The Effects of Online Learning During the COVID-19 Pandemic on Undergraduate Students' Well-Being at McMaster University

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Abstract

The present study investigates how online learning has influenced the well-being of undergraduate students. In March 2020, the COVID-19 pandemic was declared, thus forcing all education to be administered online. The following research employs an anonymous online survey that uses both qualitative and quantitative measures to evaluate the impacts of online learning on students' well-being. The survey targeted undergraduate students in second year and above at McMaster University and yielded a sample size of 61 participants. Four key variables were assessed: cognitive wellness, physical well-being, interpersonal relationships, and academics. Using symbolic interactionism (SI), self-determination theory (SDT), identity theory and basic psychological needs theory (BPNT), this study aims to provide a deeper understanding of the effects of mandatory online learning on students' overall well-being. An analysis of internal processes (i.e., meaning-making, role taking, types of motivation, satisfaction of basic psychological needs) shows that each facet of students' well-being has been negatively impacted by online learning, with an emphasis on motivation and cognitive wellness. Results suggest that further research and improvements to online education are necessary to fully understand this relationship. Students recommend different/removal of anti-cheating software, modified participation, more interactive content delivery, and reduced workload and content to improve online education delivery.

Introduction

Since the COVID-19 pandemic was declared in March 2020, the ways in which education has been administered is only one of many changes that accompanies the virus. As McMaster University declared its 2020-2021 academic year to be delivered completely online, we wonder how the university population will perceive and handle these changes. As current fourth year students of McMaster, we are curious about the experiences of our fellow peers and the similarities that may occur between our ordeals and the general theme of the data collected. Considering the undergraduate population of our school, we are choosing to investigate how the changes of online learning during the COVID-19 pandemic have impacted students' well-being at McMaster University. As

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members of the university demographic, the goal of this research is to better understand how our peers experience the adjustment to online learning and to uncover data that will allow the University to better assist its undergraduate population.

Social Psychological Context

This research was designed in accordance with existing social psychological concepts and will help to expand on these topics. The social-psychological concepts used and developed in this study include but are not limited to meaning-making processes, interpersonal interactions, identity salience, extrinsic vs. intrinsic motivation, and the basic psychological needs of autonomy, competence, and relatedness. These concepts are positioned within the social psychological theories of symbolic interactionism (SI), self-determination theory (SDT), identity theory, and basic psychological needs theory (BPNT), which guided the design of this study and the interpretation of its results.

Research Questions

Our area of study regarding the effects of online learning in undergraduates at McMaster University works as an umbrella statement for multiple areas of study and finite factors of said effects. Foremost, cognitive wellness will be included as an area of investigation. From this topic, we hope to better understand the positive and negative wellness and intrapersonal effects that this adjustment in the delivery of academics has caused the students at the University, and how these changes have impacted their experiences. Physical well-being was also considered, specifically in comparison to the last academic year of 2019-2020, prior to the pandemic. We are interested in learning if physical well-being can be impacted by the change of environment, the varying levels of stress, and levels of fatigue compared to in-person learning. The use of comparison to the prior academic year is also the reason we are only including undergraduates who are in their second year of study and up. Additionally, we will also be looking at interpersonal relationships, specifically communication and levels of connection to peers, family, and friends in comparison to pre-COVID-19 circumstances. Finally, a large portion of our research will be focused on the academic aspect of online learning. We are interested in students' academic achievements in comparison to pre-pandemic experiences, as well as comparisons of time consumption, motivation levels, level of academic difficulty, and other aspects of the university experience.

Purpose of the Research

The question that will be at the forefront of our minds in conjunction with being the foundation of our research is as follows: How have the changes of online learning during the COVID-19 pandemic impacted undergraduate students' well-being at McMaster University? It is in unanimous agreement that the COVID-19 virus has changed lives, however the question remains has it changed in more positive or negative ways? As students, this population was chosen to acknowledge the experiences of our peers alongside other undergraduate students at McMaster University. The chosen topic also represents an untapped opportunity while the prevalence of COVID-19 is still rampant, and the presiding consequences are still unfolding. Although research is scarce on the topic of undergraduate students' experiences with online school in relation to COVID-19, we hope to gain an understanding of how the virus has impacted students' well-being,

both academically and personally. Pertaining to McMaster University, we would like to achieve a better understanding of how our limited population is experiencing these changes, whether it be positively and/or negatively. Through our research, we gained crucial information regarding the students of McMaster and hope to be given the opportunity to present our findings to the University to gain better insight into the well-being of their students.

We chose to utilize a quantitative methodological approach to our research, specifically an anonymous online survey. This method was chosen not only with consideration to a lack of time and funds, but also holds a component of anonymity, and can provide us with a larger opportunity for data collection. The anonymity of the survey provides limited ethical issues, as the population may participate at their own free-will, and all identities remain anonymous and confidential. This method also provides us with more opportunities to collect information, as unlike interviews, surveys are quick and easy to complete. The following section contains a review of the literature to further provide us with knowledge of past research in order to identify what we can do to improve the literature within our study.

Overview

In this paper, a theoretical framework is identified that helped better guide us while conducting our research. Our research purpose will later be discussed, as well as the current problem and what we hope to learn from our data. Our literature review will further situate the context of our topic and provide us with knowledge of past research to identify what can be improved with our observations. Furthermore, the research methodology utilized will be identified in the later section, along with our research questions regarding our areas of interest and compelling themes. Further, we will also outline our results and provide a discussion interpreting the meaning of these results while linking them back to the theoretical framework and literature review. We provide notable limitations that we have identified, and how we can improve on these in the future, as well as provide recommendations for further research.

Literature Review

Online learning is often examined and compared with education that is delivered on campus, face-to-face. The effects of online learning on students' well-being are mediated by varied factors, such as motivation, whether the individual's psychological needs are satisfied, and stress level (Chang et al., 2013; Chen & Jang, 2010; Fang et al., 2019; Figlio et al., 2013; Im & Kang, 2019; Yang et al., 2020; Yeh et al., 2019). However, studies on this topic typically cover voluntary online learning; where in the circumstances of COVID-19 this has not been voluntary, therefore, investigation from a new perspective is needed. In this review, factors that influence the quality of online learning as well as the effects of online learning on students' well-being will be discussed and analyzed, followed by the limitations and recommendations of previous studies. Due to a lack of research discussing well-being as a part of the impact of online learning, we will be observing the factors and effects as malleable guides rather than strict categories.

Factors of Influence

Motivation

Motivation is one of the key components that has a direct impact on students' learning outcomes, both offline and online (Yeh et al., 2019; Chang et al., 2013). There are a variety of factors that may affect a student's motivation levels; Im & Kang (2019) suggest that "qualities of online learning content" are significant factors in determining students' motivation levels (p.113). Additionally, it was observed that the level of motivation affects students' sense of satisfaction of learning more so than the learning outcome (Im & Kang, 2019). Satisfaction of learning refers to the level of joy and satisfaction one feels while learning (Topala & Tomozii, 2014). Given this information, if students are satisfied with the quality of the content they are learning in their online courses, hypothetically they would be more motivated, and in turn they would have increased satisfaction of learning.

Another factor that may contribute to a students' motivation levels is achievement goal orientation (Im & Kang, 2019). Im & Kang (2019) describe achievement goal orientation as the intent that affects the individual's decision of how and why they should participate in specific learning activities. Achievement goal orientation focuses on the ways in which individuals "think about their motivation and intent to learn" (Im & Kang, 2019 p. 113) and has been previously used as a framework that explains students' motivation. However, in some other studies, motivation can sometimes become a confounding variable since level of motivation can vary for different individuals depending on personality traits, age, and so on (Figlio et al., 2013). Therefore, students' motivation levels will be divergent in terms of the difference between in-person courses and online courses. Although no link between motivation and students' well-being has been examined, we propose that a higher level of motivation may predict better mental well-being of students, or vice versa, that greater well-being improves motivation.

Autonomy & Self-Efficacy

According to Basic Psychological Needs Theory (BPNT), there are three major elements of psychological needs: autonomy, competence, and relatedness (Fang et al., 2019; Chen & Jang, 2010). Moreover, research has demonstrated that autonomy is related to students' participation or engagement level in that it has a weak but positive relationship with an individual's engagement during online courses (Fang et al., 2019). As mentioned previously, autonomy refers to the "need to act with a sense of ownership of [one's] behaviour [to] feel psychologically free" (Van den Broeck et al., 2016, p. 1198). Therefore, students who have higher levels of autonomy are more likely to engage with their online courses, consequently leading to their success in those courses. Although limited studies have explicitly focused on this relationship, researchers propose that students' autonomy and engagement in their courses are positively correlated (Fang et al., 2019). Nevertheless, the level of autonomy required to succeed varies depending on the individual and the context. Autonomy needs satisfaction for students without mental health impairments during online learning will be distinctive from students with impairments, as they may face additional barriers or disruptions due to the illnesses they experience (McManus et al., 2017). Therefore, these students need more flexibility and support than what currently exists. Regarding self-regulated learning, several strategies are proposed by Yeh et al., (2019), including metacognition or thinking about thinking, effective planning, and organizing an environment dedicated to studying.

Along with autonomy, self-efficacy is frequently mentioned in related studies (Im & Kang, 2019; Chang et al., 2013; Chen & Jang, 2010). They share similar definitions, and both have a positive relationship with regards to successful online learning. In the context of online learning, self-efficacy refers to an individual's beliefs about one's capability to successfully complete the course (Im & Kang, 2019). Compared with autonomy and stress levels, self-efficacy is identified as the strongest predictor of course engagement level. Moreover, a high level of self-efficacy also predicts a higher level of motivation (Chang et al., 2013). John M. Keller (1987) developed the attention, relevance, confidence, satisfaction model (ARCS) to examine the impact of self-efficacy on the motivation of students during online learning and found its influence on male students is stronger compared to female students (Chang et al., 2013). However, more studies are needed to validate the gender difference situated in the context of impacts of online learning on students. In relation to our interest in well-being, Chen & Jang (2010) note that individuals enhance their emotional well-being through developing a positive self-concept and fulfilling the three basic psychological needs. Though no connection between autonomy and students' well-being is specifically mentioned, we propose that they share a positive relationship since once the autonomy need is fulfilled, students are more likely to experience a positive sense of self.

Competence

Among the three components of psychological needs, competence holds the most significant positive effect on students' learning engagement (Fang et al., 2019). Feeling competent is associated with feeling confident about the tasks that are assigned in the courses (Chen & Jang, 2010; Fang et al., 2019). Previous studies have found that when students are more engaged in the content and learning environment, they are more likely to feel confident about themselves and focus on what they gain from learning (Chen & Jang, 2010; Fang et al., 2019). Thus, students are more likely to discuss course-related topics with peers during group activities and discussions (Fang et al., 2019). Fang et al., (2019) also emphasizes the significance of analyzing competence as it is directly related to engagement level, which will be discussed in more detail in the following section. Although competence is a crucial factor to investigate, it is rarely measured. Moreover, there is no explicit connection discussed between competence and students' well-being. We speculate that the fulfillment of competence needs and well-being of students are positively correlated since the fulfilment of competence needs predicts a higher engagement level, which may then lead to improved students' well-being.

Participation & Engagement Level

In much of the literature, participation and engagement work to facilitate the satisfaction of the need for relatedness or participation and engagement are the measures of the need for relatedness (Chen & Jang, 2010; Fang et al., 2019). Participation and engagement involve individuals having an inclusive and connected experience. Similar to the other components of basic psychological needs, in the context of online courses, when students engage with others and/or feel included in discussions, their need for relatedness is fulfilled, which in turn fulfills their need for autonomy (Fang et al., 2019). Participation and engagement levels are also connected with one's intrinsic motivation and play a crucial role in completing online courses (Fang et al., 2019). Pertaining to participation and

engagement level, three areas are investigated: the medium that delivers study materials and course content, facilitators, and learners (Fang et al., 2019). Among all three areas that have an impact on students' engagement level, social interactions between students and/or facilitators greatly increases learners' participation and engagement levels (Cho & Cho, 2014; Fang et al., 2019).

Vlachopoulos & Makri (2019) extensively explore how different types of interaction influence students' learning experiences in the context of online learning. Three types of interactions are included: peer interaction, facilitator-learner interaction, and learner-content interaction, with a lack of focus on learner-content interaction (Vlachopoulos & Makri, 2019). However, it directly reflects the impact of online learning on students; therefore, it is crucial for us to investigate the connection between students and the learning content or material. Moore (1989) also proposed a framework called the transactional distance theory, which emphasizes how online education can create additional barriers to communication between learners and instructors (Vlachopoulos & Makri, 2019). This initiates our interest to explore the impact of online learning on students and to aim for improvement in terms of how the learning process is conducted and delivered.

Meanwhile, recommendations to improve engagement are also proposed in the research. For peer-to-peer interactions specifically, it has been suggested to provide discussion topics and encourage collaboration on a voluntary basis (Vlachopoulos & Makri, 2019). To increase facilitator-learner interaction, it has been suggested to provide frequent feedback, leading in voluntary discussions, and continuous encouragement (Vlachopoulos & Makri, 2019). As for learner-content interaction, this can be enhanced by providing clear instructions and having the learning process be as interactive as possible (Vlachopoulos & Makri, 2019). No certain association between engagement level and students' well-being is suggested, but we propose a high engagement level may predict better well-being of students as fulfilling relatedness needs may enhance one's well-being.

Academic Satisfaction

Academic satisfaction is a learning outcome with varying effects and implications depending on the research context. In Im & Kang's (2019) study on factors affecting student outcomes in online schooling, they define the satisfaction of learners to be one of the most vital and researched learning outcomes. The results of this study disclose that the most prominent determinant for academic achievement is learning satisfaction (Im & Kang, 2019). Moreover, learner's participation as well as test anxiety also greatly influence academic satisfaction (Im & Kang, 2019). Similarly, an article by Chen & Jang (2010) details how course satisfaction is frequently connected to motivation, leading them to study the connection between motivation and self-determination theory (SDT). Contrarily, results of the study suggest that SDT does not successfully predict course satisfaction as a learning outcome (Chen & Jang, 2010). Thus, the data suggests that academic satisfaction may prove better as a research factor rather than an effect, though the inconsistencies in research results warrants caution in generalizing the effects of academic satisfaction.

Perceived Stress

As numerous articles would demonstrate, perceived stress in this research context tends to be limited to an extraneous variable rather than a main research factor. Im & Kang's (2019) research observes test anxiety as a variable that directly affects academic outcomes and defines it as feelings of stress during testing situations. The research results show that academic satisfaction, participation, and achievement increase when test anxiety increases, likely identifying that more test anxiety is linked to increased motivation, which leads to greater achievement (Im & Kang, 2019). This increased motivation may be due to online testing environments being less stressful than in-person testing situations (Im & Kang, 2019). In Thoits' (1983) reformulation of the social isolation hypothesis, she elucidates the parameters of 'isolation' and hypothesizes that increased identity obtainment is contrarily associated with less mental distress. Comparably, Thoits (1983) uses psychological distress as a measure for her research and the data shows that increases in age, family income, and education are linked to decreases in psychological distress. Most notably, women are more stressed than men and psychological distress does not significantly increase with amassing identities to result in role strain, proving Thoits' reformulated social isolation hypothesis (Thoits, 1983).

