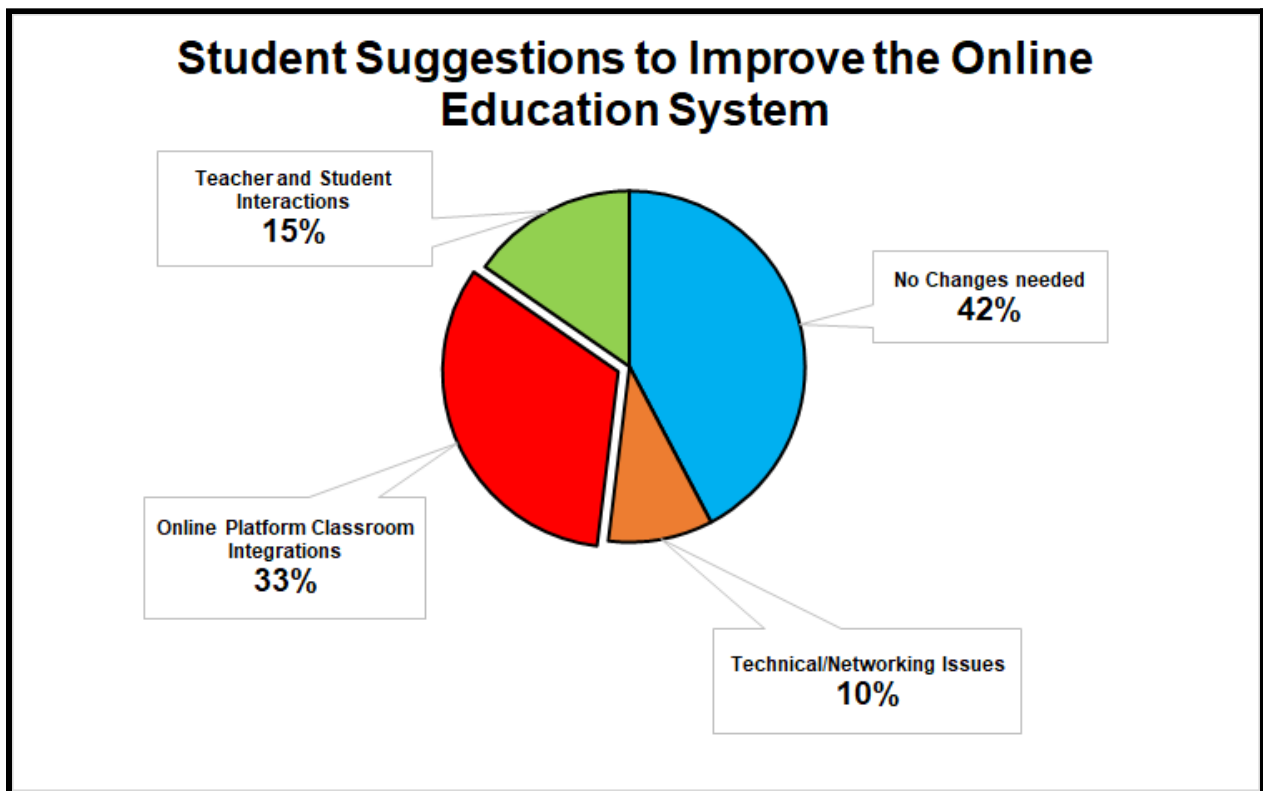


Figure 24: Student Suggestions for Online Education System Improvements

For the most popular response, 42% of students suggested that the current online education system at BUCT is up to par with their standards. 44 students from our survey noted that they experienced an excellent transition from in-person learning to fully remote learning during the initial months of the pandemic. This number of responses was unexpected as the group anticipated more students to address issues they experienced with online education. This

showcases that BUCT handled remote education to the highest of standards and created a learning environment best suitable for higher education students. In another perspective, this also depicts that the general student public was either satisfied with existing, available online platforms or they did not view online education to be of high importance due to minimal effects on their personal lives.

For the second most frequent response, 33% of students suggested an improvement in online classroom integrations and functionalities. One particular function of online platforms heavily noted in our survey responses is the lack of a well-integrated video referencing system. Due to the nature of online courses being scattered throughout the day and the busy daily schedules of students at home, some students may not have been able to attend all lectures. Most professors, in this case, recorded all their lectures and input them on a hard drive in their respective online platforms. The main concern for online platforms such as WeComm and Zoom is convenience factors for students. By having an easy-to-use system that contains all available resources for a student to access all on one webpage, students can efficiently study better and feel more at ease in a better learning environment.

Another prevalent suggestion that students input into the survey was to have better teacher-student interactions. With the implementation of online learning, students expressed that their motivation for the school declined. Despite the relaxed environment of hybrid classes, students stated that they were often distracted by outside sources. This awareness of a declining retention rate for lectures led to an insufficient learning environment. Furthermore, several students noted that their social life ceased to thrive during the pandemic. Students felt introverted to the point of loneliness. This mental health aspect carried over to the classroom as students did not reach out to professors as often. The complicated system of scheduling office hours and directly contacting professors proved too much of a hassle for the majority of students. Most students noted that despite the increase in learning pathways available for students, there was no significant progress in increasing their grades. This demotivated students from contacting their professors for more aid as they often turned to internet search engines and online educational videos instead. To create a more traditional inclusive interaction between students and

professors, a system of communication must be implemented, in addition to email requests and office hour sign-ups.

For the fourth most frequent response, 10% of students suggested that network and technical problems from both their internet and the schools were too common. This becomes a nuisance not only to the students but also to professors trying to teach online. Most of these responses noted that visualizations from live lectures were often unclear and the audio seemed to cut off relatively frequently. This is a difficult issue to resolve as it pertains to both the school's host server as well as student's internet access at home. Location of services plays a critical role as some rural communities may not receive quality bandwidth and Wi-Fi to sufficiently connect to online live resources. Although these software issues may be difficult to pinpoint, a response from the school's internet maintenance system can improve this issue.

By comparing the frequency of keywords and phrases in this open-ended response, we can procure what higher education students regard as the critical points to potentially alter and improve upon in the online education curriculum and online platforms. These suggestions have an emphasis on our group's final suggestions and recommendations to BUCT as well.

#### **4.2 Objective 2: One-on-one Interviews Analysis**

The information collected in this second objective is through one-on-one interviews with professors and staff at BUCT. This interview process aims to gather specific insight and experiences from a wide variety of staff in differing majors across the Chinese education system. The interview consists of roughly 10 questions divided into the following sections, interviewee background, current implementations, effects of technology in education, and educational needs and opinions. Each section focuses on how each professor has personally dealt with the pandemic and their teaching methods during this past year. A frequency keyword analysis was utilized to obtain sufficient data from the perspective of professors. This data was then compared from the findings in the previous section regarding the student questionnaire. By comparing and contrasting the findings in graphical and tabular form, we were able to parse sufficient data to make well-rounded recommendations for the university, as well as other institutions in the future past this pandemic.

