International Journal of Instruction
e-ISSN: 1308-1470 ● www.e-iji.net

July 2023 ● Vol.16, No.3
p-ISSN: 1694-609X
pp. 343-362

Article submission code: 20220720192629

Received: 20/07/2022
Revision: 03/01/2023

Accepted: 25/01/2023
OnlineFirst: 10/04/2023

Impact of the Digitization of Teaching on Undergraduate Students as the Result of the Covid-19 Pandemic and Transitioning to Online Learning

Issa I. Salame
Asst. Prof. Department of Chemistry and Biochemistry, The City College of New York of the City University of New York, New York City, USA, *isalame@ccny.cuny.edu*

Victoria Gomes
B. S. Department of Chemistry and Biochemistry, The City College of New York of the City University of New York, USA, *vgomes000@citymail.cuny.edu*

Morgan K. Moreira
B. S. Department of Chemistry and Biochemistry, The City College of New York of the City University of New York, USA, *mmoreir000@citymail.cuny.edu*

Hebah Jihad
B.S. Department of Psychology, The City College of New York of the City University of New York, USA, *hjihad000@citymail.cuny.edu*

The novel coronavirus pandemic has disrupted everyday life infrastructure and greatly impacted educational systems worldwide in many ways. More specifically, Covid-19 confinement has significantly impacted students' learning abilities and their academic performance as they adapt to remote learning. There are significant differences between online learning and a traditional face-to-face format. Pandemic induced remote-learning negatively impacted students' access to education, most notably, low-income minority students. This research study aimed to examine the challenges students faced and the strategies they utilized to overcome them during the covid-19 transitioning to online learning. The investigation took place at the City College of New York, an urban, minority-serving institute. The number of research participants was 156 and our method of data collection comprised a survey made up of Likert-type and open-ended questions. Our findings suggest that students faced many challenges as a result of moving to online learning due to household distractions, technology issues, lack of socialization and interaction with peers and instructors, decreased motivation, increased feelings of isolation, and higher difficulty level of assignments and examinations. We should highlight that students found that online learning negatively impacted their mental health and increased their anxiety levels around science courses. However, students also reported positive aspects of transitioning to online learning.

Keywords: challenges to learning, online learning, covid-19, learning, teaching

Citation: Salame, I. I., Gomes, V., Moreira, M. K., & Jihad, H. (2023). Impact of the digitization of teaching on undergraduate students as the result of the Covid-19 pandemic and transitioning to online learning. *International Journal of Instruction*, *16*(3), 343-362. https://doi.org/10.29333/iji.2023.16319a

INTRODUCTION

Educational system all over the world has been greatly affected due to the pandemic. Covid-19 pandemic has affected every aspect of our lives including economic, social, psychological, and educational areas (Hindun et al., 2021). More specifically, Covid-19 confinement has significantly impacted students' learning abilities and their academic performance as they adapt to the remote learning education system. Schools have become one of the top environments in danger of rapidly spreading Covid-19 as students constant interact with one another, touch surfaces, and utilize communal bathrooms and water fountains (Mulenga & Marbán, 2020). Therefore, students were forced to familiarize themselves with digital learning platforms to continue their education. Online learning platforms have minimized the possibility of face-to-face or physical interactions while maintaining social distancing rules (Gonzalez et al., 2020). Online learning is defined as the "learning process which takes place through the internet as one of the forms of distance learning" (Al Kandari & Al Qattan, 2020).

Based on traditional education research, low-performing students may experience less self-efficacy and motivation than high performing students. In transitioning to online learning, low-performing students already lacking self-efficacy can experience increased stress in adapting to a digital classroom. Self-efficacy refers to the personal belief or to an individual's confidence in his/her own ability to perform effectively specified tasks (Yusuf, 2011). Online-learning tasks that produced symptoms of stress or negative affect may be interpreted by students as competency limitations (Bates & Khasawneh, 2007). Perceived competency limitations are shown to decrease self-efficacy and motivation.

Following global school closures resulting from the Covid-19 pandemic, this potential bias was mitigated. To fully understand the impact of online learning during the Covid-19 pandemic, pre-existing disparities in education are explored in relation to resource-dependent attributes of online learning. A parent's post-secondary education and professional income impact the likelihood of their children's post-secondary education and professional income. A minority parent's ability to invest in their child's education and college trajectory is impacted by socioeconomic status and racial status (Charles et al., 2007). The pandemic has had a negative impact on learning throughout all of the educational levels. This has adversely affected teaching and learning at the K-16 levels of education institutions. Covid-19 pandemic negatively influenced students with lower income and this was shown in one study where the author found a correlation between financial stress and learning stress and that students with better financial conditions had less stress adapting to the new online learning environment (Lulaj, 2022).

Parental financial assistance for college is a major contributor to Black and White educational disparities in the United States. Disparities in education and economic outcomes are closely related (Blundell et al., 2020). The Covid-19 pandemic has made it clear that there exists a digital divide which has profound impact on learning for students who are disadvantaged (Verma et al., 2020). There is a large gap in 4-year college matriculation between racial minorities and their White peers. Educational inequality by race, ethnicity, and socioeconomic status has also been shown in the online learning environment. In the transition to online learning, although every student showed

decreased adaptability to the online learning environment, the extent of lowered adaptability differed across subgroups. Age, sex, and race corresponded to varying degrees of adaptability in online courses. Even if online learning content is strong, if students cannot access a supportive environment or resources, there may be a decrease in cognitive engagement with online courses. Environmental conditions and familial attitudes impact concentration and accessibility to online learning tools (Aguilera-Hermida, 2020).

Differing from past recessions, the economic impact resulting from the Covid-19 pandemic was abrupt and immediate (Witteveen, 2020). Given the information provided on the disparity in education and socioeconomic resources across race and ethnicity, it is not surprising that the effects of the Covid-19 pandemic were distributed unequally. During the lockdown, when compared to the tier of highest-paid workers, low-pay workers were 2.5 times more likely to experience income loss and pre-existing socio-economic inequalities are often worsened by macroeconomic downturns (Witteveen, 2020). The economically disadvantaged are more likely to work in lower-paid, essential roles in retail, healthcare, and the service –sector. These roles include public transportation workers, security guards, and delivery drivers. During the Covid-19 pandemic, employees of these professions faced increased exposure to large numbers of people, increasing their risk of transmission and infection.