Furthermore, in a study by Yang et al., (2020), they regard negative thoughts as a facet of the 2019-nCoV victimization experience—the harmful experience of living through the current pandemic—and research how positive mentality and resilience mediate the negative effects. This data exhibits a decrease in negative mental health effects when positive thinking and resilience intervene (Yang et al., 2020). Overall, the displayed data suggests that stress can lead to increased work ethic, where it significantly increases in women, negatively affects students in a pandemic, and decreases with optimism and resilience (Im & Kang, 2019; Thoits, 1983; Yang et al., 2020).

Effects of Online Learning

Feelings of Isolation

Feelings of isolation are more present than ever given the state of the world during a pandemic. This has been exacerbated as education has been transferred online, leaving students one of two choices: defer their education or continue it online. Vlachopoulos & Makri (2019) make note of how students often feel isolated when partaking in distance education (DE) in their study on education communication from a distance. Given that isolated feelings can almost be viewed on a spectrum due to its varying nature, it makes sense to think of the effects of isolated feelings to also be varied (Thoits, 1983). Thoits (1983) reformulates the social isolation hypothesis to observe the differences between isolated and integrated individuals' identity accumulation and makes sure to note that isolation can be both a symptom and cause of mental illness. The research results find that amassing identities are more common for isolated individuals since they are usually under 50 years old and will naturally gain more identities during their life course (Thoits, 1983).

Furthermore, isolated individuals will be more affected by identity change if they segregate their identities due to an inherent lack of network-embeddedness (Thoits, 1983). Similarly, McManus et al., (2017) details feelings of isolation when barriers to learning for those struggling mentally are evident because of unresolved accessibility issues, students felt further estranged from the institution (McManus et al., 2017). Overall, findings would suggest that feelings of isolation and isolated identities are significantly

impacted by a lack of interaction via online education and conditions can become increasingly worse.

Overall Learning Experience

Besides feelings of isolation, several other significant outcomes are observed among the research that may prove valuable for our study. First, Im & Kang (2019) found that increased participation leads to an increase in self-regulated learning, test anxiety, self-efficacy, satisfaction, and achievement – demonstrating that increased participation may be the key to success in academics. Moreover, Yeh et al., (2019) unveils that having a dedicated study space has numerous positive effects such as an increase in time management skills and persistence. Persistence is also positively related to nearly all e-learning behaviours that are conducive to academic success (Yeh et al., 2019). Healthy learning behaviours for online schooling are positively correlated with self-regulation methods, ultimately leading to increased grade predictions – and the reverse can be said for those with more mastery-avoidance goals (Yeh et al., 2019). Yeh et al.,'s (2019) research shows that attaining general positive studying behaviours can increase academic success.

Other valuable research on learning performance comes from Chang et al., (2013) where they conclude that increased internet self-efficacy has positive effects on motivation as well as learning outcomes; students that feel more technologically competent also feel increased confidence and find course content more relevant (Chang et al., 2013). Thus, the research by Chang et al., (2013) implicates that a measure of internet self-efficacy speaks to one's abilities as a student to an extent. The preceding research indicates that participation, persistence, supportive learning behaviours, and internet self-efficacy may be useful factors to use in our research on well-being and online learning.

Implications of Literature

As the discussed data would suggest, there are numerous limitations to the existing research surrounding the factors and effects of online-learning and wellness-based data. Most notably, Im & Kang (2019) are mindful of the fact that the number of studies researching the interconnected systems of learning outcomes and distinctive factors is very limited, thus, there is a gap waiting to be filled in this specific area of research. As a result of the lack of research for academic achievement in connection with wellness, we included academic achievement as a factor in the study at hand. Moreover, stress levels are rarely discussed as an effect or factor of the aforementioned studies, therefore we also included a measure for stress levels within our own research. Figlio et al., (2013) specifically observe that supplementary qualitative work and surveys on social intricacies in online learning environments can be valuable, thus we included this gap in our research too.

Lastly, McManus et al., (2017) valuably note how online learning research lacks measures of issues about disability, so we embraced this factor in our study. Other limitations in the research include the need for longitudinal research (Yeh et al., 2019), panel data (Fang et al., 2019), and other methods besides self-report (Im & Kang, 2019), but the nature of our study does not allow for us to fully explore these factors directly. Therefore, our study has included measures for academic achievement, stress levels,

social complexities, and disability-related issues because these factors have limited supporting data in studies about well-being and online learning.

Theory

In this section, the theoretical frameworks of symbolic interactionism and self-determination theory will be outlined, providing definitions and context regarding why they were chosen and how they guided our research. Further, the theoretical perspectives of identity theory, derived from symbolic interactionism and basic psychological needs theory, derived from self-determination theory, will also be outlined and discussed within the context of our research.

Symbolic Interactionism

Symbolic interactionism (SI) is a broad perspective that is ever-present in sociology and social psychology. SI was founded by George Herbert Mead and Charles H. Cooley and is said to be an overarching framework that lays the groundwork for more specific theories (Delamater et al., 2014). SI came from the Chicago School, with key theoreticians like Mead, Cooley and Dewey working to elaborate on SI as a theoretical perspective (Meltzer et al., 2015). Symbolic interactionism holds the perspective that the human experience and social order are the products of negotiated meanings produced through social interaction (Delamater et al., 2014). In other words, humans utilize a complex interpretive process during interactions to shape the meanings of the things under discussion (Denzin, 2004). These meanings are influenced not only by the other people within the interaction, but also by the current cultural world (Denzin, 2004). Meanings can also be negotiated by the individual as they possess the agency to create their own subjective experience through interaction, making agency another central tenet of SI and the meaning-making processes (Denzin, 2004).

Herbert George Blumer was another early symbolic interactionist who coined the three premises of SI (Blumer, 1969). First, humans react to things according to their associated meanings, second, social interaction facilitates the meaning-making process, and lastly, interpretation of interactions helps shape and change meanings (Blumer, 1969). These three premises work to unravel the inner workings that social interaction and meaning-making processes entail for individuals. Symbolic interactionism highlights the importance of these meaning-making processes, but also the malleability of them, in that meanings can easily change over time through new social interactions (Blumer, 1969).

Charles H. Cooley began the tradition of SI with early ideas of the self emerging out of experiences in primary groups and the influence of the media, specifically, the focus was on the family (Cooley, 1998). Cooley also focused on role taking, where the self is a social object whose meaning is negotiated through interactions (Cooley, 1998). The meaning of the self is understood through role-taking, where the individual imagines themself in the other person's role to understand how the other person sees them and therefore, how they should see and identify themself (Cooley, 1998). Alternatively, Mead focused on meaning-making, the reciprocal process of interaction which joins the self and society together as well as taking the position of the other within a social situation to see how other people view the individual (Mead, 1934).

As previously mentioned, there are many different versions of SI used in different contexts and across multiple disciplines as well as a multitude of theories built off SI, one

of which that is relevant to our research is identity theory (Denzin, 2004). The primary theorists of identity theory are Sheldon Stryker and Peter J. Burke. These individuals came from different strands of this theory; however, they worked together to identify the commonalities between the two strands to refine and expand the scope of identity theory (Stryker & Burke, 2000). Stryker primarily focused on how the social structure impacts the self and in turn how the self impacts social behaviour, while Burke primarily focused on the impact that internal self-processes have on social behaviour (Stryker & Burke, 2000). Both conceptions of identity theory easily go hand in hand, therefore for our purposes we will be focusing on identity theory as a whole rather than looking at one specific strand.

Identity theory holds the importance of self-meanings in guiding an individual's behaviour as a main premise (Stryker & Burke, 2000). This theory builds off role theory by adding three additional types of identities alongside role identities, including person, social and group identities (Stryker & Burke, 2000). Identity theory states that individuals often occupy more than one identity at a time and acknowledges that salient identities are more likely to be enacted at any given time as they are central to the individual's identity (Stryker & Burke, 2000). The extent of an identity's salience depends on how much the individual has invested in this particular identity, for example, the quantity and quality of social ties that have been built through this identity is a factor in this (Stryker & Burke, 2000).

To summarize, symbolic interactionism is a theory that focuses on social interactions and the meanings that arise out of these interactions, however the individual is understood as having the ability to create their own subjective reality as well. Moreover, identity theory is derivative of SI and looks at how individuals negotiate their identities, keeping in mind identity salience and the possibility for multiple identities to be enacted at any given time. The ideas of meaning-making, role taking, and identity are relevant to our research as our perceptions of our own identities and roles may change as our means of education has. For example, with school being online, our forms of communication and therefore social interactions have gone from mostly in-person to mostly on-screen, which may have implications for the ways in which meanings are created, exchanged, and interpreted. Further, the content of these meanings can have consequences in how we identify ourselves and interpret our roles.

Self-Determination Theory

Self-determination theory (SDT) is a theory of human motivation which holds the perspective that humans seek out challenges and new experiences to further develop and master; it also considers the impact of different social environments and the implications they may have on motivation (Deci & Ryan, 2008b). Early works of this theory date back to the 1970s, with the main theorists being Edward L. Deci and Richard M. Ryan. These two produced this theory and have since continued to give rise to new adaptations and further understandings of SDT (Deci & Ryan, 2008b). Within the past two decades, the amount of research utilizing SDT has increased dramatically as this theory has been used in a multitude of applied research settings (Deci & Ryan, 2008b). In this section, a brief overview of Deci & Ryan's conception of SDT will be provided, followed by a further look into BPNT which was born out of SDT.

Self-determination theory is characterized by intrinsic and extrinsic motivation (Deci & Ryan, 2008a). Intrinsic motivation is when the individual inherently finds their behaviour

satisfying and/or interesting, therefore, the behaviour is engaged in due to positive feelings that arise from it (Deci & Ryan, 2008a). On the other hand, extrinsic motivation is when the individual engages in a behaviour due to it resulting in a separate consequence, for example, a tangible reward or threat of punishment (Deci & Ryan, 2008a). These tenets of intrinsic and extrinsic motivation are not additive, in fact, studies have found that when extrinsic factors were used to motivate behaviour that was already intrinsically motivated, the intrinsic motivation decreases for this behaviour (Deci & Ryan, 2008a).

Moreover, SDT can further explain extrinsic motivation by identifying the three ways in which the individual internalizes the extrinsic motivation, these are differentiated by their level of autonomy (Deci & Ryan, 2008a). First, introjection is the weakest type of internalization, involving the individual acknowledging the external contingency, but not accepting it as their own (Deci & Ryan, 2008a). This type of internalization involves minimal levels of autonomy, therefore people who engage in this type of internalization tend to not feel a sense of ownership over the behaviour they engage in, for this reason the individual feels controlled by the behaviour (Deci & Ryan, 2008a).

The next form of internalization is identification, which involves the individual both acknowledging and accepting the importance of the behaviour, therefore accepting it as their own (Deci & Ryan, 2008a). This type of internalization involves a greater sense of autonomy; therefore, the individual does not feel controlled by the behaviour they are engaged in (Deci & Ryan, 2008a). Integration is the last form of internalization in which the individual successfully integrates the behaviour with other aspects of their self, and the behaviour is assimilated into their sense of who they are (Deci & Ryan, 2008a). This type of internalization is the fullest form of internalization, meaning there are high levels of autonomy involved and the previously extrinsically motivated behaviours become self-determined (Deci & Ryan, 2008a).

Furthermore, SDT is also characterized by the distinction between autonomous and controlled motivation which reflect the individual's intention to act (Deci & Ryan, 2008a). Controlled motivation refers to extrinsic motivation and internalized extrinsic motivation in the form of introjection, the motivation for these behaviours is controlled by external factors and therefore are not autonomous (Deci & Ryan, 2008a). Alternatively, autonomous motivation refers to intrinsically motivated behaviours and internalized extrinsic motivation in the form of identification and integration (Deci & Ryan, 2008a). The motivation for these behaviours is autonomously controlled, meaning it is at least partially controlled by internal factors, such as the satisfaction of the need for autonomy (Deci & Ryan, 2008a). Additionally, there is a third type of motivation which arises when there is a lack of intention to act, called amotivation (Deci & Ryan, 2008a).

A significant difference between autonomous and controlled motivation is their outcomes. Autonomous motivation has been associated with many positive outcomes such as enhanced performance and greater psychological well-being, whereas controlled motivation is not associated with these results (Deci & Ryan, 2008a). This raises the question: how do we facilitate autonomous motivation as opposed to controlled motivation? The best way to promote autonomous motivation would be to facilitate the internalization of extrinsic motivation via identification and integration, with integration being the primary goal (Deci & Ryan, 2008a). For this to be possible, the social conditions

that the individual is under must meet their basic psychological needs as this tends to facilitate identification and integration (Deci & Ryan, 2008a).

Basic psychological needs theory (BPNT) is one of the six sub-theories of SDT founded by Deci & Ryan (2008a). BPNT helps us to understand the impact that social environments have on the type of motivation the individual possesses for any given behaviour (Deci & Ryan, 2008b). BPNT states that for an individual to achieve effective internalization of extrinsic motivation, there are three basic psychological needs which need to be met, these needs include autonomy, competence, and relatedness (Van den Broeck et al., 2016). The need for autonomy refers to the individual's "need to act with a sense of ownership of their behaviour and feel psychologically free" (Van den Broeck et al., 2016, p. 1198). The need for autonomy is the most contested of the basic psychological needs as cultural relativists argue that the need for autonomy is a Western ideal stemming from individualism (Deci & Ryan, 2008a).

On the contrary, SDT would make the counterargument that culture does influence people in important ways, but all humans have essential needs as individuals (Deci & Ryan, 2008a). This argument is solidified by research which found that the satisfaction of the need for autonomy was important in various cultures, though this need may be satisfied differently from one culture to another (Deci & Ryan, 2008a). Moreover, the need for competence refers to the individual's "need to feel a sense of mastery over the environment and to develop new skills" (Van den Broeck et al., 2016, p. 1198), while the need for relatedness refers to the individual's "need to feel connected to at least some others, that is, to love and care for others and to be loved and cared for by others" (Van den Broeck et al., 2016, p. 1199). The need for relatedness is seen as less essential for some outcomes; for example, a child may be satisfied by playing with a toy by themselves even though they are not a member of a group in this scenario or have close relations at play (Van den Broeck et al., 2016).

To summarize, SDT is a theory of motivation which identifies two main types of motivation: autonomous and controlled, the social and interpersonal environments the individual is exposed to helps to determine which type of motivation will be initiated for the behaviour at hand. Autonomous motivation has many prevalent positive outcomes, making it the preferred type of motivation, but to facilitate autonomous motivation more freely the basic psychological needs of autonomy, competence and relatedness must be met in the current social environment. The ideas of motivation in relation to the environment are relevant in our research as the environments in which students are used to learning and studying in have been forcefully changed due to the COVID-19 pandemic. As per SDT, these environmental changes can have consequences for students' motivation to engage in online schoolwork. Moreover, the change in environment, but also the change in content delivery may have implications on students' ability to have their basic psychological needs met.

SI & SDT in the Present Study

The principles of SI and SDT are useful when looking at the impacts that the changes of online learning during the COVID-19 pandemic have had on students' well-being. SI and SDT served as the theoretical frameworks for the study at hand, more specifically with use of identity theory and basic psychological needs theory. Both SI and SDT focus on the individual and the impacts their interactions and social environment have on their

internal processes, whether it be role taking, meaning-making, or motivation. A fundamental commonality between SI and SDT is their view of individuals as goal seeking and motivated to work towards these goals (Delamater et al., 2014). For example, BPNT and SI work concurrently since the individual often gets satisfaction of their needs for autonomy, competence, and relatedness from social interaction (Chen & Jang, 2010). This next section will explore how these theories will offer deeper insight into the impacts that the switch to online education has had on students' well-being.