### 4.2.1 Opinions on Remote Learning

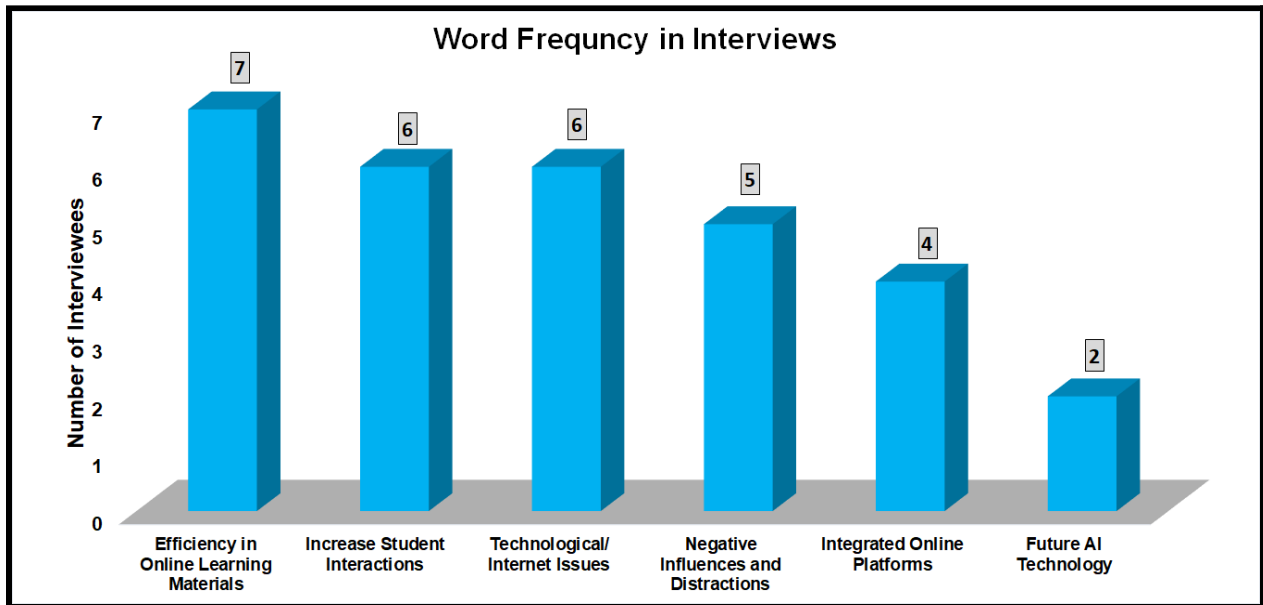


Figure 25: Interview Word/Phrase Frequency

Throughout the pandemic, professors have all dealt with online teaching in different manners. This section addresses how professors view the effectiveness of commonly used online platforms such as WeComm and ClassIn. To transition classes online, BUCT relied on an online platform called BUCT Online. This platform serves as a school-wide communication interface in which students can submit their assignments, engage in discussion forums, and receive feedback from their professors. The majority of learning material and resources were uploaded onto this site or other specific platforms that professors were comfortable with. Some notable sites included Tencent Classroom and Moodle. Tencent is mainly used as a video conferencing platform while Moodle is an intricate teaching platform used by several professors, specifically in the foreign language department. Moodle allowed interactions between students through discussion forums, as well as providing easy access to recorded lectures and any supplementary class materials after each lecture. Overall, each of these online platforms used had their specific purposes that aided professors in teaching their courses effectively.

As interviewed, 7 out of 7 professors and students have harped on the positive responses and results of online teaching. These responses were categorized with keywords used in the interview responses that fall under each category. Some key indications that were mentioned



included the convenience of lecturing in different locations, ease of receiving quick responses from students through online polls, better student interaction with one another on online forums, and having a database to store materials and recordings of lectures. Despite these positive aspects of online education, professors also noted several disadvantages and hardships they experienced while teaching online. 6 out of 7 professors and students felt that issues pertaining to internet connection were not ideal. Since professors live-streamed through the school's Wi-Fi, some students based in different geographical locations were not able to connect well to the lectures. Rural places and even some buildings on campus, notably the dormitories, had trouble with unclear presentations and muffled audio. In addition to these software problems, students and professors noted that online courses were not as efficient as in-person classes. Our results show that some students would tune into class in non-ideal learning environments such as walking outside and in loud crowded public areas. Professors found this to be a hindrance as students were easily distracted by their surroundings and background noises often interrupted the class. One professor harped upon the point that there would always be a delay between a proposed question and receiving a response from students. In some cases, students would even skip live lectures and opt to watch recorded lectures during their own free time. This causes a divide between the student and the professor as they are no longer provided the same learning environment as in-person classes where they can immediately ask questions and address any issues with the subject matter at hand.

All in all, these results from one-on-one interviews showcase that online teaching may be difficult to execute initially, but to contribute to a broader range of online learning for the future, critical steps can be taken to improve upon online teaching. This format of teaching contains numerous positive aspects such as ease of obtaining learning material online and flexibility of schedules. In addition, opinions from teachers and professors are similar to those of students but include a position of power and decision making. Professors are allowed to change the learning environment of their class as they see fit to effectively teach their students. Throughout this past year of teaching students online, professors have been constantly altering their teaching process to accommodate students and provide a more efficient learning environment. These positive aspects and drawbacks distinctly convey how online education can be utilized further in the future, in case a similar situation like a pandemic were to occur in the future again.

### 4.2.2 Professor Interest in Remote Learning Platforms

Professors proved to have insight on the performance of staff and students that was not possible from a student perspective. This section addresses the effects remote learning had on classes as a whole and the overarching organizational issues that arose. Several professors found Moodle to be particularly useful during their lectures. Three of the four professors interviewed mentioned Moodle when asked about their in-class activities. After analyzing the transcripts of the interviews for a sentiment of several learning tools, the following distribution resulted:

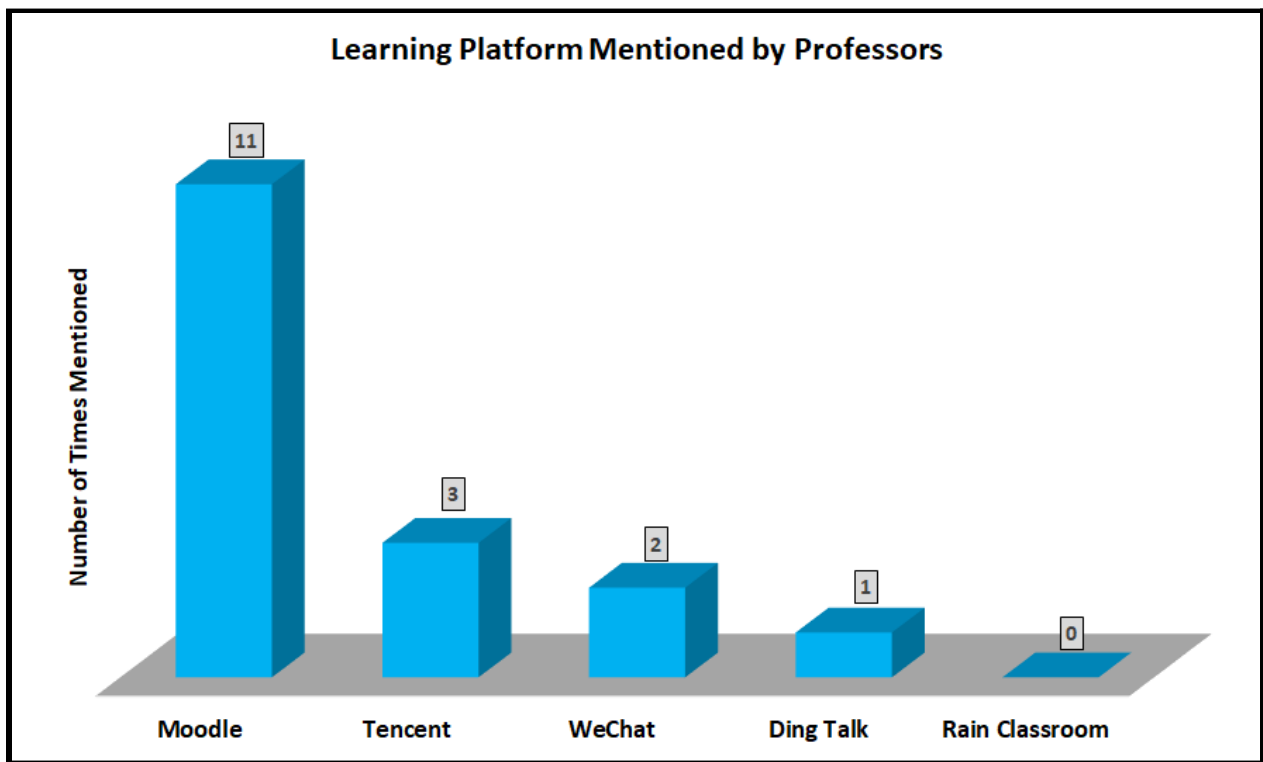


Figure 26: Frequency of Learning Platforms Mentioned by Professors

While the graph above demonstrates a much higher level of interest in Moodle than other learning platforms, it is worth noting that Moodle was of particular interest during the survey as it had been largely overlooked during the preliminary research phase. We asked one professor about what Moodle was and how it was used in the classroom: Moodle is an open-source course dashboard software that allows for the posting of assignments, events, and forum discussions with students. It is similar to Canvas: a platform many American college students may be familiar with. With a focus on assignments and asynchronously accessible materials, Moodle

does not include any real-time meeting features such as video conferencing. The professor reported that, after the pandemic, 60-80 professors at BUCT were using Moodle as their platform of choice. These same professors reported using other platforms for in-person meetings.

Although many platforms such as Tencent offer integrated suites that include both real-time meetings and asynchronous posts, the majority of interest seems to have been put onto platforms like Moodle and Tencent, which focused on these aspects of remote learning individually. We could formulate three possible explanations for this phenomenon. These platforms either performed their functions better than the integrated platforms, there is something inherently easier to use about separate software than an integrated suite (at least within the context of teaching), or professors simply preferred platforms they were used to using prior to the pandemic. More research would be needed into which parts of these platforms professors struggled with to determine which of these explanations is correct.

On the point of professors' familiarity with the learning platforms in question, several professors stressed the difficulty of the transition to new remote learning platforms during the initial weeks of the pandemic. One professor highlighted how staff members were given only 2 weeks and a summer of dedicated 'transition time' to grow accustomed to online teaching. Another mentioned how during this period, they switched between several different platforms. Another still claimed that they stuck largely to the platforms they were familiar with and used others for purposes that were not possible with the ones they used before. The short time given for the switch to online teaching influenced long-term decisions that professors made about what tools they would use. However, in the future of remote learning professors would already have a grasp on understanding these platforms, and would need little time to readjust. More research should be conducted about what effects and/or benefits a longer and more structured transition period would have on the viability of the remote learning platforms voluntarily chosen by university staff.