There were higher mortality rates among members of minority groups, specific occupations. and poorer communities (Blundell et al., 2020). The Covid-19 pandemic highlighted stark racial inequalities in the United States and other developed countries. Communities with large Black and Hispanic populations experienced increased rates of Covid-19 transmission and disease severity. The Covid-19 pandemic prompted an emergency response to online learning, which is not representative of current studies in this field. Both school faculty and students experienced challenges during the Covid-19 pandemic. The immediate transition to online instruction during the Covid-19 pandemic did not allow for planning a proper online course design or transition. The effects of the Covid-19 pandemic on teaching style are likely intertwined with the students' learning process (Aguilera-Hermida, 2020).

The learning experience of a marginalized student presents new complexities in the context of the Covid-19 pandemic (Soudien, 2020). Inequalities in access to technological tools and family conditions created limitations that may have impacted students' performance (Aguilera-Hermida, 2020). Therefore, pandemic induced remote learning most notably impacted low-income students' access to education. According to Rofial and co-workers transitioning from in-person to online learning as the result of the pandemic had many challenges (Rofiah, et al., 2022). In one research study, authors report that despite their availability, online learning tools were rarely used before the pandemic which forced teachers to teach online. Furthermore, in comparing traditional teaching to electronic teaching, the authors present data that traditional learning tools were more effective (Ismaell & Mulim, 2022).

Transitioning to a new method of online and blended learning has provided the opportunity to adopt digital learning and ways to cope with new technologies during a

time of national emergency (Ali, 2020). Campuses should have been prepared to loan devices to students so that online transition can be smooth and flexible (Villanueva et al., 2020). The use of social media has become a popular way of sharing educational content among students. Despite technological advancements, most students and teachers encountered challenges caused by the pedagogical transformation. Online learning barriers are divided into material and non-material barriers in which material barrier refers to a lack of online resources and non-material barrier refers to a lack of proper knowledge and skills pertaining to the uses of those resources (Mailizar et al., 2020). However, the availability of resources alone may not be enough to implement information & communication technology. Trust factors contribute a lot to running online learning activities successfully. Security systems should be updated, and privacy policies should be applied to improve the adaptation of the online learning system (Almaiah et al., 2020).

Students form high-income families spend more time learning online than offline due to their accessibility to more home resources such as high-speed internet, new technologies, subscription to online lessons, etc. (Tran et al., 2020). Poor access to online resources, lack of feedback, and inadequate course time can cause ambiguity (Akbulut et al., 2020). Some students are falling behind while others can continue to participate in online education resulting in educational inequality (Akbulut et al., 2020). Along with students, parents are also facing financial problems to gather these resources for their education. Sharing electronic devices used for remote learning with other family members is another struggle that students can face in remote learning. As a result, access to resources and time spent on assignments are reduced in reality.

Educational continuity played a major role in adapting to remote learning (Dietrich et al., 2020). Financial issues are not the only problems students face in distance learning. Technical issues seem to impact students' mental health significantly. Besides technological issues, students also encounter mental challenges such as depression, stress, and fearfulness (Turner et al., 2009; Warner et al., 2008). Emergency transition to remote learning has impacted the non-STEM major students because of the modifications of both the teaching and learning method of chemistry courses (Perets et al., 2020). Students were found to withdraw from general chemistry at a higher rate due to the challenges faced during the transition.

The results of an online survey from chemistry students at the University of Boumerdes-Algeria showed that students have a negative perception of online learning. Algerian students experienced an instant shift from face-to-face to online learning due to schools and university closures in response to the Covid outbreak (Blizak et al., 2020). Both students and teachers can contribute to adapting to these new learning processes considering the challenges and difficulties one can face during this pandemic. However, significant differences were observed when the education level of those students was considered. Overall, for most of the students indicated a negative perception of online learning and preferred the in person learning method post the Covid-19 confinement period (Blizak et al., 2020). Furthermore, in one research study, it is reported that a negative correlation exists between pandemic stress and digital competence of

instructors in their adaptation to online learning environments (Vergara-Rodríguez et al., 2022).

In Italy, just like other nations, closure of schools and universities was an immediate emergency measure in response to the Covid-19 epidemic (Gallè et al., 2020). Although a decrease in physical activity was observed, most students did not modify their behavior pertaining to their daily habits during the lockdown. Observations revealed that students retained new information faster when learning online. On the other hand, class rhythm could be too fast for some students to understand or ask questions about the topics taught in class. Majority of students reported an increase in workload and that they are less effective while studying because they did not have a physical classroom, or any educators present in-person during class.

According to student testimonials, collaborative learning courses such as chemistry and mathematics play important roles in improving student performance as they assist students to build their confidence (Gemmel et al., 2020). Observations indicated that more questions were asked during online lessons compared to physical class sessions (Tan et al., 2020). Virtual collaboration and group projects can develop critical thinking skills for the future as graduates may work with people from different parts of the world. Students are often encouraged to clarify their doubts using tools found in online learning platforms which allow students to reflect and achieve a deeper understanding of the content.

Studies have found that "technology in mathematics education improve learning" although further studies are needed to conclude what type of technological tools would be appropriate for online learning during the Covid-19 confinement period (Mulenga & Marbán, 2020). Given the current circumstances, chemistry educators are concerned whether the same level of engagement can be achieved through online teaching as in-person lessons. Maintaining students' engagement and commitment to the educational process seems to be the biggest challenge of online learning (Rodríguez-Rodríguez et al., 2020). The combination of social presence, cognitive presence, and teaching presence creates a fruitful and rich education experience (Garrison et al., 1999).

In comparison with in-person classes, students now have access to more resources and contents for online courses such as recordings, simulations, seminars and multimedia materials for chemistry learning (Rodríguez-Rodríguez et al., 2020). Both synchronous and asynchronous online learning have some advantages and disadvantages depending on how often interactions occur between students and teachers as the media of communication varies in both methods. Students may feel lost about the assignments and their deadlines due to lack of assistance when needed (Rodríguez-Rodríguez et al., 2020). Therefore, students indicate their interest in in-person classroom environment over online lessons (Rodríguez-Rodríguez et al., 2020).