As mentioned previously, SI has been identified as a useful theoretical approach when looking at online learning and the interaction and communication involved in it (Vlachopoulos & Makri, 2019). We know the concept of meaning-making is central to SI, and currently, meanings are constantly being negotiated during the ever-changing and uncertain times of the COVID-19 pandemic. Symbolic interactionism understands these meanings as arising from interactions and our interactions themselves have had to change greatly in coping with the pandemic. During this time, many things have shifted to online format, for example, quality time with family and friends has often been replaced with facetime calls, and in-person classes have been replaced with pre-recorded or live zoom lectures. There are many factors in the current situation of the COVID-19 pandemic that may be altering the meanings many have held for concepts such as "school life" and "home life" and what it means to be "in class". Also, our meaning-making processes themselves are being altered with the present changes to interactions. For these reasons, SI has been determined to be a useful theoretical lens for the purpose of this study.

Additionally, identity theory offers a useful perspective to our research topic. Our understanding of our roles and identity salience is changing during these times as well. Individuals must learn to make distinctions between their roles now that many of these roles are being performed in the same physical space—home. This has important implications for identity salience as salient identities are more likely to be enacted at any time, this means that the given situation has the potential for these salient identities to always be enacted or to have salient identities competing at all times.

For example, if an individual's most salient identities are "mother" and "student" prior to the pandemic, it was most likely clear when each of these identities was to be enacted based on a physical location—at school or study spaces versus at home. Now, both identities of "student" and "mother" are most likely active within the same space. If these two identities are each enacted within the same location, what will happen? The individual will have to negotiate their identities, draw clear lines between them and may potentially have to identify with one identity more than the other. However, we know that more than one identity can be enacted at any given time, but now that these identities are all performed in the same physical space, will the lines between these identities become blurred? Will these identities all be enacted at the same time all the time? These are the types of questions identity theory poses in the context of this study. Identity theory combined with SI and SDT will help us acquire a deeper understanding of these questions and we hope with our research we are able to answer them.

Moreover, when looking at the changes to online learning and the impacts it has had on the well-being of students at McMaster, the topic of motivation is a prevalent issue. Are students still achieving autonomous motivation or has this switch resulted in an increase in controlled motivation, with the external factors being due dates, the grades you receive, or the threat of punishment for late assignments? We know that the type of

motivation is mediated by the satisfaction of basic psychological needs, therefore a question arises: are students still able to meet these needs or has stress, uncertainty, and social isolation acted as a barrier to this satisfaction? Specifically, threats to the fulfilment of the needs for competence and relatedness are of concern. With the difficulties that online learning brings, a sense of mastery over the environment may be more difficult to achieve, especially since the current "school" environment is quite precarious.

Additionally, skills may be more difficult to develop during these times when much of the learning is now up to the individual to complete and understand, specifically in lectures that are pre-recorded where there are minimal opportunities for questions or comments. Particularly, the need for relatedness is being threatened significantly during these times as interactions have become minimal and mainly occur online. It is evident that the need to feel connected to others could easily not be met during the current social climate of the COVID-19 pandemic. To elaborate, students are no longer interacting with peers during lectures and tutorials, friends from school may be living in different cities and social interaction is scarce.

Self-determination theory has been previously used in studies looking at online learning to identify and address issues of motivation in these online learning settings, therefore it will be useful to include in our research (Chen & Jang, 2010). In addition, using BPNT alongside SDT will be helpful as it generates changes for enhanced motivation (Chen & Jang, 2010). In fact, a study conducted by Chen & Jang (2010) found that the satisfaction of basic psychological needs was the strongest positive predictor of learning outcomes in online learning settings. This has helped lead to recommendations to increase autonomous motivation in these online classroom settings, such as providing meaningful rationales as to why the task at hand is relevant (Chen & Jang, 2010).

In the context of our research, symbolic interactionism and self-determination theory work concurrently to offer a deeper understanding of the effects that the switch to online education has had on students' well-being. More specifically, identity theory and basic psychological needs theory will be used to examine these impacts. These theories examine the individual's internal processes such as meaning-making, role taking, types of motivation and satisfaction of basic psychological needs. Therefore, all these theoretical perspectives put together will offer us a comprehensive understanding of the impacts on students' well-being arising from the switch to online learning during the COVID-19 pandemic.

Methodology

This section will outline the methodological approach we employed in our research and will also clearly outline the steps we took in the research process. In this research, we followed a quantitative methodological approach with components of qualitative methodology when employing an online anonymous survey through the McMaster Research Ethics Board approved website LimeSurvey. This research was approved by the McMaster Research Ethics Board (MREB#: 0327).

Rationale

The purpose of this study was to determine how the changes of online learning during the COVID-19 pandemic have impacted students' well-being at McMaster University. In

March of 2020, McMaster University abruptly announced that in-person classes would be cancelled, and the rest of the winter term would continue via online learning. Students enrolled in classes at this time, as well as the entire university community had no other choice than to adapt and adjust to a new way of learning. This new form of content delivery was carried into the spring and summer terms as COVID-19 continued to pose a threat to society. With the rapid increase of COVID-19 cases and deaths, it was assumed the Fall 2020 term would be conducted online with the hope that society would be back to normal in time for students and faculty to return to in person classes for the Winter 2021 term. However, it was not until the Fall 2020 term began where it was announced that the Winter 2021 term would also be online, making it the first time in history where universities had no choice but to conduct the full school year completely online. As students who were impacted by these changes to university life, this is what inspired us to investigate the effects of online learning on students.

Participants

In our research, we were looking to study participants who met the following criteria: students at McMaster University who are currently enrolled in an undergraduate program in their second year of university or above, therefore 18+ years of age. We chose not to include first year students as we wanted our participants to have the ability to reflect on and compare their current academic experience to their on-campus experience. Participants were given the opportunity to complete an online, anonymous survey on a voluntary basis. We were hoping for an ideal sample size of 75 participants, but ended with a sample size of 61 participants, data collection stopped on February 12th, 2021.

Recruitment

All six researchers that participated in recruitment had peer-to-peer relationships with the participants. We also have one group member who had familial relationships with students at the university, however we planned to combat these conflicts of interest by employing an anonymous survey and having that individual avoid any contact that could be perceived to be a conflict of interest. As previously mentioned, participants were recruited on a voluntary basis, this was done through student-based organizations and clubs at McMaster University. Specifically, we recruited from the following clubs and organizations: McMaster Italian Cultural Club, McMaster Theatre & Film Society, and the sorority Nun Omega Zeta by asking for permission to send out an email or social media post to those who belong to these organizations. Additionally, participants were recruited through McMaster associated social media outlets via Facebook and Instagram. We gained permission to post the link to our survey on McMaster affiliated Facebook groups and Instagram pages such as McMaster Social Psychology Society (Facebook and Facebook group chat), McMaster Class of 2021 (Facebook), McMaster Class of 2022 (Facebook), and McMaster Social Sciences Class of 2023 (Facebook).

Participants would have found the email/recruitment script as well as a link to the survey as posted within the social media post. The link took participants to a webpage where they would have found the letter of information as well as a button to confirm their consent to participate in the study. Once they had read the terms and provided implied consent via a checkbox, they would have been able to click onto the next page where the

survey would have then taken place. Clicking the checkbox indicated that participants have provided their informed consent to participate in the research.

Survey Information

Our online, anonymous survey included 30 questions, including one consent question, two qualitative questions and 27 quantitative questions, most of which made use of a 5-point Likert scale. This survey should have taken participants approximately 10 minutes to complete and involved no risks greater than those in everyday life. Additionally, the participants had the opportunity to disengage from the survey at any time prior to completion and could choose not to answer any questions they may feel uncomfortable with. However, once the survey was submitted, participants were no longer able to remove their participation as we were unable to retract the data since there is no way to trace the answers belonging to the participant who wishes to withdraw. Moreover, once the data collection period closed, we used Microsoft Excel to analyze the data collected through Lime Survey. We also used descriptive and thematic coding for the qualitative questions.

Quantitative Data Analysis

We decided to use Microsoft Excel to analyze our quantitative data due to the large number of video tutorials for conducting data analysis on this platform that are widely available on the internet. We did not have access to SPSS as this platform is normally on the desktop computers at McMaster University and we were learning completely online for the duration of this course. We ran into issues exporting our data from LimeSurvey into PSPP during the early stage of data analysis, so we opted for Excel, which appeared to be the most plausible option.

Firstly, we ran descriptive statistics on all our sociodemographic variables, which included four questions regarding year of study, age, gender, and faculty. Program was originally included as a quantitative sociodemographic variable as well, but due to the open-ended nature of this question and the wide range of responses we received, we decided to analyze this data qualitatively. From there we created frequency tables and histograms for all 27 quantitative questions, including the four sociodemographic questions.

Once we created all the frequency tables we went through and selected the questions with the most apparent and relevant results as measures of each area of well-being to compare in cross tabulations. We identified one variable for physical health, one for interpersonal relationships, one for cognitive wellness, three for academics, one for motivation, one for stress, one for identity segregation and one for engagement level. We also decided to include two of our sociodemographic variables in the cross tabulations, gender, and faculty, since they were the most relevant and we thought they had the most potential to impact our results.

We conducted 46 cross tabulations in total across our variables. From here chi-square statistics were run for each cross tabulation to identify whether the relationship between the variables was statistically significant or not. This was calculated in excel with the formula P-value'=chi test (observed values, expected values)'. These chi-squared tests identified nine statistically significant relationships, one of which we discounted due to our small sample of male participants (8), leaving us with eight statistically significant

relationships (see Table 1). Subsequently, correlation coefficients were calculated based on these statistically significant relationships, this was calculated in excel with the formula r'=*CORREL(Array 1, Array 2)*'. Out of the nine correlation coefficients calculated, four of them appeared to be positive while the other five were negative. Only one of them was considered a moderate-to-strong correlation, one was moderate, while the other ones were either weak or weak-to-moderate.

Qualitative Data Analysis

To conduct our data analysis for the qualitative question "do you have any recommendations for improvement in the delivery of online/virtual courses (assessment strategies, course load: readings, number of assignments, number of exams, delivery of content)?" we began with descriptive coding. This process included gathering all the qualitative responses, reading through each response and taking notes on the responses that stood out to us, especially those that were mentioned repeatedly. We proceeded to read through all responses again, recording the number of times certain words or content were mentioned. From here we were able to determine which themes were significant and began to code the data into groups or themes. After noting significant themes, we were able to reduce the data, eliminating anything that was redundant or insignificant. After eliminating insignificant data and determining the more common themes, we read through the data another time, recording the frequency each theme was mentioned so we were accurately able to determine the most common themes. After descriptive analysis was complete, we moved onto thematic analysis which included identifying patterns into four themes which were the most common (see Figure 11). In the analysis of these themes, the literature review was consulted in order to deduce the implications on this area of research. Our interpretations of student answers were cross analyzed with literature findings and from there we connected the themes back to the research question.

Due to the open-ended nature of the program question and the wide range of responses we received, we decided to analyze this data qualitatively. The same process was followed to conduct the qualitative data analysis for this question. Due to the wide range of programs within the six identified faculties, no significant themes were found within the data.

Timeline for Research

Recruitment

Start: November 18th, 2020
End: February 12th, 2021

Data Collection

Start: November 23rd, 2021
End: February 12th, 2021

Data Analysis

Start: February 13th, 2021
End: March 12th, 2021

Possible Challenges & Risk Management

Psychological risks and social risks must be addressed when identifying the ethical issues that may arise in the research. Psychological risks while participating in the survey

may have included questions triggering feelings of embarrassment, worry or upset which may ultimately have caused additional stress for the participants. We combated this issue through the disclosure and explanation of intent of the research that was included in the letter of information which participants read before taking the survey. The intent of the research was to understand the lived experience of students who had no choice but to conduct most, if not all learning in an online environment to determine what effects (positive or negative) this has had on students. We hope to present the effects of the research to McMaster University, as well as professors at McMaster to show them how it has affected students while providing suggestions for improvements. Furthermore, social risks may have included privacy and confidentiality concerns. We addressed these by ensuring the participants' privacy and confidentiality in the letter of information, as well as a checkpoint that asked the participants for their informed consent before moving forward with participation in the survey.

Additionally, management of this risk was carried out by employing an anonymous survey. Participants had complete anonymity as they were able to take the survey at any time and any place with internet access. Additionally, participants could skip answering any question they did not want to answer. They were also able to choose not to submit the survey at any point before final submission. Moreover, participants were given additional information regarding access to McMaster University's wellness resources. On the final submit page, participants had access to a link which guided them to McMasters' Student Wellness Centre where they were able to access additional psychological support if they deemed it necessary.

Results

Sociodemographics

To begin, we had 94 survey responses of which 33 were not included in our results as they did not meet the completeness requirement of 75%, including the required response of yes to the consent question. This left us with a sample size of sixty-one (n=61) participants who all met the completeness criteria and answered yes to the consent question. However, the generalizability of our results is questionable due to the lack of sociodemographic diversity of our participants. In general, we believe our results best represent the viewpoints and experiences of twenty-one-year-old women in their fourth year of study in an undergraduate program at McMaster University in either the Faculty of Science, Social Sciences, Health Sciences, or the DeGroote School of Business.

Gender

Firstly, we left the question regarding gender as a blank for our participants to fill in, so as to not discriminate against any gender identities and to get the most accurate measure possible. The vast majority of our sample identified as female with fifty-one (51) respondents answering our question regarding their gender identity with either '*female*' '*f*' or '*woman*'. Eight (8) of our participants identified as male, and one (1) participant did not provide a response to this question. One (1) of our participants responded to this question with '*heterosexual*', most likely because they misunderstood gender identity for sexual orientation, we coded this response as *N/A*. In total there were two *N/A* responses for the question of gender identity. Overall, 83.6% of our sample identified as *female*, 13.1% identified as *male*, and 3.3% of participants did not provide a response to gender identity

(*N/A*). This shows how our data is skewed significantly to represent the viewpoints and experiences of women.

Age

Secondly, we also left the question regarding age as a blank for our participants to fill in, mainly due to the potential wide range of ages of our participants. 11.5% of our sample was *nineteen*, 11.5% were *twenty*, 60.7% were *twenty-one*, 13.1% were *twenty-two*, 1.6% were *twenty-four*, and 1.6% were *thirty-three*. This shows that though the age range of our participants is quite vast, ranging from *nineteen* to *thirty-three*, most participants were *twenty-one*. With significant numbers being *nineteen*, *twenty*, and *twenty-two* as well. Our sample then represents the most typical age range of post-secondary students, representing mainly the viewpoints and experiences of twenty-one-year-olds.

Year of Study

Thirdly, due to the requirements for participation in our study being undergraduate students enrolled at McMaster University in second year or above, we provided four options in our question inquiring about the participant's year of study. Overall, 14.8% of our sample was in *second year*, 9.8% were in *third year*, 67.2% were in *fourth year*, and 8.2% were in *fifth year or above*. This shows that our data is skewed significantly to represent the viewpoints and experiences of fourth year students, as to be expected due to the large number of participants who were twenty-one years old.

Faculty

Lastly, we included a question inquiring about the faculty of our participants. This question provided the respondent with six answers encompassing all the faculties at McMaster University, with the option to 'select all that apply' to allow for the inclusion of people who are double majoring and to provide the most accurate results as possible. It is also important to note that we included an open-ended question about our participants' program, the results of which were very diverse and covered a wide range of programs within the six identified faculties.