### 4.2.3 Current Implementations of Remote Learning

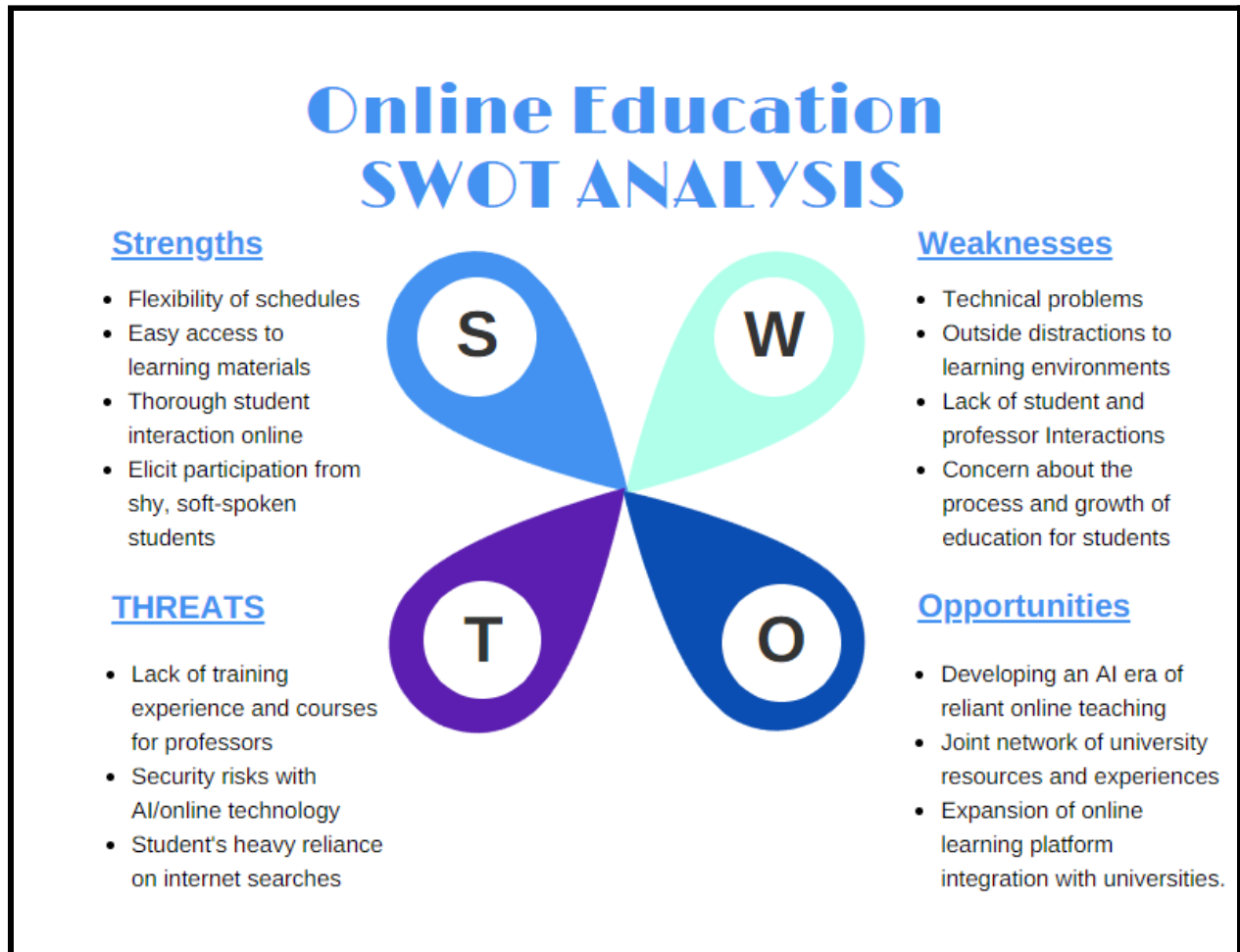


Figure 27: Online Education SWOT Analysis Chart

Currently, there exist a plethora of online teaching platforms ranging from WeComm, Zoom, to Moodle. All of these different platforms offer their distinct manner of portraying and organizing teaching tools. The most commonly used platform in Chinese universities is WeComm as it provides a secure site for students to actively learn without the interruptions of internet sources through its enhanced firewall security. Professors at Beijing University of Chemical Technology also mainly utilize this platform as well as BUCT Online and Moodle, due to their ease of use and beneficial features such as lecture recordings and participant attendance. All 4 out of 4 professors that were interviewed used and recommended these platforms. These platforms all serve a similar purpose in aiding students to successfully communicate with the

professor and each other. Despite this, each platform has its perks and uniqueness that make them stand out from one another. One commonly used platform in the United States is the platform Zoom. This video conferencing app allows a multitude of people to simultaneously interact with each other and share virtual screens to present data and effectively teach. That being said, although Zoom is an easy-to-use tool to communicate with others, it includes many flaws such as its security functions that are exploitable to outside users that may want to disturb and interrupt calls. These issues can be carried over to the commonly used platforms in China. Regardless of how effective a platform is, there can always be improvements and suggestions to improve them.

Through our one-on-one interviews, professors noted several strengths and weaknesses with online teaching. Some strengths of virtual teaching include flexibility of schedules, easy access to learning materials, thorough student interaction online, and eliciting participation from shy, soft-spoken students. Since students are constantly busy with occupations outside of the classroom, being able to provide asynchronous lectures and recorded material online aids students in coping and managing their personal and school life. By creating readable and compact presentations online, students can access these resources from online platforms relatively quickly and easily. They can reexamine these materials as many times as they need to, whether for daily review or to study for a final exam. Professors also noted that having online discussion forums was ideal for class interactions. Since students are given more time to read and parse other students' ideas and thought processes, they can provide more thorough responses on their own. This allows the professor to build off these topics and stimulate the class more during live lectures. In addition, one key distinction that professors at BUCT noted was the increase in participation from more soft-spoken students online. Without the peer pressure of having to ask questions out loud in class, these students can address their issues through a live written chat or personal messages to professors. This allowed more students to participate and get more information, outside of the traditional classroom.

On the other hand, during the one-on-one interviews, professors distinguished several weaknesses with online education. This included technical/internet problems, outside distractions to learning environments, lack of student and professor interactions, and a general concern of the

overall process and growth of education for students. Both professors and students alike often addressed issues regarding the school's internet system during live classes. Professors noted connectivity issues when sharing their screens, while students often experienced a lag in both visual and audio aspects on online platforms. Outside distractions were similarly present during these live lectures as students were drawn to use their phones when bored. Professors also noticed that some students would attend class while walking outside from one destination to another. These changes in the surrounding environment for students posed as a distraction that drew attention away from the learning material at hand.

One particular scenario involved one student who was supposed to take an online quiz but failed to do so on time. When confronted with this by the professor they stated that at the time they were currently learning how to drive while in class. This striking situation showcases the variance in possibilities of distractions and interjections during live online lectures. A challenge that arises for professors is gapping this distance from a distance during online classes. Professors are required to improve their class structure to keep students engaged the entire time. Furthermore, another critical weakness of online teaching lies in its inherent nature of constantly being able to easily access online materials. Since the Internet is such a broad database, students can generally find everything online. Not only does this evoke acts of cheating from students, but it also requires professors to be not only responsible for teaching knowledge about their subject matter but also for the form and methods of learning the material. Simply put, the process of finding the right answer should be heavily emphasized rather than giving the correct answer every time. All in all, innovation ability allows professors to teach students the ability to create their solutions in preparation for the real world and future careers.

Although the pandemic has reached a turning point and most Chinese students are back in universities learning in an in-person setting, educational systems still have to weigh the possible opportunities and threats for future integration of online learning. Possible threats to utilizing online learning were expressed by professors and students including, lack of training experience and courses for professors, security risks with AI/Online technology, and students' heavy reliance on internet searches. As stated before, online search engines provide a plethora of helpful information for students to learn from, such as Youtube lectures, but they also serve as a

potential shortcut for students to simply find all the answers to their assignments. Therefore, face-to-face interactions between professors and students are still largely important to education.

Learning is also used to improve emotional ability, so policies to continue having online office hours should be limited to a degree. Another crucial threat to the continuation of online teaching is the lack of preparation to educate professors on ever-evolving online technology. As expressed by all interviewed professors, the transition to online learning was so abrupt that professors only had approximately one month to learn all the ins and outs of several online platforms. The Pandemic essentially pushed professors to leap forward in their knowledge of online tools based on their little experience beforehand. So, to effectively integrate online teaching into the future curriculum, universities must set aside ample time and resources for professors to properly learn the skills to effectively teach online. Another threat to the future use of online platforms is the inherent security risks of relying on existing firewall measures. Information online is easily leaked and can be obtained in many ways. Therefore, security measures on platforms such as Moodle and WeComm have to be frequently updated and secured to prevent any malicious interruptions in live classes. This has been a prominent issue already in existing universities such as Xi'an Jiaotong University and the University of International Business and Economics (UIBE), where hackers tried to obtain information about the school through illegal and harmful means. These recent examples highlight the urgent need to create substantial preventive measures of hacking in future implementations of online classes.

Despite potential threats to online learning, there are still countless positive opportunities for this form of teaching to be implemented in future curriculums. These opportunities include developing an AI era of reliant online teaching, creating a network of joint university resources and experiences, and the expansion of online learning platform integration with universities. By creating an AI-dependent system of teaching, a broader scope for reaching out to students will be achieved. Students will be provided more convenient measures of learning that will immerse new technology into the daily lives of educational facilities. As universities and professors get more accustomed to teaching online, a database for storing relevant information and tips to handle certain situations would prove to be very useful. This elicits the creation of a joint network among neighboring universities. As professors deal with hardships and difficulties while

teaching online, they can share their experiences and any helpful online tools that they utilize with other institutions to cross-reference ideas and further improve the structure of their classes. Currently, BUCT professors have reached out to discuss with other nearby universities, such as Tsinghua University, different implementations to further improve online learning. This network would provide a strong foundation for universities not only to aid each other in the success of integrating optimal online teaching frameworks but also set an example for other institutions.