In a study in Latin America and the Caribbean, researchers report that university professors have a high self-concept of their digital ability and their ability to adapt to digital learning during the pandemic. Additionally, the study reports that female have higher digital competence and lower digital stress related to the pandemic (Antón-

Sancho et al., 2022). Additionally, A research project reports that students exhibited high levels of adaptation as the result of switching to online learning (Delgado, 2022). The pandemic has led to an increase in information and communication technologies which is found to be significantly higher for engineering and social science faculty than other areas (Antón-Sancho & Sánchez-Calvo, 2022). Because of the pandemic and the shift to online learning, faculty roles evolved to and changed to become more of a guide, companion, advisor and tutor (Ramos-Pla et al., 2022).

Parents with higher levels of education are found to provide a stimulating home environment for their children to promote cognitive development and to be successful in their learning process (DiPrete & Eirich, 2006). Computers and the internet are the most widely used components of distance learning. Despite using them at a high rate, not everyone has access to these communication tools which brings about the debate regarding equality of opportunity achieved in the online learning education system (Akbulut et al., 2020).

METHOD

The research investigation aimed to examine the impact of transitioning to online learning as the result of Covid-19 on students learning, attitudes, and how it affected their study habits and approaches to learning. Participants surveyed were students from a large and culturally diverse university in New York City. The students' majors included chemistry, biology, chemical engineering, civil engineering, and pre-health professionals. The majority of the students were minority students mostly Latino and African American. The student population also included White, Asian, and Middle Eastern students. We should note that an overwhelming majority of our student population come from lower socioeconomic backgrounds and qualify for financial aid. There was a total of 156 participants. The average participants were 22.05 (SD = 4.015) years old. The youngest participant was 18 years old, and the oldest participant was 46. The project took place during the 2021-2022 academic year. This study was approved by the Institutional Review Board of the university. The research was conducted in accordance with the Internal Review Board of the City College of New York. The surveys were anonymous and no identifiers were linked the students to the surveys. Also, a consent form has handed out to all students and participating in the research project was optional. This survey included Likert-type and open-ended questions. Demographic data including GPA, major, gender, and age were collected. The first twelve questions were a series of statements/questions regarding online versus in person learning. Statements included "I enjoy learning online more than classroom environment" and "I think that online teaching needs to be more interactive". In response students would rate each statement as it pertains to them on a 5-point scale: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5).

Two experts have examined the survey and consent that the questions appropriately and adequately express the investigation about transitioning to online learning. The reliability coefficient was determined to be 0.86 using the test-retest procedure. The data from the Likert-scale questions were analyzed using single-factor ANOVA and it was found that $p < .001$. This is confirmation against the null hypothesis and verification that

there is strong relationship between the variables. Additionally, the mean square for our data is 65.34 which is significantly larger than the mean square within the treatments which is 1.27.

The second section of the survey included five open-ended questions that focused on students' attitudes towards remote learning, specifically what they liked/disliked, the challenges they experienced and the perceived impact it had on their mental health. For four out of the five questions we compiled student responses into categories and calculated the percentages of students that fit into those categories. We used the categories and percentages to create histograms that displayed the distribution of student answers per category. This was accomplished by entering the data into Excel sheet and calculating the average value for the responses to each question.

For the open-ended question pertaining to how they believe the pandemic has impacted their mental health, we created a rubric to score each answer based on a 1 to 5 scale. A score of 1 depicts that remote learning positively impacted mental health, students recall enjoying the experience and benefiting from it. A score of 2 indicates that remote learning somewhat positively impacted mental health; a score of 3 refers to remote learning as having no impact on mental health and that student's outlook was neutral, rather they were impacted by other factors, ie. pandemic/Covid-19. A score of 4 is based on student's response that remote learning somewhat negatively impacted mental health and students lack motivation and recall instances of anxiety; and a score of 5 is where the student's response is that remote learning negatively impacted mental health, students recall feeling burned out, and displayed increased levels of stress, anxiety and/or depression.

Guiding Research Questions

1. What are some of the challenges and difficulties that students face as the result of transitioning to online learning due to the Covid-19 pandemic?

2. What strategies and approaches did the students rely on to cope with online learning?

3. What did the students appreciate or oppose about online learning?

FINDINGS AND DISCUSSION

Table 1 presents the averages of the questions that utilized a Likert scale to gauge student perceptions and attitudes regarding online learning. Results indicate a neutral attitude towards questions 1, 3, 4, and 5. These questions pertained to preferring an online interface over an in-person environment, whether it was easy for them to utilize platforms necessary for online learning i.e., Zoom, and Blackboard; whether they struggled with internet connections; communication with professors, and lastly if they would prefer in-person learning. Students generally agreed that they had access to the necessary resources required for online learning. These resources can include access to computers, online videos, and tutorials, as well as recitation sessions and office hours. In addition, students generally agreed that they believe online learning could have been more interactive, that family distractions made it difficult to concentrate in class, and that professors assigned more work while they were learning online in an effort to

ensure success in the classroom by providing additional studying material. This is supported by research that reports students expressed sadness and anger resulting from online practices (Varea & González-Calvo, 2020).

Table 1
Likert-type and open-ended questions and average answer from respondents

Likert-type Question	Average Answer from Respondents
I enjoy learning online more than classroom environment.	2.75
I had access to enough resources necessary for remote learning.	3.59
I found online learning platforms easy to work with.	3.23
I struggled with using devices and internet connections while attending online classes and completing assignments.	2.90
It was easy to communicate with teachers during online learning.	2.70
If I had a choice, I would attend online classes instead of in person learning.	2.75
I think that online teaching needs to be more interactive.	3.84
Family distraction and lack of space can be problematic to concentrate while learning online.	4.37
There is an increased number of assignments in online learning.	4.15
Open-ended Question	Average Answer from Respondents
How did remote learning affect your mental health? (Positive 1, Negative 5)	3.87

One of the open-ended questions asked students how they believed remote learning impacted their mental health. We created a Likert ranging from 1-5 with 1 as strong positive impact and 5 as strong negative impact to rate student responses. The average of these responses was 3.87 which indicates a somewhat negative impact on mental health. This is consistent with other research findings that report undergraduate students affected by emergency situations may have experienced increased anxiety and stress in adapting to new learning methods mid-semester and as concerned over academic outcomes, social isolation, and ability to learn entirely online (Unger & Meiran, 2020). Also, other researchers have reported similar results about negative emotions such as technology-related fear, increased anxiety, anger, and helplessness (Butz et al., 2015). Online learning increased stress and anxiety, and negatively impacted students' mental health which would have a negative impact on students' learning and performance. Research has reported that low-performing students seem to experience increased stress in adapting to transitioning to online learning which can impact their competency (Bates & Khasawneh, 2007). Additionally, according to Oducado and co-authors in a study in the Philippines they obtained results that demonstrate that more than half of teachers experienced moderate stress due to covid-19 (Oducado et al., 2021). Furthermore, Boonroungrut and coworkers reviewed published an article related to the pandemic and found that mental health and psychological issues gained plenty of interest by researchers worldwide followed by distance and online learning (Boonroungrut et al., 2022).