Figure 1

Faculty of Participants

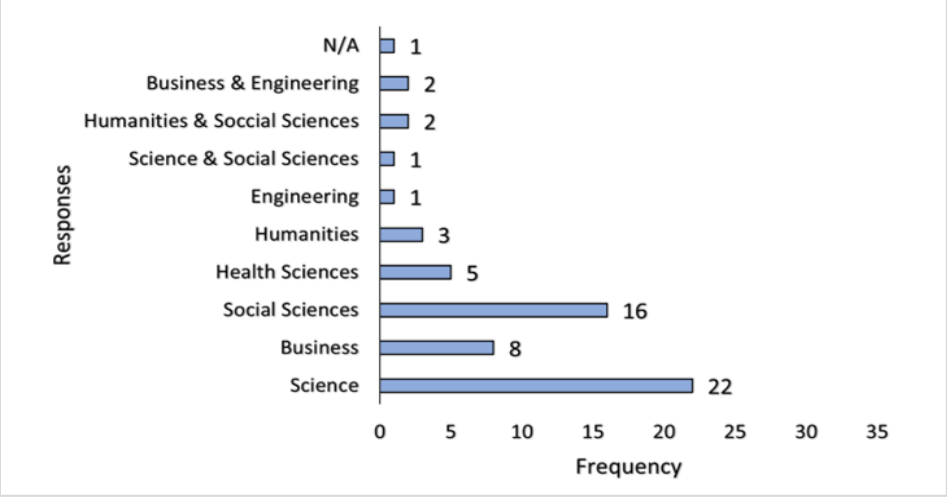


Figure 1 shows the distribution of our sample across the faculties. Overall, 36.0% of our sample was in the *Faculty of Science*, 13.1% were in the *DeGroote School of Business*, 26.2% were in the *Faculty of Social Sciences*, 8.2% were in the *Faculty of Health Sciences*, and 4.9% were in the *Faculty of Humanities*. Additionally, 1.6% of our sample was in the *Faculty of Engineering*, 1.6% were in the *Faculty of Science and the Faculty of Social Sciences*, 3.3% were in the *Faculty of Humanities and the Faculty of Social Sciences*, and 3.3% were in the *DeGroote School of Business and the Faculty of Engineering*. 1.6% of our sample also fell under the category of *N/A* as they did not provide a response to this question.

This shows that our sample was diverse in terms of faculty, with most of our participants being in science, social sciences, or business. We had the smallest sample of students from the *Faculty of Humanities* and *Faculty of Engineering*. For this reason, our results may not be representative of the viewpoints and experiences of students in these two faculties. Finally, we had a smaller sample of students from the *Faculty of Health Sciences*, but due to the overall smaller size of this faculty in comparison to the others, we believe that our results may still be generalizable to students in the *Faculty of Health Sciences* as well.

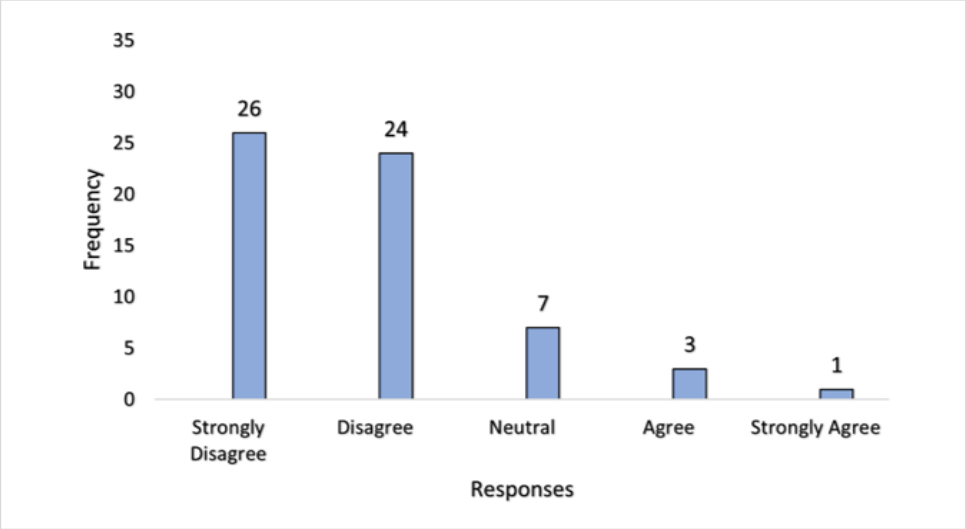
Cognitive Wellness

To begin, cognitive wellness was one of the four identified areas of well-being we attempted to measure. Overall, our results showed that online learning had a negative impact on our participants' cognitive wellness.

The question "My mental wellness has improved during online classes in comparison to in-person classes" was intended to measure the overall impact that online learning has had on the cognitive well-being of our sample. 50.8% of participants *strongly disagree*, 29.5% *disagree*, 8.2% were *neutral*, 8.2% *agree*, and 3.3% *strongly agree*. Due to some issues with the wording of this question, we cannot take away from this question alone that cognitive wellness has been negatively impacted by online learning. However, we can conclude that cognitive wellness has not improved during online learning for most of our participants.

Figure 2

Question: I feel less mentally drained from online classes in comparison to in-person classes



The question in Figure 2 was intended to measure if our participants were feeling less mentally drained since beginning online classes. As shown in this figure, 42.6% of participants *strongly disagree*, 39.3% *disagree*, 11.5% were *neutral*, 4.9% *agree*, and 1.6% *strongly agree*. We can take away that the majority of our participants feel more mentally drained since beginning online classes, when compared to in-person classes, indicating increased mental fatigue.

From this, we can conclude that online classes have not improved the cognitive wellness of our participants, and in fact online classes have led to our sample experiencing increased mental fatigue. These findings paired along with our findings surrounding stress allow us to conclude that online learning has negatively impacted the cognitive wellness of our participants.

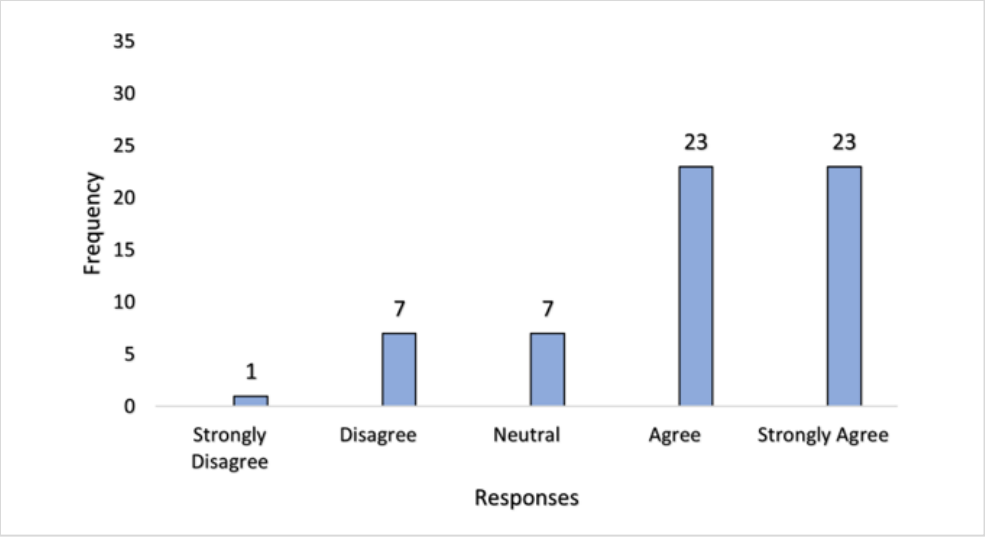
Stress

We included a measure for stress, which we initially categorized under the area of cognitive wellness, since we believe that stress most directly affects the individual's cognitive well-being as opposed to our other three areas of well-being. With that being said, stress inevitably affects the individual's physical health as well as their academics, but for the purposes of our research we intended to look at stress and its role in our participants' cognitive well-being.

The question about whether online classes are more stressful than in-person classes with regard to workload was intended to measure if online classes have increased levels of stress in our participants, in comparison to in-person classes. As shown in the figure, 1.6% of participants *strongly disagree*, 11.5% *disagree*, 11.5% were *neutral*, 37.7% *agree*, and 37.7% *strongly agree*. This shows that most participants felt that online classes were more stressful than in-person classes in terms of workload. From this we can assume the negative impacts this increased stress will have on our participants'

Figure 3

Question: Online classes are more stressful than in-person classes with regard to workload



cognitive wellness given what we know about the detrimental effects of stress on mental health.

Physical Well-being

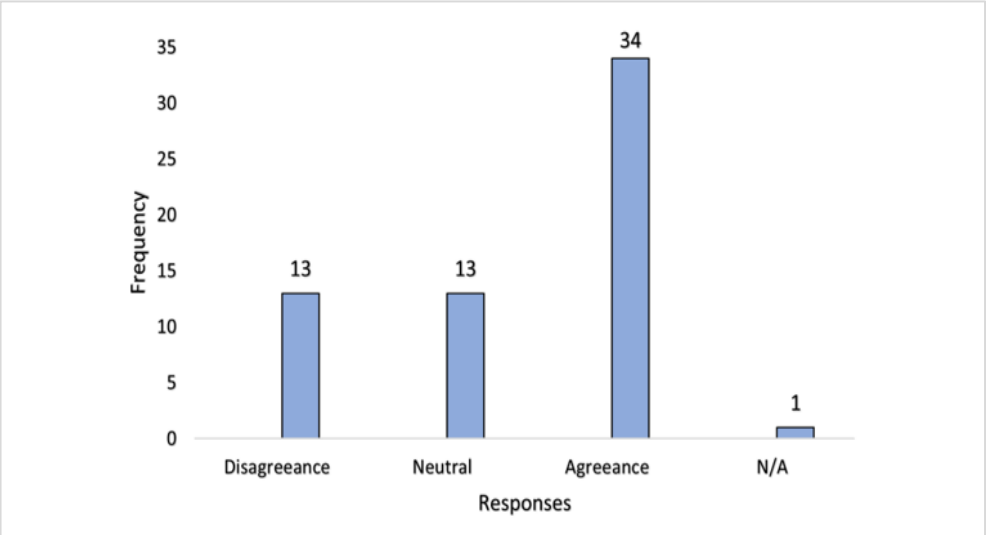
Physical well-being was one of our main areas of well-being we were attempting to measure. The questions under this area of well-being aimed to measure overall physical health, energy levels, and specific physical strains caused by online learning, including eye strain, neck/back strain, and headaches. Overall, our results showed that online learning had a general negative effect on our participants' physical well-being.

In Figure 4, the responses of *strongly disagree* and *disagree* have been collapsed into *disagreeance* and the responses of *agree* and *strongly agree* have been collapsed into *agreeance.* We did this because no respondents (0) selected the strongly disagree option, so by collapsing the categories we can more accurately see the distribution of our results. This question was intended to measure the overall physical health of our participants during online school in comparison to during in-person school. As shown in the figure, 21.3% of participants are in *disagreeance*, 21.3% are *neutral*, 55.7% are in *agreeance*, and 1.6% did not provide a response to this question (*N/A*).

It is important to note with these results that a large part of our sample was *neutral* on this question, the same number of participants were neutral that were in *disagreeance*. This could potentially be due to the question being worded in a way that is over-simplistic and does not consider severity of sickness. Participants may also not have felt confident that they were answering correctly, since they had to compare the amount of days sick from the previous year, and this is often hard to recall. Overall, these results show that most of our participants have been sick less during online school, potentially showing an improvement in physical health among our sample. However, the large number of *neutral* responses should be noted, along with the shortcomings of the question wording, and the subjectivity and potential lack of reliability that comes with asking participants to recall how often they were sick last year.

Figure 4

Question: I've been sick less during online school then when attending in-person classes



Additionally, the question “my energy levels have lessened since beginning online classes compared to when I’ve been enrolled in in-person classes” was intended to measure our participants’ energy levels since beginning online classes as a variable of physical well-being. 1.6% of participants *strongly disagree*, 11.5% *disagree*, 8.2% were *neutral*, 37.7% *agree*, and 41.0% *strongly agree*. From this, we can conclude that most participants experienced decreased energy levels since beginning online classes, showing the negative impact of online learning on physical well-being.

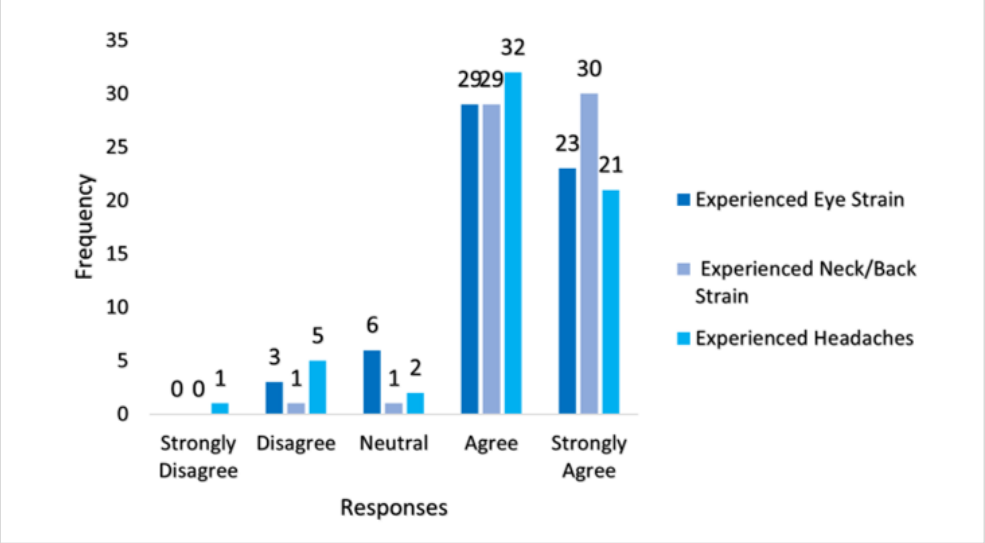
Firstly, the question “I have experienced eye strain due to online classes” was evidently intended to measure if our participants have experienced eye strain due to online classes (see Figure 5). 0.0% of participants *strongly disagree*, 4.9% *disagree*, 9.8% were *neutral*, 47.5% *agree*, and 37.7% *strongly agree*. This shows that most of our participants experienced eye strain due to online classes, demonstrating a negative impact of online learning on physical well-being.

Secondly, the question “I have experienced neck/back strain due to online classes” was evidently intended to measure if our participants have experienced neck/back strain due to online classes (see Figure 5). 0.0% of participants *strongly disagree*, 1.6% *disagree*, 1.6% were *neutral*, 47.5% *agree*, and 49.2% *strongly agree*. This shows that there was consensus among participants that they have experienced neck and back strain due to online classes since all our participants, except for two, agreed with this question. This allows us to conclude that neck and back strain is an apparent negative impact that online learning had on the physical well-being of our sample.

Thirdly, the question “I have experienced headaches due to online classes” was evidently intended to measure if our participants have experienced headaches due to

Figure 5

Questions: I have experienced eye strain due to online classes, I have experienced neck/back strain due to online classes, and I have experienced headaches due to online classes



Note. We also included specific measures for the physical strains of online learning in the form of eye strain, neck/back strain, and headaches.

online classes (see Figure 5). 1.6% of participants *strongly disagree*, 8.2% *disagree*, 3.3% were *neutral*, 52.5% *agree*, and 34.4% *strongly agree*. This shows that most of our participants experienced headaches due to online classes, allowing us to conclude that headaches are a negative impact that online schooling had on our participants.