Overall, the potential of online learning platforms is prevalent as expressed by numerous professors, but they can surely be improved upon to provide students with a more efficient and effective learning environment. These suggestions and current implications will be further addressed in the concluding remarks and recommendations to improve online education not only at BUCT but for all higher education universities throughout the world in the future.

### **4.3 Remote Learning Platforms Analysis**

During the pandemic, there have been many different remote learning platforms that have been implemented in class. Each platform operates differently and includes different features and benefits to its users. One issue with this widespread adoption of platforms is that there is no way to tell the benefits of each platform before using them in the classroom. The research team, along with the help of the BUCT team, analyzed the most common Chinese remote learning platforms to help guide universities in deciding which are appropriate for different settings. To view the results see Figure 28, which shows the comparison table. Despite the popularity of the Moodle platform mentioned in the professor interviews, it was excluded due to the basis of this analysis being focused on video conferencing platforms as opposed to web management services. This analysis checked for specific qualities that were reported to be integral during the professor and student interviews. For example, the ability to record lectures and poll student opinions were some of the most prominent features mentioned. Different platforms excelled at different categories, with Ding Talk being the best overall platform. Other platforms like WeChat Conference and Rain Classroom were close alternatives. In the end, it is ultimately up to the professor to decide which features they will require for class, and choose the platform they are most comfortable with. This diagram could be used to guide and develop a standardized remote learning setting, which will be addressed in more detail in the recommendation section.



Features of Online Teaching		Lark	Ding Talk	WeChat Conference	Rain Classroom	Tencent Meeting	Tencent Classroom
Recording Lectures	Teachers and students are able to record meetings	√ (Teachers only)	√	√	√	√	√ (Teachers only)
	Students can watch/download the playback video	√	√	√		√	√ (Only with the teacher's help)
	Students can view the documents displayed in the meeting		√	√	√	√	
Live Surveys	Professors are able to send out live polls in a meeting	√	√	√	√	√	√
	Professors know how to use this feature	√	√	√	√	√	√
Classroom Recording	Record in-person classrooms for online participants		√		√	√	

Figure 28: Remote Learning Analysis Comparison Table

## **V. Conclusion**

After analyzing the results from the methodology findings, the team has identified some key takeaways from the research into remote learning. Our data collection methods may have a potential location, and population size bias present due to the demographics of the survey respondents. To counter this we encourage further study, as the methodology can easily be adapted to other universities not only in China but across the globe. The main takeaway from the survey is that most students at university are willing and able to learn remotely. Students noted that their educational experience did not alter, and in some cases improved. Specifically, BUCT adapted and implemented remote learning in a very capable manner allowing for students to prosper and grow in these never before seen circumstances. Furthermore, the interviews provided more insight into the opinions of administrative staff and students. A key takeaway from the interviews is that professors view the educational experiences of remote learning in a very positive light. Of the professors that were interviewed all of them spoke very highly of the applications and positive aspects of online education. Some disadvantages are present in an online setting, yet no system will be perfect. There will always be difficulties and challenges for students and professors, and remote learning is no different. The overall consensus and conclusion from the data collected are that remote learning via information technology is a valuable and effective strategy never before used on a large scale in education. The results of the research have shown that not only professors are capable of adjusting to the online teaching model, but students as well. Due to the pandemic, and the large-scale use of online learning as the primary means of education, remote learning will continue to gain recognition as a valid and credible form of education accessible to all.

## VI. Recommendations

Throughout the past few months, our group confronted numerous unprecedented challenges in this project to improve online learning for higher education. By collecting statistical and opinionated responses through surveys and interviews, we were able to successfully gather and analyze information on the impact of virtual education and its possibilities in the future. Our results suggest a multitude of impactful conclusions which supplement our initial research and thought process. Following our analysis of this collected data, we wrote and provided several recommendations for the future of online education after the pandemic. We sincerely hope that the recommendations we conclude from our data analysis results will be useful in assisting our sponsor at BUCT to implement a foundation for online education. The recommendations are summarized in the five following bullet points:

- Establish a communication network with other schools and universities implementing online learning.
- Standardize the remote learning platforms implemented by professors.
- Improve the infrastructure of the university and further training of professors to better implement remote learning platforms.
- Integrate remote learning into the classroom to benefit professors and students.
- The continued study and analysis of remote learning platforms in the post-pandemic educational world.

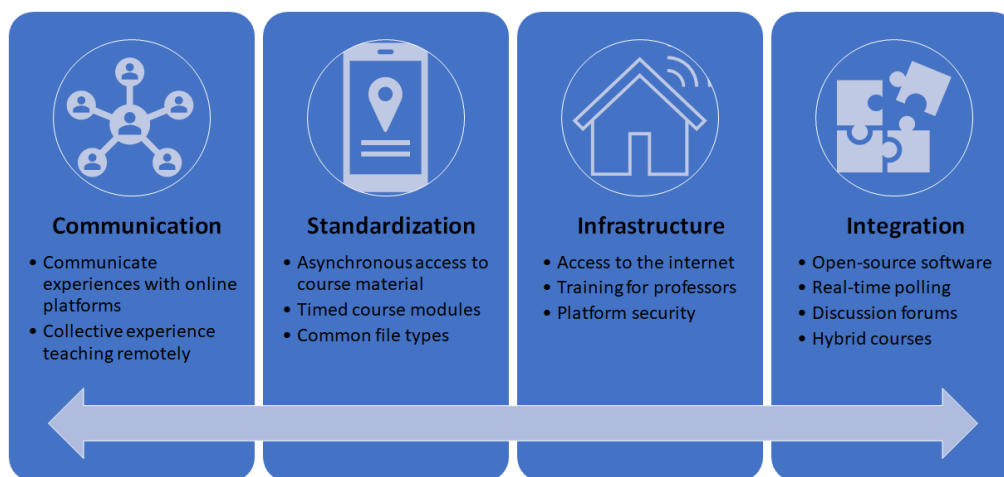


Figure 29: Recommendation Chart

## **6.1 Communication Network with other Schools for Online Learning**

To effectively learn from previous experiences from online education, universities should look to implement a connected network of communication between one another. By having a centralized hub of relaying information such as a OneDrive, universities can upload all critical and new information that they obtained through their own experiences from teaching online. Posted information can include a multitude of findings from using different online platforms and tools. One professor may find that a particular platform such as Moodle is straightforward and effective to use to post online discussion forums for students. This discovery can then be posted to the communication network between universities so that other professors from different schools can easily search for the best option to teach their students in a specific manner and implement these findings into their classes. As BUCT professors have noted in one-on-one interviews, some professors have reached out to other educators from nearby universities, like Tsinghua University, to seek their knowledge and experience of teaching during the pandemic. This initial contact can be expanded upon by building off one idea to another. Nearby universities in the same communities can exchange the upsides and downsides of online education and store this information for the following school years. Although this may seem to follow a trial-and-error process, within the time a multitude of professors will have tried and covered a vast array of online platforms and tools. This can aid professors in the future by saving them time and resources to simply search through this network for the best possible way to interact with their students from the information piled in this network. Furthermore, universities with more experience and knowledge can help educate other professors via workshops and training. One professor from BUCT noted gaining significant help from other university professors when navigating the online landscape. Ultimately, this communication network between nearby universities can be expanded nationwide and possibly on a worldwide scale.