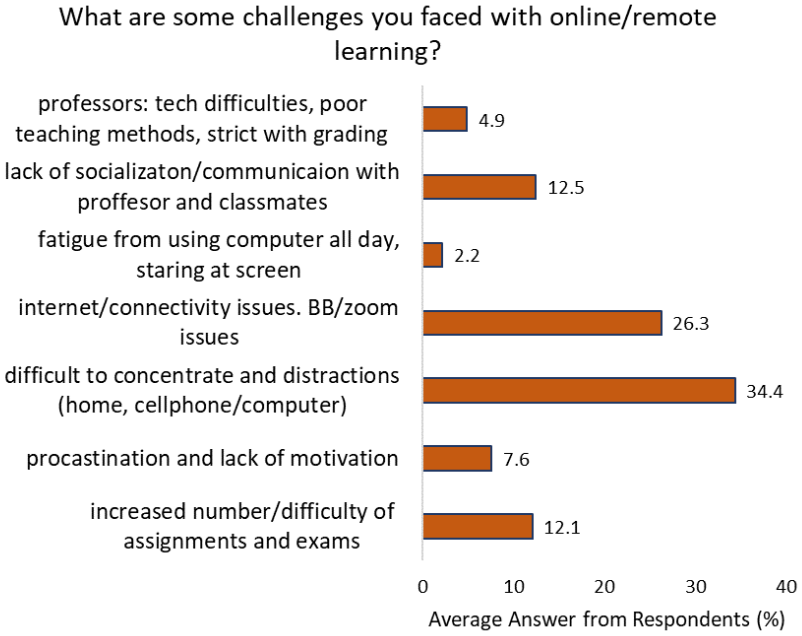

Figure 1
Bar chart depicting the students' perceptions about the challenges that students faced with online/remote learning

Figure 1 presents the eight categories that were created after reading through all the students' short answer responses and finding commonalities in their struggles. Results indicate that approximately a third of the students (34.4%) found it extremely difficult to concentrate in class due to various distractions at home, some of which included the presence of their family and technological devices. Over a quarter of the students (26.3%) struggled with connectivity issues in terms of WI-FI connection as well as issues with the platforms necessary for learning such as Zoom and Blackboard. Since our students are mostly minority students who come from poor backgrounds and qualify for financial aid, socioeconomic status and racial status can negatively impact a student's education due to the lack of parents to invest in student's education and this has been found to be more common with minority students (Charles et al., 2007). Additionally, research findings report that due to financial need and lack of available resources, students from low-income backgrounds living in rural areas were less prepared for online education during the pandemic (Blizak et al., 2020). Educational disparities related to race, ethnicity, and socioeconomic status have been found to negatively impact online learning (Blundell et al., 2020).

An almost equal number of students felt that there was an increased number of assignments and that the difficulty of assignments and exams was greater (12.1%). in addition, students felt that communication with professors and classmates was extremely

poor and this made them feel isolated (12.5%). This is in line with research in the field that reports one major negative impact of Covid-19 pandemic and the move to online synchronous and asynchronous learning is the loss of socialization (Alomyan, 2021). The last fourth of the students was split among three different challenges. The first of these challenges comprised 7.6% of students who found that they struggled with procrastination and a lack of motivation, 4.9% of students struggled with the professor's teaching style and attitude. Many students are worried and concerned about the quality of the education they are receiving online (Kirschner et al., 2020). Lastly, 2.2% of students struggled with screen fatigue. Regardless of their age and gender, most students who participated in a survey reported that many different factors influence their online learning environments such as disruption of the internet, lack of electronic devices, stress and anxiety, high volume of homework assignments, and a lack of communication with professors (Blizak et al., 2020).

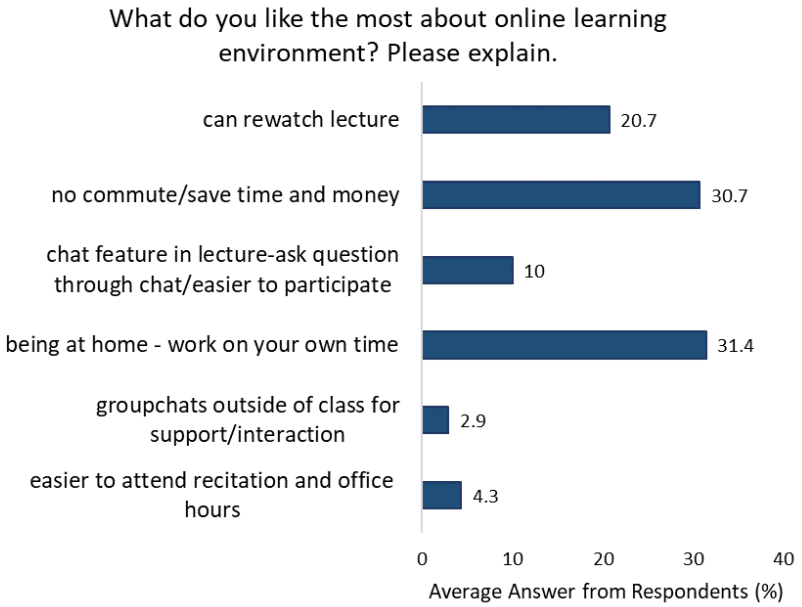

Figure 2
Bar chart depicting what students appreciated about online/remote learning environment

The second open ended question asked students to name some of their likes and dislikes of the online learning environment. Answers from this question were categorized into figures, Figure 2 which presents student likes and figure 3 which presents student dislikes. Approximately two thirds of the students either liked the time and money saved from classes being online and the fact that there was no more need for commuting (30.7%) or the fact that they were physically at home and therefore can work on their own time and manage their schedules as they see fit (31.4%) which is in line with research reports that that technology in mathematics education can enhance learning

(Mulenga & Marbán, 2020). The final third of students was split among four other likes, the first of which was that they were able to re-watch previous lectures (20.7%), which has also been reported by other researchers that many students enjoy the opportunity of re-watching lectures on their own (Kirschner et al., 2020).