Overall, our results demonstrate that online learning has had a negative impact on our participants' physical well-being. Despite the majority reporting being sick less since starting online school, the overwhelming consensus surrounding the increased physical strains demonstrates an overall negative impact of online learning on physical well-being. Specifically, online classes have resulted in increased physical strain on our participants, with the majority reporting experiencing eye strain, neck/back strain, and headaches. Our participants have also experienced decreased energy levels since starting online classes.

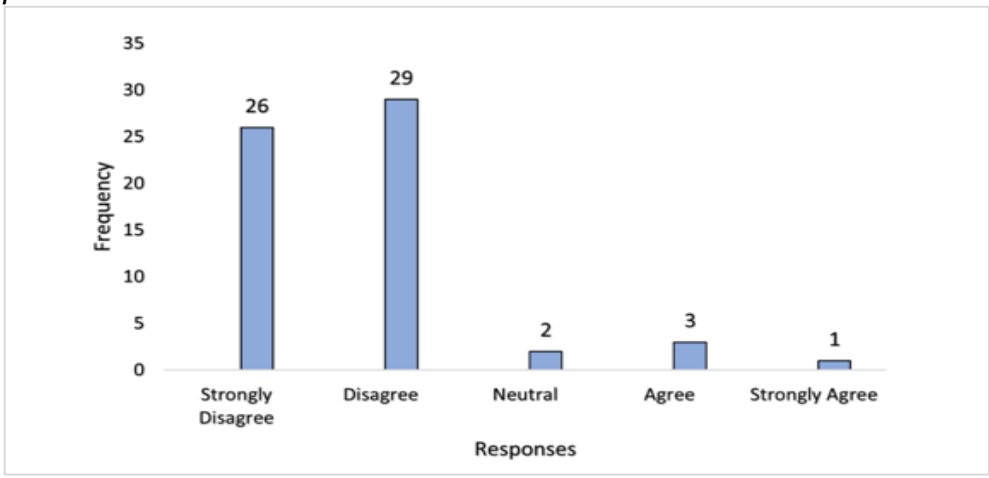
Interpersonal Relationships

In the category of interpersonal relationships, we investigated several scopes which included students' willingness to seek assistance from peers and/or faculty members, students' perceptions of connectedness with family and friends, the frequency of communication with family and friends, and time spent with family. Dependent on the focal point of interpersonal relationships, distinct opinions were exhibited. One of the questions explored participants' opinions on the statement "I often reach out to other students and/or faculty for assistance". 11.5% of participants *strongly disagree*, 24.6% *disagree*, 18.0% were *neutral*, 36.1% *agree*, and 9.8% *strongly agree*. As a result, we can conclude that there are similar numbers of students who are somewhat frequently seeking assistance from students and/or faculty members and somewhat rarely seeking assistance from students and/or faculty members, with a slight emphasis on students who seek assistance frequently.

Most of our participants reported a negative response to the question about whether they felt more connected to their family and friends during online learning versus in-person learning. 42.6% *strongly disagree*, 47.5% *disagree*, 3.3% were *neutral*, 4.9% *agree*, and 1.6% *strongly agree*. This shows that most of our participants felt less connected to friends/family during online school.

Figure 6

Question: I feel more connected to my friends/family during online school compared to in-person school



In terms of the question investigating opinions on the following statement 'I have been communicating less with my peers/friends during the online school year than during in-person classes', 3.3% *strongly disagree*, 3.3% *disagree*, 1.6% were *neutral*, 41% *agree*, and 50.8% *strongly agree*. Half of our participants reported communicating less with families and friends during online learning, which further explains the previous finding, a decrease in perceptions of connectedness with families and friends. Lastly, a question examining the viewpoint on the statement "online school has increased how much time I spend with family". 1.6% of our participants did not provide a response (*N/A*), 4.9% *strongly disagree*, 37.8% *disagree*, 6.6% were *neutral*, 37.8% *agree*, and 11.5% *strongly agree*. The disparate responses to this question may be explained by a lack of clarity in terms of the definition of time spent with families. In general, our participants felt less connected with their families and/or friends since online learning, which is a major part of fulfilling psychological needs.

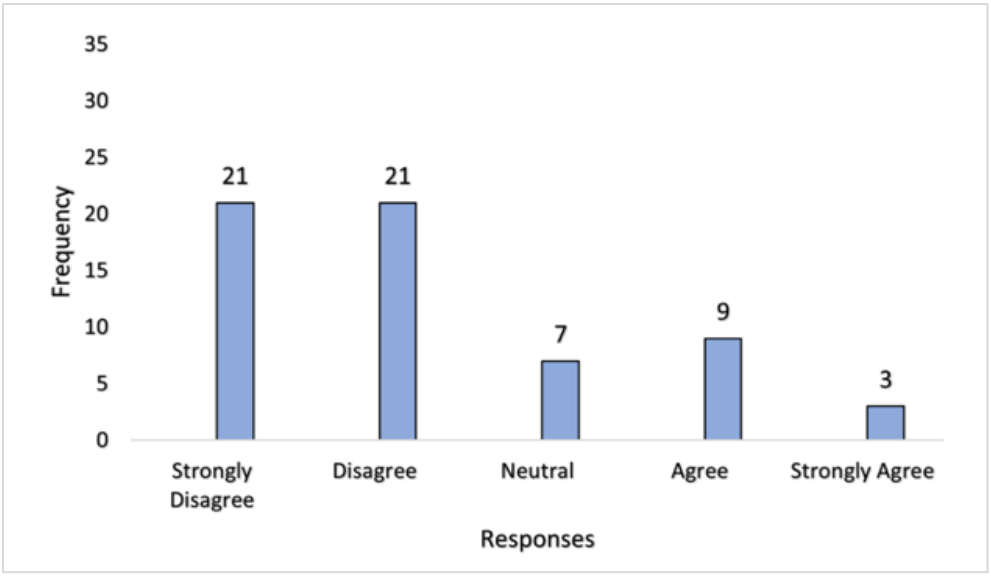
Academics

Due to our main interest in this research, the impacts of online learning on students' well-being, academic-related experiences were thoroughly examined. Several areas focusing on a comparison between online learning and in-person classes were assessed in our research, including students' preferences of online lectures versus traditional in-person lectures, ability to stay on-task, amount of time spent completing schoolwork, education quality, academic achievement satisfaction, academic performance/grades, and engagement level.

Most of our participants expressed a preference for traditional in-person lectures over online lecture style. Particularly, 68.9% of our participants preferred in-person lectures over online lectures, 11.5% were *neutral,* and 19.7% preferred online learning over in-person lectures.

Figure 7

Question: I prefer online lecture style (live or pre-recorded) compared to in-person lectures



To measure students' engagement level, one of our survey questions explored participants' ability to stay focused while completing schoolwork. 85.2% of our participants reported experiencing difficulty staying on task while doing online schoolwork compared to in-person classes, 4.9% were *neutral*, and 10.0% found it easier to stay focused during online learning compared to in-person classes. Moreover, 65.6% of our participants perceived spending more time on completing schoolwork during online learning, 3.3% were *neutral*, and 31.1% perceived spending less time on completing schoolwork during online learning. This suggests that our participants experienced more difficulty engaging with academic learning during online classes compared to in-person lectures, which may lead to a decline in effectiveness and efficiency of learning.

In order to learn more about the preferences of the education delivery method, three other measures were examined in this study, which were education quality, academic achievement satisfaction, and academic performance/grades.

Majority of our participants perceived that the quality of online education is worse compared to in-person classes. Specifically, 1.6% of our participants *strongly disagree*, 11.5% *disagree*, 8.2% were *neutral*, 32.8% *agree*, and 46.0% *strongly agree*.

The responses are significantly skewed towards agreement with the statement, suggesting that a notable decline was observed in the quality of education since transitioning to online learning. This contributes to the negative impact that the COVID-19 pandemic has had on students' well-being.

Figure 8

Question: The quality of my education with online classes is worse than in-person classes

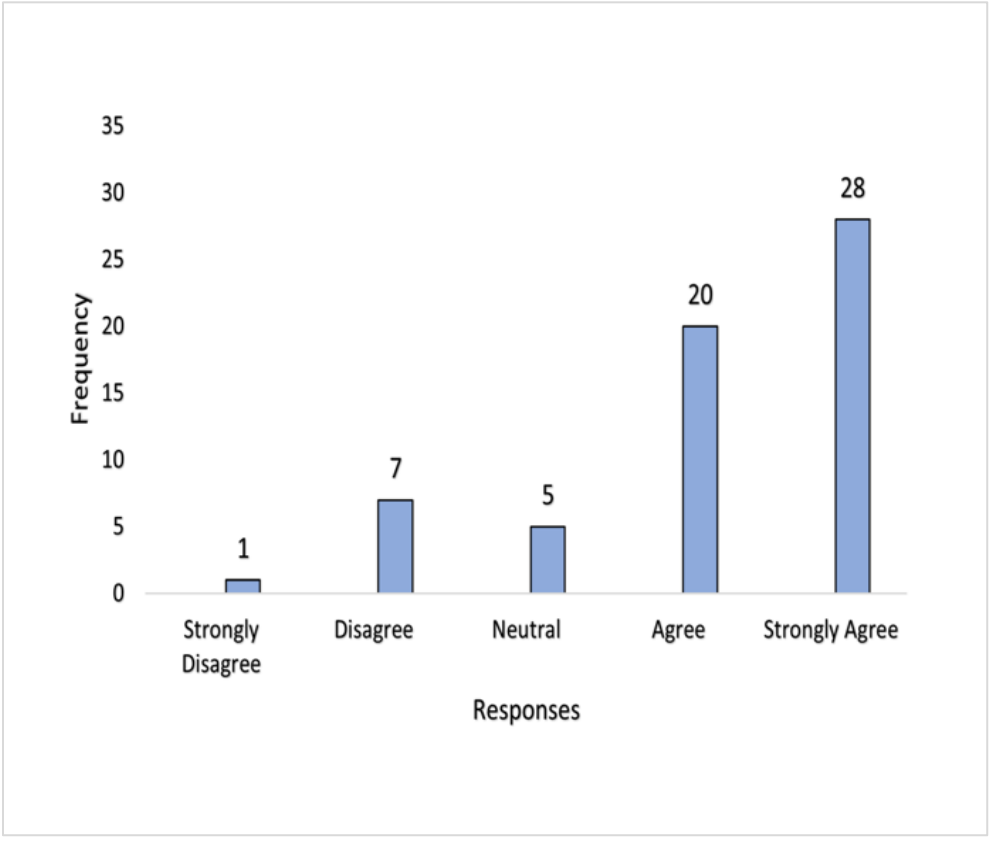
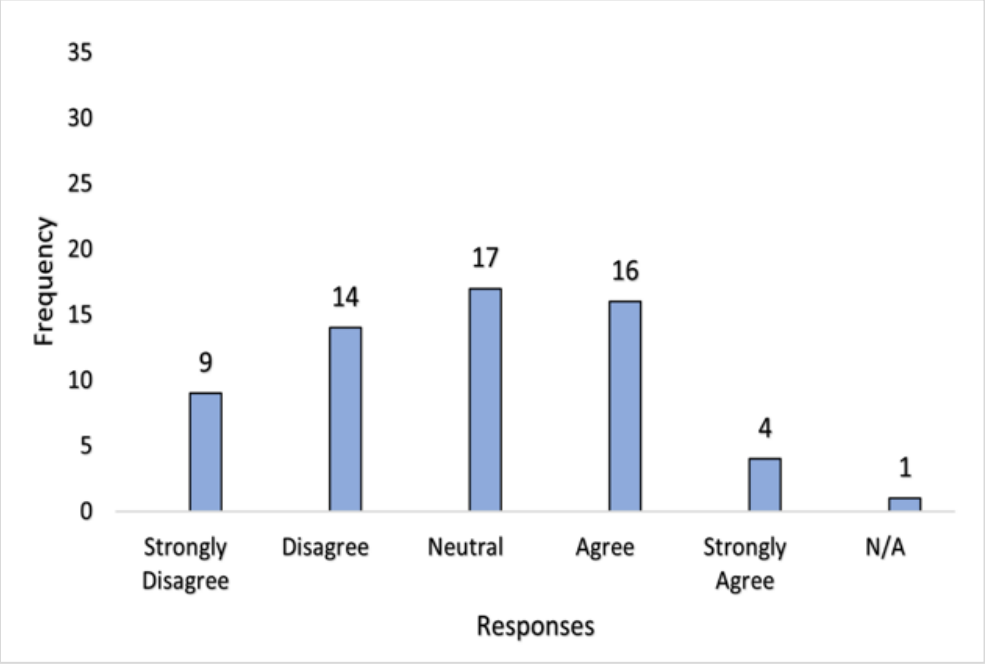


Figure 9

Question: I feel satisfied with my academic achievements since being in online school, compared to in-person classes



Among all responses, 14.8% strongly *disagree*, 23% *disagree*, 27.9% were *neutral*, 26.2% *agree*, 6.6% *strongly agree*, and 1.6% did not provide a response (*N/A*). Participants' opinions on this question were evenly distributed with a minor prominence placed on the category of disagreement, but the high rate of *neutral* responses should be considered when interpreting these results.

24.6% of our participants reported a *decrease* in their grades during online learning versus in-person classes, 37.8% found no change in their grades during online learning, 27.9% reported an *increase* in their grades, and 10.0% either did not provide a response (*N/A*) or selected *prefer not to say*. As shown in Figure 10, most participants experienced an improvement in their academic achievements. On the other hand, a similar number of participants experienced a decline in academic achievement as those who experienced no change.

These findings suggest that more effort needs to be devoted into online learning for it to be considered comparable with traditional in-person lectures, which is aligned with the literature review conducted for this study. Furthermore, within the academic area of well-being we also included a qualitative question, with which we aimed to uncover students' recommendations for improvement in the delivery of online learning.

Some common themes discussed were the need to reduce workload and content (62.2%), the need for a more interactive content delivery method (37.8%), modified participation (21.6%), and different/removal of anti-cheating software/online proctoring software (8.1%). Participants' answers were organized and coded by the common themes that emerged from all responses. This figure demonstrates the frequency of common themes emerging from our participants' responses to this question (n=35).