## **6.2 Standardize Remote Learning Platforms**

Universities should seek a standardized feature set and/or platform to utilize for their remote learning programs. While a competitive market is good at breeding innovation and unprecedented features in remote learning software, a solid standard is needed to ensure the consistency of the quality of remote learning software and the familiarity of the software for staff

and students. Our survey revealed strong support for features in the vein of asynchronous learning. Students reacted very positively to the ability to review all course material, including lectures, when and where they wanted. A conferencing software like WeComm should have built-in recording capabilities to fulfill this purpose. While it is possible to record lectures via screen recording with third-party software, this would require technical knowledge and effort on the part of the professor or student. Because of this, an intuitive and seamless function is important to minimize the friction that is caused by recording lectures. Adding dates to assignments and course modules should also be a standardized feature. Asynchronous course materials are accessible at any time, so it is important to be clear about when each module is relevant. Many of the existing platforms such as Rain Classroom already have the capability to assign dates to modules. If at all possible, however, the platform should make the allotment of dates to course materials a default. Subtle design cues such as this will encourage professors to make their online classrooms easy to navigate. Just as important as the streamlining of individual classrooms is the ability to exchange information with the broader education community. This requires compatibility between platforms through the ability to exchange information. For this purpose, custom file types should be strongly discouraged. While they may allow for a wider variety of data to be stored and shared, they limit the cross-compatibility between different programs. It is much easier to transfer data in the form of a .jpg, .pdf, or pure Unicode than it is to integrate highly custom features between platforms. The standardization of design practices and features such as these would go a long way to make remote learning a more seamless process. We recommend that any university selecting software look for these key features.

### **6.3 Infrastructure and Training Improvements**

Throughout the pandemic, one of the major concerns from students and faculty is the general lack of infrastructure and training for students and professors. In general, infrastructure refers to the requirements for students and faculty to teach in an online setting involving network and hardware concerns. One major factor when dealing with infrastructure was the network connectivity for students and professors all across China. Networking is a major concern since a lack of proper network structure can cause these students to be unable to attend lectures, and in more serious cases cause professors to be unable to teach lectures. As mentioned in the

background section, to counteract this the Ministry of Education paired with many companies and universities to improve the network infrastructure before remote learning, and overall these improvements made mass remote learning feasible. However, even now, after entertaining remote education during the pandemic, network concerns still prevail among students and faculty. The data collected by the team shows that students and professors did encounter numerous network issues when undergoing remote learning. Many of the students interviewed noted that around campus the wifi can be quite difficult to deal with, and oftentimes leads to disconnection from online calls and important meetings. We encourage universities that intend to continue remote education to some degree to work with network companies in establishing a more stable and responsive network infrastructure on campus, and possibly in neighboring environments. Extending the signal range of the on-campus wifi network is something realistically within the school's power to accomplish that would significantly streamline the experience. Mobile internet stations may be a serious consideration for students living in areas with less access to the internet. If many universities go about these improvements and build a vast network infrastructure then students and faculty can receive a better remote learning experience. Furthermore, we encourage universities to invest and develop their online platform capabilities and security. As more and more educational materials shift online it is becoming imperative that security increases as well. A university reliant on online tools such as websites and video conferencing tools must prepare for when these systems fail due to malicious intent.

In terms of training professors and students, the team believes that it would be beneficial to educate staff and students on how to use online platforms for learning. One of the concerns professors mentioned in interviews was the lack of training for the remote setting. At the beginning of the pandemic, professors were granted a mere two weeks to learn the information technologies they would use in the classroom. To further the educational experiences in lectures, professors should be educated on the benefits and drawbacks of each platform, especially for those standardized platforms. Learning to better use and implement the educational tools technologies provide to professors can allow more student interaction in the classroom, and an overall more enjoyable experience due to a lack of technical difficulties. Many professors have likely already spent time during the pandemic learning about the technologies they implemented in the classroom so more experienced professors can lead lessons for professors. Another option

for training would be to record training videos for professors and students on specific platforms. Students raised other concerns that are more general and don't relate specifically to technology. This training can also focus more on less technical aspects of online learning, such as keeping students engaged in the classroom. Keeping students engaged in the course is crucial for both the typical in-person setting and also for remote settings while gauging user-friendliness.

#### **6.4 Integration of Remote Learning**

Despite most universities returning fully back to in-person teaching, online education can still serve an important purpose. A multitude of professors and student options our group surveyed and interviewed found multiple online platforms and tools still impactful in their everyday class. In addition, the majority of surveyed BUCT students noted that they would prefer a hybrid learning format for future classes. We recommend that professors keep certain aspects of online education that benefit both the educator and the students. Some of the most notable functions that we found were keeping lecture recordings and material online, having live time poll questions, and maintaining an online discussion forum for student discussions. Lecture recordings and class material uploaded online allows for students to effectively review information after the class has passed. This gives students more time to consistently rewatch and further understand lecture material, even if they were to miss class on that corresponding date. Another function that professors felt was useful was implementing a live poll for questions during class. By having students log into a website, such as Poll Everywhere, on their phone or laptop during class professors can ask quick questions about the current topic they are teaching at hand. These online tools give immediate responses and allow professors to gauge if they have successfully taught the material well. This instantaneous feedback allows professors to improve upon their teaching style efficiently and rapidly unlike traditional responses from having students speak out loud or giving a long survey at the end of a semester. Professors should also consider hosting online office hours as opposed to solely in-person meetings, as they can help improve student attention rate, as well as, help students contact professors that would otherwise be too shy. Many professor interviews noted an increase in student attention rate due to the online format creating a much different and less formal learning environment. The final online education integration that we recommend for professors is creating a virtual discussion forum for

students to interact with one another before and after class. These discussion forums elicit in-depth responses from students as they have time to give sufficient and thoroughly written responses to questions/comments posted by other students. Notably, this will allow professors to build off from important online discussions and utilize this as a topic to further inspect during live classes. These distinct implementations of online learning for in-person classes only encompass a few aspects that professors have harped on at BUCT. Thus, there are a plethora of other online tools that professors can implement in their classes based on preference.