In addition, students liked that they could interact with the professor and their classmates through a chat feature in online learning that made it easier to participate (10%). Researchers report that students asked more questions using the chat feature in remote learning than raising their hand and participating in in-person classrooms (Emenike et al., 2020). Furthermore, students liked that they found it easier to attend office hours and recitations through either Zoom, or Blackboard (4.3%) and lastly 2.9% liked that they could communicate with each other outside of the classroom through group chats where they felt supported. This is supported by research findings that report that technology in mathematics education can enhance learning (Mulenga & Marbán, 2020).

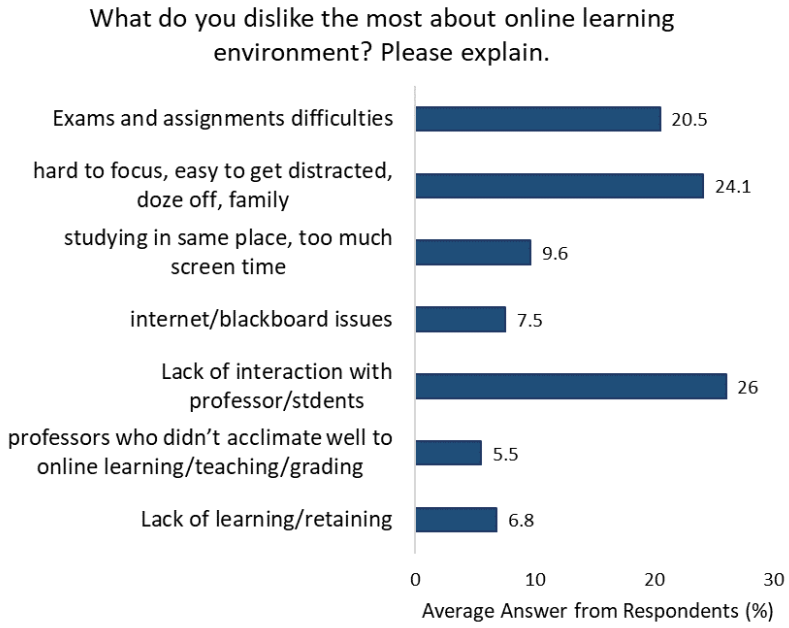

Figure 3
Bar chart depicting the students' dislikes about online learning environment

Approximately two thirds of the students disliked one of three categories; one of which being the lack of interaction and communication between professors and other classmates (26%). This is in line with a study in Turkey, where the Ministry of National Education used a different method of delivering online lessons in which pre-recorded lectures were broadcasted on new channels during the day. Despite replays being

available on a specific website, students did not get the opportunity to participate actively or discuss anything with their teachers (Akbulut et al., 2020). Additionally, the term active learning defines the active participation of students with the faculty members during lectures (Tan et al., 2020). Group discussion, class activities, and case studies are great examples of creating an active learning environment. Since the transition to online learning minimizes the chances of students' interactions, active learning can be challenging to achieve during the pandemic compared to face-to-face lessons.

In addition, students report that they disliked the increased number of distractions at home including family and environment that made it harder to focus and devote time to studying (24.1%). This finding is in line with reports that familial attitudes and environmental conditions can influence concentration and accessibility to online learning tools (Aguilera-Hermida, 2020). Studying at home would most likely be full of distractions for many reasons (Villanueva et al., 2020). This situation gets worse especially because other members at home can possibly also be working from home. Lastly, at home, students' learning process is often distracted by entertainment activities (Oyemi et al., 2015).

Additionally, students disliked the increased level of difficulty for assignments and exams as a result of online learning where professors would make tasks more difficult as a counter to the higher probability that students would cheat (20.5%). This is consistent with other research findings that students have expressed feeling lost about assignments and their deadlines due to lack of assistance when needed (Rodríguez-Rodríguez et al., 2020). The last quarter of students was split among four different dislikes, the most popular of which was their environment and the fact that they were studying in the same space for extended periods of time (9.6%).

In addition, 7.5% of participants disliked the fact that they had to deal with internet and connectivity issues to online platforms, 6.8% disliked the teaching style as it felt that they were not actually learning or retaining any information, and lastly 5.5% disliked the way professors taught. The online learning system can fail due to multiple reasons such as technological challenges, lack of awareness and technical support, universities readiness, quality course content, lack of security and technological infrastructure (Almaiah et al., 2020).

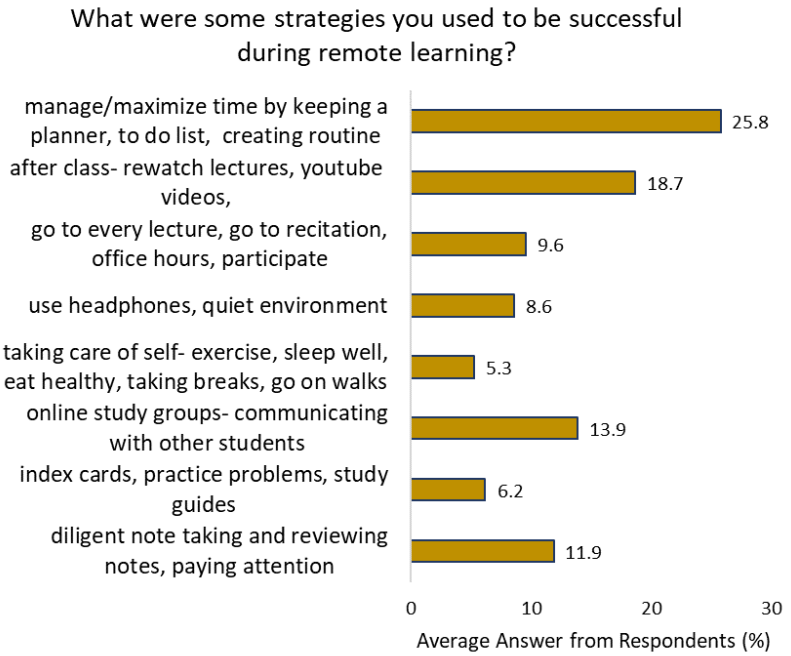

Figure 4
Bar chart representing percentages of students' responses explaining strategies they used to succeed in online learning

In understand how students acclimated to an online learning experience, we asked what were some strategies that they found to be successful during remote learning. Their responses were compiled into 8 separate categories. Approximately a quarter of the students (25.8%) found that by creating to-do lists or maintaining a planner they were able to create a routine for themselves, therefore managing their time better to maximize their studying. Approximately a fifth of the students (18.7%) found the ability to re-watch old lectures and YouTube videos as successful strategies for retaining information. A few notable strategies include online studying groups where students can communicate with one another and simulate study sessions (13.9%), going to recitation sessions and office hours outside the classroom (9.6%), diligent note taking and actively listening in class (11.9%), and lastly utilizing headphones to simulate a quiet environment (8.6%).