Figure 10

Question: Since starting online classes, compared to in-person classes, have your grades:

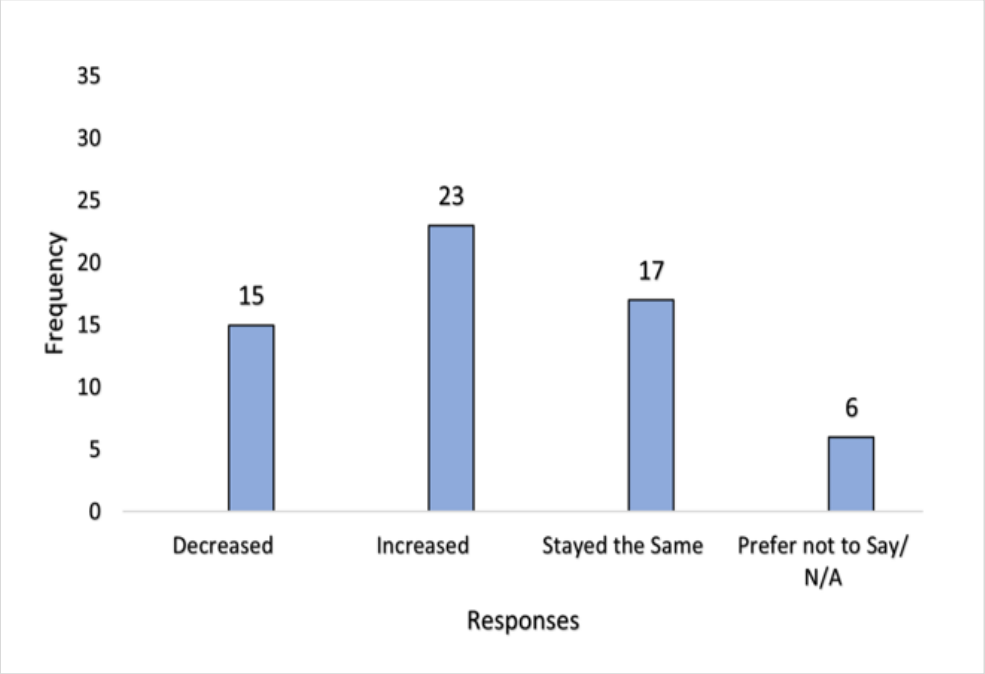
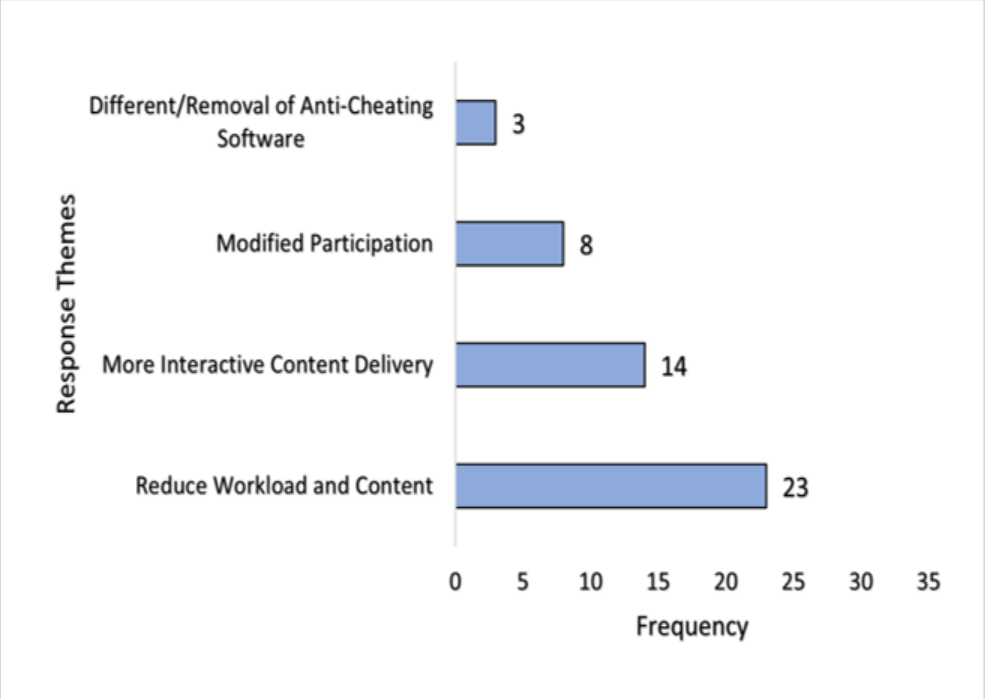


Figure 11

Question: Do you have any recommendations for improvement in the delivery of online/virtual courses (assessment strategies, course load: readings, number of assignments, number of exams, delivery of content)?



Reduce Workload and Content

I feel as though professors think we have more time on our hands and therefore give out more assignments. But with 5 profs doing that at once is overwhelming and not manageable… I only have 1 live zoom class a week, whereas the rest of profs pre record lectures and/or post slides and I teach myself. I think that is unacceptable for the amount of money I am paying and not receiving anything close to the academic standard.

> ...Many of my courses have 2 hours of scheduled class time but often lecture content adds up to be around 4hours of recorded time per week. But getting through pre-recorded lectures takes much longer than it would in person…

Majority of our participants disclosed an overwhelming amount of workload and difficulty with the transition process between traditional in-person lectures and online learning. Among the responses shown above, the component 'time' was frequently highlighted and emphasized. This also aligned with one of the previous questions exploring students' responses to the statement "I feel as though less time is spent doing schoolwork online versus in-person classes" (24.6% *strongly disagree*, 41.0% *disagree*, 3.3% *neutral*, 19.7% *agree*, 11.5% *strongly agree*). A lack of time to regulate students' mindset and connect with families and friends may contribute to a decrease in students' well-being during online learning, which can be reflected in this quote: "Modified assignment, test, and midterm schedule to allow for more self-care during the time of a global pandemic killing millions of people."

However, opposing opinions were also demonstrated in our participants' responses: *"*Small quizzes and assessment seem more manageable than large tests and exams online. Difficult to have quiet time for long periods of time, difficult to focus for long periods of time after being on computer all day."

Diversity in responses to this question indicates the possibility of inconsistent interpretations of workload, and preferences of workstyle among our participants. Therefore, more flexibility, creativity, and empathy are critical for assisting students with the transition process from traditional in-person learning to online learning. In general, many responses from our participants reveal a need for reduced course load during online education.

More Interactive Content Delivery Method

"More interaction is required to learn. Students cannot learn from watching hours of pre-recorded lectures. It has been taught and encouraged since my first year of university that learning is strengthened through interaction with the material." Another theme that was highlighted frequently is the need for more interactive content delivery methods. Primary reasons include time-consuming, overwhelming length of lecture time, and decrease in students' engagement level. All three dimensions of engagement level in the literature are demonstrated in the responses: interaction between students and learning materials, interaction between students or peers, and interactions between students and instructors (Vlachopoulos & Makri, 2019). In combination with the quantitative question mentioned earlier that was intended to measure engagement level, it suggests that different dimensions of engagement level during online learning is one of the key determinants of online education quality and students' well-being, especially cognitive wellness.

Modified Participation Method

"Making things mandatory/marking for attendance would definitely incentivise me to participate. However, this is not fair to students with poor or inconsistent internet, in different time zones, etc. I believe there is no good way to do university online."A secondary theme regarding the lecture style was the request to modify the participation method of assessment. Among the responses that reflect this theme, participants either requested reduced or eliminated participation requirements for courses during online learning, which also resonates with the previous theme of reduced course load. This theme demonstrates the concept of autonomy, however, our speculation that a higher level of autonomy predicts improved well-being cannot be validated due to the failure to measure this variable explicitly in the quantitative survey questions.

Different/Removal of Anti-cheating Software

Lastly, a shared negative attitude towards anti-cheating or proctoring software was observed in the responses. Although it was less frequently mentioned compared with other themes, surveillance technologies are often a notable concern for many students. The related responses are as follows. **'***... no use of invasive proctoring software... stop using invasive (in terms of privacy and security) proctoring systems; professors should use other methods to mitigate against cheating*…'

Other Variables

We also included measures for three other variables which were relevant to our research: motivation, identity segregation, and disability. Motivation was originally included as a measure for cognitive wellness, but because it directly relates to self-determination theory, which was a framework for our research, and could potentially impact all four areas of well-being, we felt it would be best to examine it as its own variable. Identity segregation was included to measure the impacts of another theory which provided a framework for our research, identity theory. Lastly, a question regarding disability and its impact on the experiences of online learning was included to address a gap in this area of research, as identified in the literature review.

Motivation

We included measures for both overall motivation and for the extent to which intrinsic versus extrinsic motivation is used for our participants when doing online school. Overall, our results show that online learning has a negative impact on our participants' motivation. This does not necessarily prove our prediction that higher levels of motivation lead to increased well-being among students, however we suppose our results can be used to indirectly prove this. Since our participants' motivation decreased and their overall well-being worsened, we can conclude that lower levels of motivation lead to worse well-being among students. In turn, we could assume this also means that higher levels of motivation lead to increased well-being among students, thus proving this speculation.

The following question (Figure 12) was intended to measure the impact that online learning has had on our participants' level of motivation. As shown in the figure, 0.0% of participants *strongly disagree*, 11.5% *disagree*, 3.3% were *neutral*, 26.2% *agree*, and 59.0% *strongly agree*. This shows that most participants feel as if their motivation levels

have been negatively affected by online classes, demonstrating that motivation has been negatively impacted by online learning.

Figure 12

Question: My level of motivation has been negatively affected by online classes in comparison to in-person classes

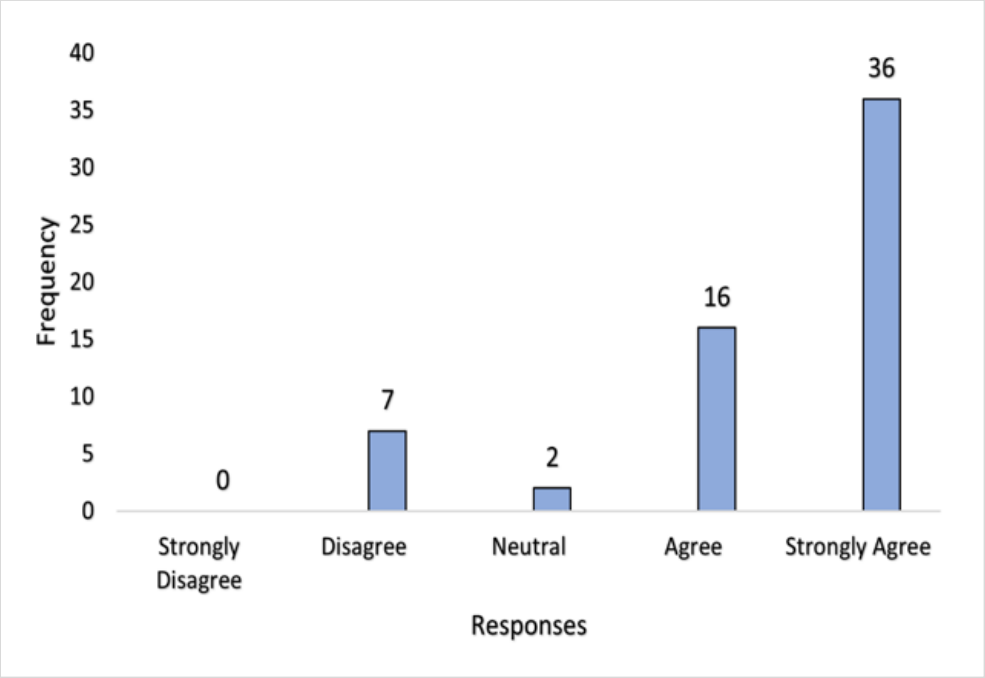
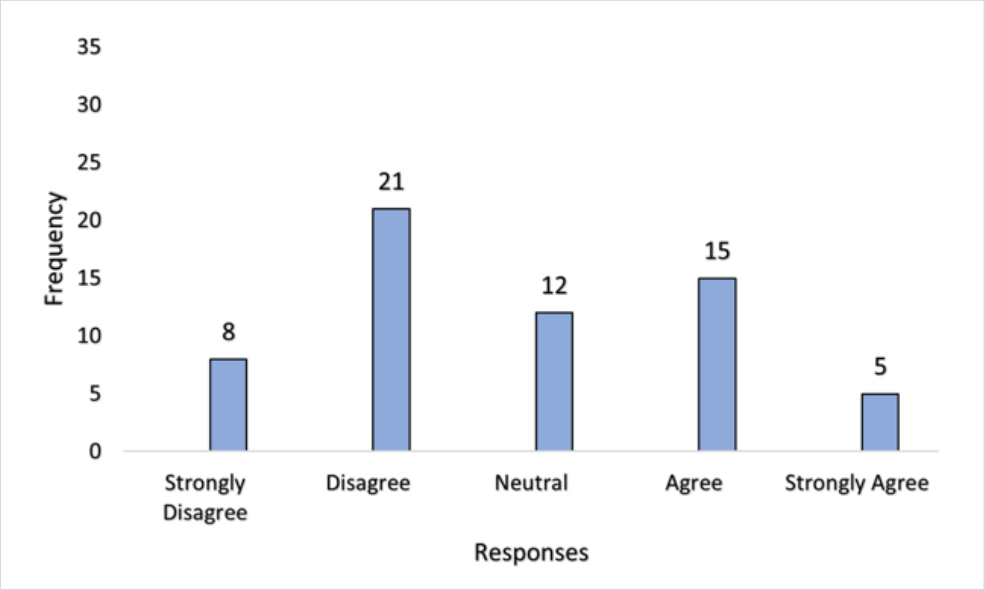


Figure 13

Question: My motivation for schoolwork comes from more internal sources (i.e., being interested in the content you're learning) than external sources (i.e., due dates, late penalties, etc.) during online learning



The question in Figure 13 was intended to measure the extent to which intrinsic motivation is used in comparison to extrinsic motivation during online learning among our participants. This question is a measure directly related to SDT and the negative outcomes that often come with extrinsic motivation. As shown in the figure, 13.1% of participants *strongly disagree*, 34.4% *disagree*, 19.7% were *neutral*, 24.6% *agree*, and 8.2% *strongly agree*. This shows that most participants feel as if their motivation comes from external sources, meaning they are engaging in extrinsic motivation. It is important to note that there was a large portion of participants who responded with *neutral*, meaning there might have been some confusion with the question wording. Additionally, participants may not have known how to tell where their motivation is coming from, meaning these results have questionable reliability.

Regardless, this allows us to conclude that extrinsic motivation is used more during online learning, which constitutes controlled motivation. We know that controlled motivation does not lead to the positive outcomes of enhanced academic performance and greater psychological well-being that autonomous motivation does (Deci & Ryan, 2008a). This finding suggests that the heightened use of controlled motivation during online learning will most likely lead to increased negative outcomes in the areas of academics and cognitive wellness. Overall, this finding alongside the finding that most participants feel as if their motivation has been negatively impacted by online learning allows us to conclude that participants' motivation has been negatively impacted by online learning. These negative impacts to motivation can potentially be seen in all four areas of well-being, but most notably in academics and cognitive wellness.

Identity Segregation

The question "my varying identities (i.e., student, friend, sibling, parent, co-worker) are less distinguished now in comparison to when school was in-person" was intended to measure the identity segregation of our participants' competing identities. This measure came directly out of our framework of identity theory and aimed to look at the multiple identities an individual has as well as their ability to distinguish between them in their new social environment for school, since it has moved online. 1.6% of participants *strongly disagree*, 8.2% *disagree*, 23.0% were *neutral*, 32.8% *agree*, 27.9% *strongly agree*, and 6.6% did not provide a response to this question (*N/A*). This shows us that most of our participants felt as if their identities were less distinguished since beginning online learning.

It is important to note there was a high non-response and *neutral* response rate for this question, with over a quarter (29.6%) of our participants falling into the *neutral* or *N/A* category. This means that this question was potentially confusing to participants, and they did not know how to answer, or tell if their identities are distinguished or not. Regardless, our results show that most participants felt as if their identities were less distinguished since starting online school, though the reliability of these results is questionable. The lack of segregation between identities can lead to negative impacts in all four areas of well-being, but most notably in the areas of cognitive wellness, interpersonal relationships, and academics.