Several interviewees mentioned their use of Moodle, an open-source class management software. Open-source software has the benefit of community extensibility. If a feature is missing from the base product, then a large enough community would surely develop an addon for such a feature. This constant input from the community also means that open-source software tends to comply more with compatibility standards to ensure cross-functionality with other software. Some drawbacks include difficulty funding such projects and a lack of customer support. Open-source software often relies heavily on voluntary work and generous donations to keep development active. This low funding also means that open source software often has no customer support programs. Large organizations, namely schools, often rely on such programs to ensure the smooth functioning of the software suites they use for their students and staff. Moodle has recently added a paid support program on top of its existing program. This is a step towards better support for large organizations however, it does not obligate them to major bug fixes and changes to the platform when needed.

Finally, remote learning can continue to be implemented as the sole method of instruction for online universities. Entirely online universities have been growing in popularity in recent years, as mentioned in the background section of this report, and education during the pandemic has likely only increased their popularity. The pandemic has shown that remote learning has merit to its educational reliability, and has given much more credibility to these online universities. In the future online universities are likely to grow in popularity and renown, and the team encourages universities to embrace this transition to online teaching. One option is for standard universities to implement these remote teaching methods to some capacity. However,



universities can also consider implementing entirely remote courses and staff for students, and possibly even open departments focusing entirely on fully remote online education.

### 6.5 Continued Study of Remote Learning

The research team encourages the usage of remote learning platforms in education in the years to come after the pandemic. One topic of discussion is the impact the pandemic played on the collection of data, and how a remote setting might differ in a typical world environment. During the pandemic students and professors were suffering from many more external factors than just remote education, which in part can lead to data differences. If a study was to continue the same research study in a more normal world environment then the results could differ. The team encourages BUCT to implement a similar model of remote learning to their students in a post-pandemic world and continue the study. This new study can better ascertain student opinions on remote learning once it is not forced upon them due to the danger of disease.

Another field of exploration in terms of remote learning is to judge the results among different universities with a widespread net of diversity among students and school types. As mentioned previously BUCT is a S.T.E.M. school with majors and students primarily focusing on those departments. An expansion of the research conducted could be to analyze the impacts of remote learning across numerous universities with different majors and student backgrounds. This type of study can help researchers better ascertain if there are specific areas and fields where remote learning is a better instruction method.

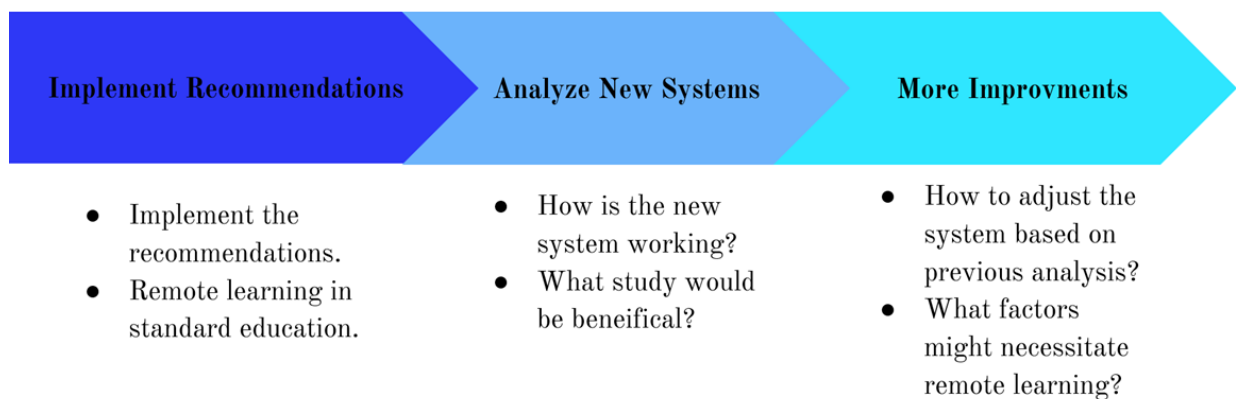


Figure 30: The Future Research Plan

## **6.6 Recommendations Conclusion**

In summary, our research has found that there is a high demand for a few key features of online learning. Many professors use live polling to receive instantaneous feedback on students' performances and where to focus their lectures. Lecture recordings allow students to access course information at any time, adding flexibility to their complex schedules. Without network access, remote learning is nearly impossible. Some areas, however, could use further development in internet infrastructure. Forums allow students to formulate clear and thought-out discussions in less formal settings. These features of remote learning technology should be sought out when determining which software should be used going forward. It's important that the software used be qualitatively maintained in both fully online and hybrid learning environments. Implementing online teaching technologies in the right segments of the classroom and in the right way could vastly improve the experience for professors and students.

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## VI. Appendices

### Appendix A: Student Questionnaire Questions

\*For questions requiring a rating the scale is for 1, Strongly Disagree to 5, Strongly Agree

1. Optional Enter: Age, Gender (Male/Female/Other), Grade, Major, and University
2. My university handled remote education during the pandemic well. (1 - 5)
3. If offered, I am likely to take this type of course online. (1 - 5 for each)
  - a. Core Professional Courses
  - b. General Education Courses
  - c. Professional Elective Courses
  - d. General Elective Courses
4. Your professors adjusted well and were efficient in the online teaching format. (1 - 5)
5. Did online teaching impact your grades at all? (1-5)
  - a. Greatly decreased, decreased, stayed the same, increased, greatly increased
6. What aspects of online courses have appealed to you? (select all that apply)
  - a. Not commuting to a classroom
  - b. Course materials available online
  - c. Online submissions
  - d. More time at home
  - e. Remote access to professors/staff
  - f. Other (Specify)
7. What online learning tools did you use during the COVID-19 pandemic? (select all)
  - a. 钉钉 (DingTalk)
  - b. 腾讯课堂 (Tencent Classroom)
  - c. 企业微信会议 (Enterprise wechat conference)
  - d. 企业微信直播 (Enterprise wechat live broadcast)
  - e. 腾讯会议 (Tencent Meeting)
  - f. 雨课堂 (Rain Classroom)
  - g. Other (Specify)



8. Have you used any of these online learning resources before the COVID-19 pandemic?  
(Y/N) (If yes, what specifically? Same options as previous)
9. Are there any technologies that you hope will be implemented in future courses to aid students?
  - a. Hybrid in-person and online courses
  - b. Fully remote courses
  - c. Asynchronous lectures (recorded lectures)
  - d. Virtual office hours
  - e. More in class discussion via online platforms
  - f. Other (Specify)
10. Did you have any personal difficulties when using the online learning platform? (Y/N)
11. (If yes, what specifically?)
  - a. Network/Technical Communication problems with teachers
  - b. Network/Technical Communication problems with classmates
  - c. Lack of a physical learning environment
  - d. Activities that require in-person contact (i.e. labs, hands-on demonstrations)
  - e. Other (Specify)
12. How do you think online learning personally affects your motivation in school/your mental health?
13. Input any suggestions on how to improve the online education system and any takeaways from online learning that you would like to be implemented in the future.
14. Would you be open to a one-on-one interview to gather more information? (Y/N)

## **Appendix B: Interview Questions**

### **Interviewee Background**

1. What is your role at Beijing University of Chemical Technology? Can you tell us a little about your history?
2. How do you believe technology can play a role in education?
3. What impacts has the pandemic had on the Beijing University of Chemical Technology?