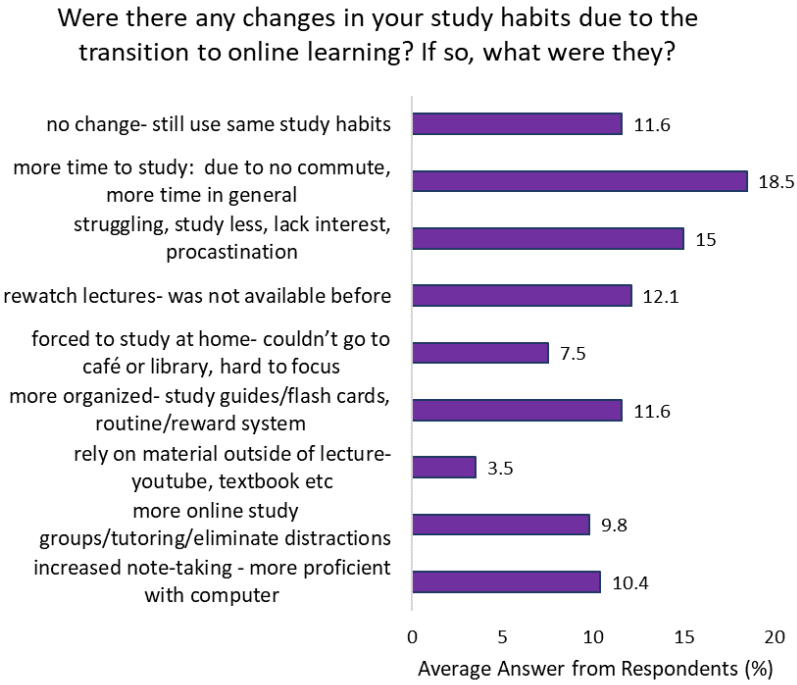

Figure 5
Bar chart representing percentage responses from participants on changes to study habits as a result of transitioning to online learning

In ascertain the impact of online learning on students' study habits, we asked students to express in which ways their study habits changed as a result of transitioning to an online learning environment. While some students observed no change in their study habits (11.6%), the vast majority observed either positive or negative changes. These positive changes include having more time to study as they were at home and therefore saving time on not commuting to and from campus (18.5%), being able to re-watch lectures (12.2%), becoming more organized with keeping a routine and making study guides (11.6%), increased note taking and becoming more efficient with a computer (10.4%), and lastly making sure to study in groups online and attend tutoring sessions (9.8%).

Some of the negative changes include struggling with procrastination and maintaining interest in the material (15%), and being forced to stay in the same environment and finding it hard to focus at home. This is consistent with research findings that students also encounter difficulties completing group projects due to lack of group members' participation and motivation and that class rhythm could be too fast for some students to understand (Dietrich et al., 2020). The lack of proper training for emergency transition negatively affected non-STEM majors and failed to engage them in online education effectively (Perets et al., 2020). Lastly, (7.5%) of students claim that they changed their

study habits by having to rely on external resources such as YouTube videos to understand content as being in class was not enough (3.5%). Research reports that according to students, access to digital devices, internet connection and software, as well as the ability to manage time and avoid distractions, were most important in online learning during the Covid-19 pandemic (Rapanta et al., 2020).

CONCLUSIONS

Our student population, from minority backgrounds and lower social economic status, overall had the perception that they possessed adequate resources for online learning which include computers, online videos, and tutorials. They also think that online learning needed to be more interactive, house distractions made it difficult to concentrate, and that instructors assigned a higher volume of assignments. Furthermore, students reported that online learning negatively influenced their mental health and increased their anxiety levels about science courses. Also, our data suggests that our student population faced difficulties concentrating in class due to various distractions at home and struggled with connectivity issues in terms of internet connection and platforms necessary for online learning. This issue might be more pronounced at our institution due to the socioeconomic status of our student population. We should note that more than ninety percent of our students receive financial aid.

The data also shows that students had the perception of increasing quantity and difficulty of assignments and exams and decreasing communications and interactions with professors and classmates and which led to them feeling isolated. Students also report feeling less motivated. Also, students disliked the increased distractions and the challenges to focus and devote time for classes due to family, and home environment which is not conducive to learning.

Some of the positive aspects of online learning as reported by our student participants include saving time and money on commute, working on their own time and managing their schedules as they see fit, and having the ability to re-watch previous lectures. Furthermore, students developed strategies to cope with online learning which include creating to do lists, keeping a routine, managing their time effectively, re-watching lectures to improve learning, forming study groups, and taking notes strategically. Finally, students evolved and changed their study habits as a result of transitioning to online learning by becoming more organized, keeping a studying routine, and taking better note. We would suggest enhanced periodic training and support for faculty and students in the use of technology as well as setting clear guidelines for roles and responsibilities for an improved teaching and learning experience.

LIMITATIONS

One limitation of the study is that our research results and conclusions are based on data collected from one urban, minority serving institution, where the students population is very diverse and that was not accounted for in our data analysis. A similar research study with data collected from several different institutions could provide valuable insights and build on the findings of this study.

Our study is limited by the answers we received in the survey. Interviewing a subset of students and asking them probing questions about specific challenges about online learning as the result of Covid-19 pandemic can provide invaluable information. Future work that elicits more detailed data and in depth interviews would make for a future research study.