Disability

The question “experiencing any type of disability can have a negative impact on online learning” was intended to measure the differential impacts that online learning may have on individuals living with a disability. This was included to fill in the gap in the literature regarding disabilities and online learning. 3.3% of participants *strongly disagree*, 3.3% *disagree*, 9.8% were *neutral*, 41.0% *agree*, 31.1% *strongly agree*, and 11.5% did not provide a response to this question (*N/A*). Due to the large number of non-responses to this question, participants may have found this question confusing, or did not feel comfortable answering. Overall, due to some wording issues and the low-risk nature of our research we cannot take away if online learning has any unique negative impacts on individuals with disabilities. Therefore, our research does not fill this gap in the literature of online learning pertaining to disability. What we can take away is that the general opinion among our participants is that experiencing a disability can have a negative impact on online learning. Possibly, the negative impacts identified through our research would be exacerbated by experiencing a disability, but further research is required to properly conclude this.

Significant Relationships

In this section, we want to highlight several statistically significant relationships between variables ($P \leq 0.05$to be considered statistically significant). Statistically significant relationships indicate that a meaningful relationship is shared between two variables, apart from random chances. Due to the limitation of the small sample size of the current study, although the variables below were found to be statistically significant, this might not fully represent an actual effect between these variables. However, these could serve an educational and reference purpose for both junior researchers included in this study and for potential future research.

Table 1 demonstrates all the statistically significant relationships between variables uncovered during the cross-tabulation tests. *IR: Interpersonal Relationships; Gd: Gender; CW: Cognitive Wellness; EQ: Education Quality; Mot: Motivation; IS: Identity Segregation; AAS: Academic Achievement Satisfaction; St: Stress; EL: Engagement Level*.

Table 1

Statistical Significance Between Variables

	P-value (*P*)							
	IR	CW	EQ	Mot	IS	AAS	St	EL
IR		.0003						
Gd	.001							
CW			.025	4E-07	1E-07			.004
EQ							1E-05	
Mot			.001			.019		

Table 2 demonstrates the correlation coefficients (r) of all the statistically significant variables. *IR: Interpersonal Relationships; Gd: Gender; CW: Cognitive Well-being; EQ: Education Quality; Mot: Motivation; IS: Identity Segregation; AAS: Academic Achievement Satisfaction; St: Stress; EL: Engagement Level*. In this table, only *Motivation* shares a moderate-to-strong negative linear relationship with *Cognitive Wellness*. Additionally, *Education Quality* shares a positive mild linear relationship with *Motivation*. Other correlations were all found to be relatively weak, either positive or negative.

Regarding the relationship between *IR* and *Gd*, we primarily assessed whether our participants felt more connected to their families and friends during online learning versus in-person school. Therefore, it suggests that there might be a gender difference in terms of how they perceived their connectedness with their families and friends during online learning. However, due to the small sample size of the current study and the significant number of participants who identified themselves as female compared to male, this relationship might not be valid, therefore, it was discounted. As for the variables *IR* and

CW, we may conclude that a small positive correlation (*r = .29)* is present between perceived connectedness with families and friends and students' cognitive wellness.

Due to the nature of the way our survey questions were phrased regarding *AAS* ("Please consider the following statement and select an answer: I feel satisfied with my academic achievements since being in online school, compared to in-person classes") (see Figure 9) and *Mot* ("Please consider the following statement and select an answer: My level of motivation has been negatively affected by online classes in comparison to in-person classes") (see Figure 12), the correlation coefficient between *AAS* and *Mot* appeared to be negative (*r = - .46*), we confirmed that there is a negative small-to-mild linear relationship between *AAS* and *Mot*.

In addition, students' cognitive wellness was found to have a significant relationship with education quality (*P = .025*), motivation (*P = .0000004*), and identity segregation (*P = .0000001*) (see Table 1). A moderate positive linear relationship between *Mot* and *EQ* was observed (*r = .53*), which is aligned with findings mentioned in the literature review. Similarly, since the nature of the survey questions regarding *Mot* ("Please consider the following statement and select an answer: My level of motivation has been negatively

Table 2

Correlation Coefficient Between Statistically Significant Variables

Correlation Coefficient (r)								
	IR	CW	EQ	Mot	IS	AAS	St	EL
IR		.29						
Gd	.32							
CW			- .35	- .64	- .40			- .47
EQ							.44	
Mot			.53			- .46		

affected by online classes in comparison to in-person classes") (see Figure 12) and *CW* ("Please consider the following statement and select an answer: My mental wellness has improved during online classes in comparison to in-person classes") oppose each other, though the correlation coefficient between *Mot* and *CW* appeared to be negative (*r* = *-.64*), we suppose that there is a moderate-to-strong positive correlation between these two variables. This finding aligns with our prediction that a higher level of motivation results in better student well-being. However, as previously mentioned, there is a possibility that there might not be real effects between these variables.

In the earlier sections, we also speculated that a higher engagement level would predict better students' well-being. Although a minor negative correlation exists between *EL* and *CW*, we expect that there is a minor positive relationship between these two variables, which is consistent with our prediction. Since we failed to measure autonomy and competence in our quantitative survey questions, we failed to validate or invalidate our other two speculations. These were: a higher level of autonomy correlates with an improvement in students' wellness, and a higher level of competence along with an increased level of engagement predicts better students' wellness.

Lastly, *St* was found to hold a weak-to-mild negative linear relationship with education quality although the correlation coefficient appeared to be positive (*r* = *.44)* (see Table 2). The survey question intended to assess *St* was "Please consider the following statement and select an answer: Online classes are more stressful than in-person classes with regard to workload" (see Figure 3) while the question assessed *EQ* was "Please consider the following statement and select an answer: The quality of my education with online classes is worse than in-person classes" (see Figure 8). This finding implies that the key to reducing students' stress levels during online learning may be greatly dependent on improvements in online education quality. While these variables might exert an impact on students' cognitive wellness, they are discussed as the main contributing factors of the decrease in students' cognitive wellness and will be discussed in detail in the later section.

Discussion

In the following section the results and their greater significance in our study of the effects that online learning has on students' cognitive well-being, physical well-being, interpersonal relationships, and academics will be discussed. These four measures of well-being will be expanded through the theoretical frameworks of SI, identity theory, SDT, and BPNT, as well as be compared to the findings of previous literature in this area of study.

To further interpret this study's findings, SI provides a framework for negotiating meaning-making in interactions, where meanings are influenced by others within the interaction and the current cultural world (Blumer, 1969). This is relevant for our research because the switch to online learning, as well as extraneous variables brought upon from living amidst a global pandemic, have played a role that resulted in decreased well-being. Identity theory shows the impact that salient identities and role-taking may have on an individual's opportunity to perform academically. SDT provides a framework that helps interpret the results for intrinsic and extrinsic motivation as well as autonomous motivation, controlled motivation and amotivation. BPNT helps us to understand the impact that social environments have on the type of motivation the individual possesses for any given behaviour (Deci & Ryan, 2008b). Moreover, BPNT postulates that there are

three basic but innate psychological needs which can affect an individual's well-being and motivation if they are not being properly met; these three needs are autonomy, competence, and relatedness (Van den Broeck et al., 2016). Finally, both SI and SDT focus on the individual and the impacts their interactions and social environment have on their internal processes, whether it be role taking, meaning-making, or motivation.

Cognitive Wellness

The results of our questions measuring students' cognitive wellness showed an apparent decline in this area of well-being since beginning mandatory online learning. In the four survey questions that were aimed to measure cognitive wellness, respondents expressed that due to online school they experienced increased stress and mental fatigue. Moreover, students also perceived difficulty with identity segregation and motivation as a result of online learning. Taking from a deductive approach, these results would suggest that cognitive wellness in students has decreased since beginning online learning.

Students were asked about their viewpoints on two statements measuring cognitive wellness and mental fatigue. As a result, most respondents displayed a lack of improvement in cognitive wellness (approximately 80.3%) and increased mental fatigue (approximately 81.9%) (see Figure 2). The literature on online learning needs additional research on its effects on well-being. As a result of this, our cognitive wellness analysis will concurrently refer to SDT and BPNT, to further explain the measurement of this area of well-being. The foundation of SDT relies on motivation and BPNT focuses on the psychological needs of autonomy, competence, and relatedness; these are connected in that to effectively internalize extrinsic motivation, an increase of which was observed in our data, the three psychological needs of BPNT must be fulfilled (Deci & Ryan, 2008a). Satisfaction of autonomy, competence, and relatedness then facilitate autonomous motivation (Van den Broeck et al., 2016) and, in turn, result in positive psychological outcomes and enhanced academic performance (Deci & Ryan, 2008a). Our four predictions infer the effects of these factors based on the literature.

First and foremost, motivation was speculated to increase cognitive wellness concurrently with motivation. Despite this prediction, most students expressed decreased motivation (approximately 85.2%) (see Figure 12) and a lack of improvement in cognitive wellness (approximately 80.3%). As our results elucidate, there is a moderate-to-strong positive correlation evident between motivation and cognitive wellness. Although this finding contrasts the original speculated relationship, our motivation prediction was supported. With that being said, our questions measuring motivation cannot be used to solely measure effects on cognitive wellness because motivation is a key component of SDT, thus affecting all areas of well-being in our research. The speculation for autonomy expected a positive relationship between autonomy and cognitive wellness. Given that our study failed to sufficiently measure autonomy in our survey, we cannot verify the direct relationship between autonomy and cognitive wellness. Further, fulfilment of competence needs is the strongest predictor of higher engagement levels (Fang et al., 2019), thus we predicted that increased competence would lead to improved cognitive wellness. As the variable of competence was not adequately measured, the correlation between competence and engagement level cannot be verified.

Lastly, participation and engagement levels are often measured in place of the psychological need for relatedness, and we speculated that higher engagement levels would coincide with better cognitive wellness. On the contrary, our results show a general lack of engagement from students during online school in the form of struggling to focus and decreased motivation (see Figure 12). In calculating the correlation coefficient for the relationship between students' engagement level and cognitive wellness, a weak negative correlation was revealed between higher engagement levels and increased cognitive wellness. Due to the opposing nature of the wording of these two questions, we suppose that there is a minor positive relationship instead, therefore supporting our prediction.

In addition, McManus et al., (2017) notes that students with cognitive impairments can be more susceptible to feeling isolated from the institution if their needs are not met; this means that if the basic psychological needs of students are not met, it could lead to feelings of estrangement. Therefore, the need for relatedness would also be unsatisfied, creating a perpetuating cycle of compromised cognitive wellness. To be clear, this is not an effect that would impact every student experiencing negative outcomes in cognitive wellness, but this certainly displays the possible additive and cyclic effects of these negative impacts if students live with a mental illness. Moreover, Chen & Jang (2010) find that fulfillment of one's basic psychological needs is the strongest positive predictor of learning outcomes in an e-learning setting. This elucidates that academic success is contingent upon cognitive wellness through the fulfillment of the basic psychological needs of students.

Stress Level

When students were asked if online classes are more stressful than in-person lectures, approximately 75.4% of our respondents agreed with this sentiment that online learning is more stressful (see Figure 3). We believe that stress is most directly linked to cognitive wellness in comparison to our other areas of well-being. As Yang et al., (2020) suggests in their study on the pandemic's effects on students, stress is linked to poor cognitive health outcomes, and this is punctuated by the use of resilience to mediate the negative mental effects of the COVID-19 pandemic. Stress was included as a research factor in this study due to an inherent lack of this investigative approach in the existing literature (Im & Kang, 2019). As Im & Kang's (2019) research shows, perceived stress is linked to increased motivation, which should consequently result in more academic satisfaction, participation, or achievement. However, the data from our study does not support that more stress may lead to positive learning outcomes—in fact, our results showed the exact opposite. Therefore, we can conclude that the increase in students' perceived stress is subsequently decreasing their overall cognitive wellness.

Moreover, Im & Kang (2019) theorize that decreased stress during home learning may be due to at-home testing being less stressful than in-person testing. Given that students expressed disdain for the shift to online education (see Figure 7) and the online proctoring that comes with online tests, we can conclude that students are in fact more stressed while engaging in online learning at home. As our results indicate, this negative effect could be prevented with the improvement of online education. In our results, a positive correlation ($r = .44$) (see Table 2) between stress and education quality was revealed, which would suggest that as stress increases, education quality diminishes. In turn, this also means that stress decreases as education quality improves; thus, enhanced online

learning can mediate the negative effects of stress on cognitive wellness. This is a significant finding as it touches on the collaboration between cognitive wellness and academics to achieve better well-being.

Identity Segregation

In order to capture the salience of identity in our research, respondents were asked to indicate the level of segregation between their identities. Consequently, most students (approximately 60.7%) communicated that their identities were less distinguished now than prior to the pandemic and online education. It is important to note that there was a substantial number of participants that did not provide a response (*N/A)* or chose *neutral* for this question (approximately 29.6%), possibly indicating confusion with identifying segregation between identities. Nonetheless, our data proves that the divide between identities is dissolving for most of our participants and this effect can lead to unique negative impacts on cognitive wellness.

Thoits (1983) states in their research that subjective commitment—the attached importance of each role—expands as identities continue to overlap. As a role becomes more important, this may require more time from students as a result, but the qualitative portion of our results indicates that students are already frustrated with the time-consuming nature of online learning. Additionally, student interpretations of identity salience are drastically shifting during these times. Our theory section highlights how understandings of time allocations and salient identities may change alongside role importance; the collaboration of these factors can result in negative outcomes. This helps us conclude that due to the increasing importance of their overlapping identities, students could potentially feel additional negative impacts on cognitive wellness.

Furthermore, there are added benefits to having segregated identities, such as the ability to amplify one's assets, advantages, and rewards. These additional benefits of segregated identities diminish when roles are non-segregated (Thoits, 1983). Thus, we can deduce that students with non-segregated identities are negatively impacted more as a result of online learning, adding to the overall negative effects on cognitive wellness.

Identity theory also guides the interpretation of this question in that it offers perspective as to why student identities are less segregated; the data suggests that the "student" identity has most likely become more salient, given that role distinction is becoming harder for students and identity theory states that salient identities can be enacted at any given time (Stryker & Burke, 2000). The added lack of spatial distinction to further distinguish identities has likely pushed the "student" identity to the forefront and blurred the line for when identity enactment should begin and end. These sudden changes to the student lifestyle have seemingly added stress to the lives of students given our research results that explicitly show increased stress due to online learning (see Figure 3) and show negative impacts across all four planes of well-being measured in our study.

Motivation

Initially, our study intended to observe motivation under cognitive wellness, though after considering that motivation may affect all four areas of well-being it was included as its own variable. In two separate questions, students were prompted to share if their motivation has been negatively affected by e-learning and if the source of their motivation is linked more to internal or external sources. Respondents mostly strongly agreed

(59.0%) (see Figure 12) that their motivation has been negatively affected and nearly half of our participants (approximately 47.5%) (see Figure 13) disagreed that they engage in internal motivation more than external motivation during online learning.

Lastly, motivation is also an important measurable variable because it serves as a theoretical basis for SDT. The data shows that students feel most encouraged to complete work due to extrinsic motivation—a facet of controlled motivation—meaning external pressures such as late penalties or receiving good grades (Deci & Ryan, 2008a). As discussed in the results, autonomous motivation, which uses intrinsic motivation, produces benefits like increased psychological well-being and enhanced academic performance that are not reflected by the use of controlled motivation (Deci & Ryan, 2008a). Thus, the increased controlled motivation discovered in our data could denote additional negative outcomes under cognitive wellness.