### **Current Implementations**

4. What kind of training did you undergo to adapt to the new system?
5. What technologies are being used currently at the Beijing University of Chemical Technology? Are these platforms working well in the current system?
6. How have other higher education Universities or Colleges adjusted to the new education platform during the pandemic?
7. What type of technology solutions would be considered acceptable? (e.g., technology costs, ease of access for students, viability past the pandemic, etc.)

### **Effects of Technology in Education**

8. Are any of the current policies likely to be continued after the pandemic is ended? For example, asynchronous lectures, or online lectures for students.
9. For students attending the University, have there been any disadvantages for students based on Internet Speed, Hardware, or any other reasons? Are there currently any systems in place to prevent these issues for students?

### **Education Needs and Opinions**

10. How have students at the BUCT responded to the new policies implemented during the pandemic? Have there been positive responses? Negative? Indifferent?
11. Have there been any issues with implementing online learning for students attending the Beijing University of Chemical Technology? If so, how were these issues solved?
  - a. Have you experienced similar issues with your remote classes or any negative implications from social media platforms? For example, “Zoom bombings”.

### **Miscellaneous**

12. Is there anything that you believe that we are missing?
13. Thank you for your time!

## **Appendix C: Student Interview Questions**

### **Interviewee Background**

1. What impacts has the pandemic had on the Beijing University of Chemical Technology?

### **Current Implementations**

2. You mentioned [these] platforms being used during the pandemic. How were each of these being used? How well do you think each of these platforms fulfilled their role?
3. How have other higher education Universities or Colleges adjusted to the new education platform during the pandemic?
4. What type of technology solutions would be considered acceptable? (e.g., technology costs, ease of access for students, viability past the pandemic, etc.)

### **Future Implementations**

5. Ask for their reasoning behind their rating of each category of their likelihood to take online courses.

### **Effects of Technology in Education**

6. Are any of the current policies likely to be continued after the pandemic is ended? For example, asynchronous lectures, or online lectures for students. Why are these benefits?
7. For students attending the University, have there been any disadvantages for students based on Internet Speed, Hardware, or any other reasons? Are there currently any systems in place to prevent these issues for students?

### **Education Needs and Opinions**

8. How have students at the BUCT responded to the new policies implemented during the pandemic? Have there been positive responses? Negative? Indifferent?
9. Would you say that in your experience online courses have been seen at full capacity? Less than expected capacity? Do you watch recorded lectures as opposed to attending lectures?

### **Miscellaneous**

10. Is there anything that you believe that we are missing?
11. Thank you for your time!

**Appendix D: Timeline**

TASK	WEEK							
	PQP	1	2	3	4	5	6	7
Finalize project proposal								
Get WPI I.R.B. approval								
Meet with faculty at BUCT, Revised Background								
Perform survey for data collection, Revised Methodology								
Analyze additional potential technologies, data analysis draft complete								
Interview students and faculty, revise data analysis								
Conclusion and recommendations draft								
Create recommendations for implementing technologies, Final report								

## **Appendix E: Informed Consent**

**Investigators:** Michael Zoella, Cameron Jacobson, Jason Chen

**Title of Research Study:** Assessing the Impact of Information Technology in Higher Education at China's Universities Pre/Post COVID

**Sponsor:** Beijing University of Chemical Technology

### **Contact Information:**

For more information about this research or the rights of research participants, or in case of research-related injury, contact Michael Zeolla at [mjzeolla@wpi.edu](mailto:mjzeolla@wpi.edu) with any questions or concerns. The supervisor for this research is Jianyu Liang and Xinming Huang. They can be reached by email at [jianyul@wpi.edu](mailto:jianyul@wpi.edu) and [xhuang@wpi.edu](mailto:xhuang@wpi.edu) respectively.

### **Introduction:**

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make an informed decision regarding participation.

### **Purpose of the study:**

We are undergraduate students at Worcester Polytechnic Institute conducting a research study on IT-enabled higher education in China during COVID-19. The study will be published in the WPI Electronics Projects collection. We are interested in hearing from students and faculty at BUCT that have had their education experience impacted by the unique circumstances of the COVID-19 pandemic.

### **Procedures to be followed:**

You are asked to fill out a short online survey. This survey will take approximately 15 minutes to complete and you can take more time if needed. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. The survey pertains to your personal experience of online higher education during the pandemic and any observations that you had during this past year regarding virtual learning platforms. The survey consists of both closed-ended rating style questions and open-ended opinionated questions. You will be asked if you would like to participate in a follow-up interview. If you select 'yes', then you will be contacted with further details. You may opt-out of the interview at any time even after you have chosen to take part. Please contact Michael Zeolla at [mjzeolla@wpi.edu](mailto:mjzeolla@wpi.edu) for further information. To begin the survey please tap the begin button below.

**Risks to study participants**

This study is of minimal risk. It does, however, ask questions about current opinions about BUCT online education during the pandemic that may make the respondent feel uncomfortable. Please fill out as many questions as possible, but if you are unable to complete any of these questions, you may stop at any time.

**Benefits to research participants and others:**

The benefit to research participants is aiding a study to further improve the structure and efficiency of future online education. The recommendations developed from this survey may positively impact Beijing University of Chemical Technology and other nearby universities' online and hybrid classes.

**Record keeping and confidentiality:**

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or its designee, and under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you. Official records will be kept by the study investigators for the duration of the research period.

**Compensation or treatment in the event of an injury:**

You do not give up any of your legal rights by signing this statement. This study involves no risk of injury or harm to participants.

**For more information about this research or about the rights of research participants, or in case of research-related injury, contact:**

For any questions about the nature of this study or the procedures being followed follow the contact procedure listed at the top of this form. Any questions about human rights issues should be directed to the IRB Manager (Ruth McKeogh, Tel. 508 831- 6699, Email: [irb@wpi.edu](mailto:irb@wpi.edu) ) and the Human Protection Administrator (Gabriel Johnson, Tel. 508-831-4989, Email: [gjohnson@wpi.edu](mailto:gjohnson@wpi.edu)).

**Your participation in this research is voluntary.**

Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

**By signing below**, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

**Additional clauses to add to Consent Agreements:**

Should a participant wish to withdraw from the study after it has begun, the following procedures should be followed: all data previously collected relevant to the participant will be deleted. There are no consequences for early withdrawal for the subject.

\_\_\_\_\_  
Study Participant Signature

Date: \_\_\_\_\_

\_\_\_\_\_  
Study Participant Name (Please print)

\_\_\_\_\_  
Signature Person who explained this study

Date: \_\_\_\_\_