REFERENCES

Aguilera-Hermida, P. A. (2020). College students' use and acceptance of emergency online learning due to COVID-19, *International Journal of Educational Research Open*, 1, 100011. https://doi.org/10.1016/j.ijedro.2020.100011

Akbulut, M., Şahin, U., & Esen, A. C. (2020). More than a virus: How COVID 19 infected education in Turkey? *Journal of Social Science Education, 19*, 30-42. https://doi.org/10.4119/jsse-3490

Al Kandari, A. M., & Al Qattan, M. M. (2020). E-Task-Based Learning Approach to Enhancing 21st-Century Learning Outcomes. *International Journal of Instruction, 13*(1), 551-566. https://doi.org/10.29333/iji.2020.13136a

Ali, W. (2020). Online and remote learning in higher education institutes: A necessity in light of COVID-19 pandemic, Canadian Center of Science and Education. *Higher Education Studies, 10*(3), 16-25. https://doi.org/10.5539/hes.v10n3p16

Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic, *Education and Information Technologies, 25*, 5261-6280. https://doi.org/10.1007/s10639-020-10219-y

Alomyan, H. (2021). The impact of distance learning on the psychology and learning of university students during the covid-19 pandemic. *International Journal of Instruction, 14*(4), 585-606. https://doi.org/10.29333/iji.2021.14434a

Antón-Sancho, Á., & Sánchez-Calvo, M. (2022). Influence of Knowledge Area on the Use of Digital Tools during the COVID-19 Pandemic among Latin American Professors. *Education Sciences,* 12, 635. https://doi.org/10.3390/educsci12090635

Antón-Sancho, Á., Vergara, D., & Fernández-Arias, P. (2022). Influence of Country Digitization Level on Digital Pandemic Stress. *Behavioral Sciences, 12*, 203. https://doi.org/10.3390/bs12070203

Bates, R. & Khasawneh, S. (2007). Self-efficacy and college students' perceptions and use of online learning systems, *Computers in Human Behavior, 23*(1), 175-91. https://doi.org/10.1016/j.chb.2004.04.004

Blizak, D., Blizak, S., Bouchenak, O., & Yahiaoui, K. (2020). Students' perceptions regarding the abrupt transition to online learning during the COVID-19 pandemic: Case of faculty of chemistry and hydrocarbons at the University of Boumerdes-Algeria. *Journal of Chemical Education, 97*(9), 2466-2471. https://doi.org/10.1021/acs.jchemed.0c00668

Blundell, R., Dias, M. C., Joyce, R., & Xu, X. (2020). COVID-19 and Inequalities, *Fiscal Studies, 41*(2), 291-319. https://doi.org/10.1111/1475-5890.12232

Boonroungrut, C., Thamdee, N., & Saroinsong, W. P. (2022). Research on students in COVID-19 pandemic outbreaks: A bibliometric network analysis. *International Journal of Instruction, 15*(1), 457-472. https://doi.org/10.29333/iji.2022.15126a

Butz, N. T., Stupnisky, R. H., & Pekrun, R. (2015). Students' emotions for achievement and technology use in synchronous hybrid graduate programmes: A control-value approach. *Research in Learning Technology*, 23.1-16. https://doi.org/10.3402/rlt.v23.26097

Charles, C. Z., Roscigno, V. J., & Torres, K. C. (2007). Racial inequality and college attendance: The mediating role of parental investments, *Social Science Research, 36*(1), 329-52. https://doi.org/10.1016/j.ssresearch.2006.02.004

Delgado, F. (2022). Post-COVID-19 Transition in University Physics Courses: A Case of Study in a Mexican University. *Education Sciences, 12,* 627. https://doi.org/10.3390/educsci12090627

Dietrich, N., Kentheswaran, K., Ahmadi, A., Teychené, J., Bessière, Y., Alfenore, S., Laborie, S., Bastoul, D., Loubière, K., Guigui, C., Sperandio, M., Barna, L., Paul, E., Cabassud, C., Liné, A., & Hébrard, G. (2020). Attempts, successes, and failures of distance learning in the time of COVID-19, *Journal of Chemical Education, 97*(9), 2448-2457. https://doi.org/10.1021/acs.jchemed.0c00717

DiPrete, T.A. & Eirich, G.M. (2006). Cumulative advantage as a mechanism for inequality: A review of theoretical and empirical developments, *Annual Review of Sociology, 32*, 271-297. https://doi.org/10.1146/annurev.soc.32.061604.123127

Emenike, M. E., Schick, C. P., Gay Van Duzor, A., Sabella, M. S., Hendrickson, S. M., & Langdon, L. S. (2020). Leveraging undergraduate learning assistants to engage students during remote instruction: Strategies and lessons learned from four institutions, *Journal of Chemical Education, 97*(9), 2502-2511. https://doi.org/10.1021/acs.jchemed.0c00779

Gallè, F., Sabella, E. A., Da Molin, G., De Giglio, O., Caggiano, G., Di Onofrio, V., Ferracuti, S., Montagna, M. T., Liguori, G., Orsi, G. B., & Napoli, C. (2020) Understanding knowledge and behaviors related to Covid–19 Epidemic in Italian undergraduate students: The EPICO study, *International Journal of Environmental Research and Pubic Health, 17*, 3481; https://doi.org/10.3390/ijerph17103481

Garrison, D. R., Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(2), 87-105. https://doi.org/10.1016/S1096-7516(00)00016-6

Gemmel, P. M., Goetz, M. K., James, N. M., Jesse, K. A., & Ratliff, B. J. (2020). Collaborative learning in chemistry: Impact of COVID-19, *Journal of Chemical Education, 97*(9), 2899-2904, https://doi.org/10.1021/acs.jchemed.0c00713

Gonzalez, T., de la Rubia, M.A., Hincz, K. P., Comas-Lopez, M., Subirats, L., Fort, S., & Sacha, G. M. (2020). Influence of COVID-19 confinement in students' performance in higher education, *Computers and Society, 15*(10), e0239490. https://doi.org/10.48550/arXiv.2004.09545

Hindun, I., Husamah, H., Nurwidodo, N., Fatmawati, D., & Fauzi, A. (2021). E-Learning in COVID-19 pandemic: Does it challenge teachers' work cognition and metacognitive awareness? *International Journal of Instruction, 14*(3), 547-566, https://doi.org/10.29333/iji.2021.14332a)

Ismaeel, D. A., & Al Mulhim, E. N. (2022). E-teaching internships and TPACK during the covid-19 Crisis: The case of Saudi pre-service teachers. *International Journal of Instruction, 15*(4), 147-166. https://doi.org/10.29333/iji.2022.1549a

Kirschner, R., Mohammed, M., & Weiner, Y. (2020). *How Covid-19 changed the way students experience learning: a blending of remote and conventional education,* Worcester Polytechnic Institute.

Lulaj, E. (2022). The correlation of financial-stress and educational-teaching factors on students during online learning in the Covid-19 (Cov19) pandemic, *International Journal of Instruction, 15*(2), 435-454. https://doi.org/10.29333/iji.2022.15224a

Mailizar, Almanthari, A., Maulina, S., & Bruce, S. (2020). Secondary school mathematics teachers' views on E-learning implementation barriers during the COVID-19 Pandemic: The case of Indonesia, EURASIA Journal of Mathematics, *Science and Technology Education, 16*(7), em1860. https://doi.org/10.29333/ejmste/8240

Mulenga, E. M. & Marbán, J. M. (2020). Is COVID-19 the gateway for digital learning in mathematics education? *Contemporary Educational Technology, 12*(2), ep269. https://doi.org/10.30935/cedtech/7949

Oducado, R. M. F., Rabacal, J. S., Moralista, S. B., & Tamdang, K. A. (2021). Perceived Stress due to COVID-19 Pandemic Among Employed Professional Teachers, *International Journal of Educational Research and Innovation, 15*, 305-316. https://doi.org/10.46661/ijeri.5284

Oyemi, S., Noak, A., & Olakanmi, E.E. (2015). *Effects of Excessive Usage of Social Networking on Students Learning Habit.* In Proceedings of the EdMedia 2015-World Conference on Educational Media and Technology, Montreal, QC, Canada, pp. 523-531.

Perets, E. A., Chabeda, D., Gong, A. Z., Huang, X., Fung, T. S., Ng, K. Y., Bathgate, M., & Yan, E. C. Y. (2020). Impact of the emergency transition to remote teaching on student engagement in a non-STEM undergraduate chemistry course in the time of COVID-19, *Journal of Chemical Education, 97*(9), 2439-2447. https://doi.org/10.1021/acs.jchemed.0c00879

Ramos-Pla, A., Reese, L., Arce, C., Balladares, J., & Fiallos, B. (2022). Teaching Online: Lessons Learned about Methodological Strategies in Postgraduate Studies. *Education Sciences, 12*, 688. https://doi.org/10.3390/educsci12100688

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity, *Post digital Science and Education, 2*(3), 923-45. https://doi.org/10.1007/s42438-020-00155-y

Rodríguez-Rodríguez, E., Sánchez-Paniagua, M., Sanz-Landaluze, J., & Moreno-Guzmán, M. (2020). Analytical chemistry teaching adaptation in the COVID-19 period: Experiences and students' opinion, *Journal of Chemical Education, 97*(9), 2556-2564. https://doi.org/10.1021/acs.jchemed.0c00923

Rofiah, N. L., Aba Sha'ar, M. Y. M., & Waluyo, B. (2022). Digital divide and factors affecting English synchronous learning during covid-19 in Thailand. *International Journal of Instruction, 15*(1), 633-652. https://doi.org/10.29333/iji.2022.15136a

Soudien, C. (2020). Complexities of difference and their significance for managing inequality in learning: Lessons from the COVID-19 crisis, *Prospects, 49*(1), 59-67. https://doi.org/10.1007/s11125-020-09486-x

Tan, H. R., Chng, W. H., Chonardo, C., Ng, M. T. T., & Fung, F. M. (2020). How chemists achieve active learning online during the COVID-19 Pandemic: Using the community of inquiry (CoI) framework to support remote teaching, *Journal of Chemical Education, 97*(9), 2512-2518. https://doi.org/10.1021/acs.jchemed.0c00541

Tran, T., Hoang, A.D., Nguyen, Y.C., Nguyen, L.C., Ta, N.T., Pham, Q.H., Pham, C.X., Le, Q.A., Dinh, V.H., & Nguyen, T.T. (2020). Toward sustainable learning during school suspension: Socioeconomic, occupational aspirations, and learning behavior of Vietnamese students during COVID-19, *Sustainability, 12*, 4195. https://doi.org/10.3390/su12104195

Turner, E.A., Chandler, M., Heffer, R.W. (2009). The influence of parenting styles, achievement motivation, and self-efficacy on academic performance in college students, *Journal of College Student Development, 50*, 337-346.

Unger, S., & Meiran, W. (2020). Student attitudes towards online education during the COVID-19 viral outbreak of 2020: Distance learning in a time of social distance. International *Journal of Technology in Education and Science, 4*(4), 256-266. https://doi.org/10.46328/ijtes.v4i4.107

Varea, V. & González-Calvo, G. (2021). Touchless classes and absent bodies: teaching physical education in times of Covid-19, *Sport, Education and Society, 26*(8), 831-845. https://doi.org/10.1080/13573322.2020.1791814

Verma, G., Campbell, T., Melville, W., & Park, B-Y. (2020). Science Teacher Education in the Times of the COVID-19 Pandemic, *Journal of Science Teacher Education, 31*(5), 483-490. https://doi.org/10.1080/1046560X.2020.1771514

Vergara-Rodríguez, D., Antón-Sancho, Á., & Fernández-Arias, P. (2022). Variables Influencing Professors' Adaptation to Digital Learning Environments during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health, 19*, 3732, 1-20. https://doi.org/10.3390/ijerph19063732

Villanueva, O., Behmke, D. A., Morris, J. D., Simmons, R., Anfuso, C., Woodbridge, C. M. & Guo, Y. (2020). Adapting to the COVID-19 online transition: Reflections in a general chemistry sequence taught by multiple instructors with diverse pedagogies, *Journal of Chemical Education, 97*(9), 2458-2465. https://doi.org/10.1021/acs.jchemed.0c00752

Wandner, S. A., & O'Leary, C. J. (2020). An unemployment insurance COVID-19 crisis response. *Employment Research, 27*(2), 3-4. https://doi.org/10.17848/1075-8445.27(2)-2

Warner, S., Murray, G., & Meyer, D. (2008). Holiday and school-term sleep patterns of Australian adolescents, *Journal of Adolescence, 31*, 595-608. https://doi.org/10.1016/j.adolescence.2007.10.005

Witteveen, D. (2020). Sociodemographic inequality in exposure to COVID-19-induced economic hardship in the United Kingdom, *Research in Social Stratification and Mobility, 69*, 100551.

Yusuf, M. (2011). The impact of self-efficacy, achievement motivation, and self-regulated learning strategies on students' academic achievement. *Procedia - Social and Behavioral Sciences, 15*, 2623–2626. https://doi:10.1016/j.sbspro.2011.04.158