This finding (see Figure 13) would suggest that students are seemingly less engaged in the content since they feel less inclined to complete work with the goal of self-satisfaction. Our data exhibits this proposed decrease in engagement level through the observed minor positive relationship between cognitive wellness and engagement level. As previously stated, decreased engagement also signifies a lack of relatedness which indicates insufficient satisfaction of one's basic psychological needs. Therefore, a lack of motivation in students may point to unsatisfied basic psychological needs as well as decreased engagement levels, furthering the negative impacts online learning has had on students' cognitive wellness.

As these findings would suggest, the cognitive wellness of undergraduate students at McMaster University has decreased. This apparent change in cognitive wellness is observed in increased stress levels, struggling identity segregation, and increased mental fatigue. Furthermore, approximately 80.3% of participants answered that their cognitive wellness has not improved since beginning online learning, revealing how students perceive their cognitive wellness. Overall, our data points towards students experiencing negative outcomes under the area of well-being of cognitive wellness.

Physical Well-being

The effect of online learning due to the COVID-19 pandemic on physical well-being has been deemed to be overall negative, although positive aspects were also reflected from our research. To better understand the effects of online learning on physical well-being, similar to the previous section, references to BPNT will be beneficial. The psychological needs suggested by BPNT, including autonomy, competence, and relatedness, should be met in order to achieve positive cognitive well-being, which is further impacted by physical well-being (Van den Broeck et al., 2016). In addition, this theory of motivation in relation to the environment is closely related to our area of study, as the environments that students are familiar with learning in have drastically changed due to the COVID-19 pandemic. Moreover, it is worth mentioning that no theory in discussion can be fully and directly applied to physical well-being as this area of study can be deemed relatively new in relation to online learning. Regardless, we have included this measurement because of its determined importance to the subject at hand, which has been exhibited in showing statistically significant results to the overall well-being of students in online school.

Firstly, one of our questions that was designed to measure participants' physical well-being asks individuals to consider if they have been sick less during online school than when attending in-person classes (see Figure 4). Results to this question had slightly higher levels of dispersion, with approximately 55.0% of participants showing agreement that they have been sick less during online school in comparison to in-person classes. Although this does show a positive impact on physical well-being, these results may not be in direct relation to schooling. Furthermore, other factors that lead to sickness could have affected the participants and their responses, such as external pre-existing illnesses. This question poses a possible increase in physical well-being, but the number of participants who disagreed or remained neutral to this statement (approximately 45.0%) should be noted. Limitations for this question include the possible over-simplicity of its wording, as it does not specify or consider the severity of the sickness. In addition, participants may have grappled to recall the number of times they were sick last year in comparison to the present, which may have undermined the reliability of these results. Additionally, the COVID-19 pandemic has decreased human interaction and increased hygiene and sanitation practices, and these results may be influenced by this general shift in society. The effects of online learning on physical well-being is a relatively new subject of study and resources examining this subject are lacking both in our analysis and existing research. This area is identified as an understudied factor of online learning and although results to this question may be perceived as positive, further research needs to be conducted on the association between online learning and physical wellness.

Another question aimed to measure the effects of online learning on physical well-being asks whether participants' energy levels have decreased since beginning online classes compared to being enrolled in-person. Most participants *agree* or *strongly agree* with the statement, indicating that online schooling has a negative effect on participants' energy levels. This reduction in energy levels may be explained by the lack of social interactions and movement that would be present on campus or in the classroom.

Additional questions that demonstrated a negative effect on physical well-being ask participants whether they have experienced eye strain, neck/back strain, and headaches due to online classes (see Figure 5). When participants were asked if they have experienced these strains and headaches, most participants reported either *agree* or *strongly agree*, that they have experienced these declines in physical well-being. These results indicate a negative impact of online learning on physical well-being. We can interpret these results as being caused by several factors, the most plausible ones being a possible decrease in physical activity due to the pandemic, as well as increased time spent immobile on a computer screen. The possible eye strain and headaches experienced by most of our participants could be attributed to this increased amount of time spent on virtual screens, while the neck/back pain experienced may be attributed to the lack of physical activity participants would otherwise have when classes were in-person.

The overall themes observed from our results of the impacts of online learning on physical well-being are overwhelmingly negative, although some positive effects exist. It is significant to note that participants are not necessarily getting sick as much, however this can be attributed to the shortcomings of our question as well as participant isolation due to the current pandemic. Most of our participants have been experiencing negative effects on their physical health in terms of an increase in physical strains due to online

learning, including back strain, neck strain, eye strain, and headaches. This significant insight illuminates the need for further research on how to prevent such negative impacts on physical well-being in online schooling, along with possible solutions to aid students who have previously or are presently suffering from a decrease in physical well-being.

From our research, it can be proposed that the decrease in energy and increased eye strain that students experience can possibly be explained by the increase in workload and the amount of time spent on electronic devices for online school. In respect to literature, further research needs to be conducted on the effects online learning may have on physical well-being. However, our research may provide significant insight to the possible strains and effects that online learning poses on physical health, in addition to the possible effects that decreased physical health poses on well-being.

Interpersonal Relationships

As previously mentioned, the effects of online learning due to the COVID-19 pandemic on interpersonal well-being were negative overall. These results can be further interpreted by looking at some of the theories used to guide our research, as well as comparing our results to other literature on the topic of online learning. The theory that best aids in interpreting the results surrounding interpersonal relationships is BPNT. To interpret the effects on interpersonal relationships, we look at the concept of relatedness specifically as it refers to the "need to feel connected [...] that is, to love and care for others and to be loved and cared for by others" (Van den Broeck et al., 2016, p. 1199).

Additionally, relatedness can be used as another explanation for the negative effects on interpersonal well-being in terms of the meaning-making process within social interactions, as elaborated on in SI. Because most social interactions have moved from in-person to technological means of communication, the meaning-making processes within interactions have changed, which may cause participants to feel less connected to friends and family, therefore, resulting in the inability to fulfill relatedness needs.

The first question designed to measure interpersonal well-being asked about how often students reached out to faculty for assistance during online schooling. As mentioned in the results section, the responses did not significantly lean one way or another. However, the disparity of responses may reflect a need for a more accessible support system for students that emphasizes clarity, accessibility, and reliability during online courses. This would provide a more readily available outlet that holds a space for more connection and could lead to positive outcomes on interpersonal well-being. This is reflected in the literature as Fang et al. (2019) noted that when students engage with others within the context of online learning, their need for relatedness is fulfilled.

Moreover, we included a question asking students if they felt more connected to their family and friends during online classes compared to in-person classes (see Figure 6). Approximately 90.1% of participants disagreed, stating that they did not feel more connected to these relationships. The results of this question can provide insight into the effects of the pandemic more broadly, as online education has been a result of the pandemic and the need to isolate from others. Online education in an environment without COVID-19 – where seeing family and friends would be more accessible – may not have as negative of effects on students. However, online learning due to COVID-19 has served to make students feel disconnected and experience a decrease in relatedness to their loved ones; thus, leading to students' dissatisfaction with interpersonal relationships and

negative effects on their interpersonal well-being. As noted in the literature review, Vlachopoulos & Makri (2019) postulate that students feel isolated during distance education and their findings suggest that these feelings of isolation are significantly impacted by a lack of interaction via online learning. The additional feelings of isolation due to the pandemic suggest that the psychological need for relatedness is not being met, leading to a negative impact on students' interpersonal well-being.

Furthermore, we included a question asking if participants are communicating less with their friends and family during online classes in comparison to in-person classes and the overwhelming majority (approximately 91.8%) agreed with the statement. Interpersonal well-being refers to the daily interactions an individual has with others, and their quality, which is subjective. However, we interpret that the results of this question indicate another negative impact on interpersonal relationships, as it can be assumed that a depletion of social interaction overall means relatedness needs are not being properly met. Another explanation for the lack of communication can be related to our results that indicate participants are experiencing difficulty with identity segregation. This means that participants may be having difficulties prioritizing social identities over academic identities, therefore they may not be able to communicate as consistently as they would pre-online education. This leads to a decrease in well-being as well as potential negative effects on cognitive wellness.

Our data analysis displayed a statistically significant relationship between interpersonal well-being and cognitive well-being. Therefore, the negative impacts of online learning on interpersonal relationships may also lead to negative impacts on cognitive wellness, and vice versa. Moreover, the decrease in communication could be caused by multiple factors; one may be perceived stress due to an overwhelming workload, which was a common theme that emerged in the qualitative thematic analysis, leaving less time for meaningful communication with loved ones. Another reason could be due to the general effects of the pandemic; as many people find themselves with little to do, conversations become more repetitive, mundane, and unsatisfying, therefore causing the need for relatedness to be unmet.

The final quantitative question designed to measure the impacts of online learning on interpersonal well-being asks participants if being in online school has allowed them to increase the amount of time they spend with their family. Similar to the first question, the results did not significantly lean one way or the other. This leads to a possible limitation in our research as our question may lack clarity in this regard. The term 'family' can be quite ambiguous as some may interpret this as only immediate family, while others may consider extended family when answering this question. Therefore, it was difficult to determine overall how interpersonal well-being was affected in terms of how much time participants had been able to spend with their families.

Additionally, one of the common themes that emerged from our qualitative question provided some insights into the effects of online learning on interpersonal well-being. This question was intended to explore whether students had any recommendations for improvement of the delivery of online courses. One of the most prevalent themes was that content delivery should be more interactive or synchronous, as opposed to pre-recorded asynchronous lectures, which is the method that most professors have been using. As previously mentioned, interpersonal well-being does not only refer to the frequency and quality of interactions with those who are close to us, but the frequency

and quality of interactions that we have daily as well. Based on 37.8% of our participants suggesting more interactive content delivery as an improvement to be made to online learning, this may indicate that their need for relatedness is not being met as much as it was when students were able to attend classes in-person.

If students are restricted to online classes, it would be most beneficial to their well-being if virtual classes were conducted as similarly to in-person classes as possible. Moreover, this was reflected in the literature, specifically Vlachopoulos & Makri (2019) who explored how different types of interaction influence students' experience with online learning. The authors investigated three types of interactions: peer interaction, facilitator-learner interaction, and learner-content interaction. Vlachopoulos & Makri (2019) propose that in order to increase facilitator-learner interaction, students should be provided with frequent feedback, discussions, and continuous encouragement. Moreover, to enhance learner-content interaction, the learning process should be as interactive as possible (Vlachopoulos & Makri, 2019). In other words, the literature suggests that for an enhanced experience in participating in online education, the level of interaction between the students and their teachers should be maximal.

In summary, students are experiencing a disconnect with their friends and families as they have also been communicating with them less. Further, the findings of Vlachopoulos & Makri (2019) are aligned with our results in that they both suggest that students' online education experience and well-being will improve with as much interaction as possible. Moreover, we propose that interpersonal well-being was negatively affected by online learning due to COVID-19, caused ultimately by the psychological need of relatedness not being met. Due to relatedness needs not being met, we can assume that this will lead to further negative impacts on cognitive wellness alongside interpersonal well-being.

Academics

As McMaster's undergraduate students have transitioned their learning from in-person to online learning due to the COVID-19 pandemic, their academic well-being has been negatively impacted. As students are forced to complete all their academics at one location, at home, our study has revealed that education quality has declined, online schooling is more time consuming, and there is a need for improved delivery methods. To further interpret this study's findings, this section will follow the theoretical perspectives of SI, identity theory, SDT and BPNT.

As previously mentioned, our study for academic well-being focused on comparing learning experiences between online learning and in-person classes, students' preferences for content delivery, ability to stay on-task, time spent on completing schoolwork, education quality, academic achievement satisfaction, academic performance/grades, and engagement level. This section will discuss the broader significance of these findings including the qualitative results that suggest a desire for reduced workload and content, a more interactive content delivery method, a modified participation method, and dissatisfaction with anti-cheating software.

Preferences for Education Delivery

While measuring to determine preferences of the education delivery method, our study tested participants' engagement levels. Findings showed that most participants (85.2%) reported experiencing difficulty staying on-task while doing schoolwork compared to in-

person classes. Difficulty staying on-task might have a negative impact on participants' academics as participation and engagement levels are also closely connected with one's intrinsic motivation, a necessary element when completing online courses (Fang et al., 2019). Additionally, participants may have difficulty staying on-task completing schoolwork in their home environment due to competing identities that previously would not have been a problem pre-pandemic. For example, according to identity theory, since salient identities are central to the individual's identity, they may be enacted at any given time (Stryker & Burke, 2000). This could inhibit students from prioritizing their student identity as competing roles such as parent or caregiver may take precedence.

When asked if participants had any recommendations for improvement in the delivery of online courses, 37.8% recommended an interactive content delivery method (see Figure 11). Synchronous lectures over asynchronous lectures are one solution for interactive content delivery as synchronous lectures occur at a pre-set time every week, similar to how in-person classes would take place, while asynchronous lectures can be completed at the discretion of the student. This aligns with our results that show how most of our participants expressed a preference of traditional in-person lectures over online classes. Particularly, 68.9% of our participants preferred in-person lectures over online lectures (see Figure 7). While in-person lectures are not currently an option due to the COVID-19 pandemic, synchronous lectures are the closest to in-person learning in comparison to asynchronous. Synchronous lectures are beneficial for students as they can interact with professors and peers in real-time, and previous research shows that having a live instructor can help eliminate the barriers to communication that often arise in online education (Vlachopoulos & Makri, 2019). Asynchronous lectures, however, are a more inclusive method as participating in lectures at a predetermined time may be difficult for international students. As for learner-content interaction, this can be enhanced by providing clear instructions and having the learning process be as interactive as possible, which was also highlighted in the interpersonal relationships section (Vlachopoulos & Makri, 2019).

Some participants (8.1%) also recommended a modified participation method to improve the delivery of online courses (see Figure 11). While the results are not significant, they are worth noting as participants raised concerns of technical issues, accommodating international students and time consumption. Being graded for attendance-based participation adds cognitive strain onto international students as it may require them to adopt an unhealthy sleeping schedule to accommodate class attendance. Moreover, the potential for technical issues to arise also makes attendance-based participation challenging. In terms of class participation, some students believe that participation evaluations are time consuming, although this experience is subjective.

The data shows that engagement level and social interactions between students and/or facilitators greatly increases learners' participation (Cho & Cho, 2014; Fang et al., 2019). According to BPNT, autonomy is related to students' participation or engagement level in that it has a weak but positive relationship with an individual's engagement during online courses (Fang et al., 2019; Chen & Jang, 2010). Specifically, peer-to-peer interactions have been suggested to facilitate participation such as answering discussion questions to encourage collaboration on a voluntary basis (Vlachopoulos & Makri, 2019). While some participants might not enjoy participation in their online courses, it would be beneficial for students' engagement levels as it provides them with an opportunity to

engage in interaction with instructors and peers which is significant as all interactions have been heavily depleted due to the pandemic's stay at home order.

Time Consumption

The majority (65.6%*)* of participants perceived to spend more time completing schoolwork during online learning. These findings are aligned with the qualitative results where participants (62.2%) recommended a reduced workload including reduced course content for the improvement in the delivery of online courses (see Figure 11). If students are spending more time on their schoolwork and would like the quantity of the workload and course content to be reduced, this suggests more than half of the students are overwhelmed with their current workload. This might be due to the difficulty with the transition process between traditional in-person lectures and online learning. Due to the unexpected occurrence of the COVID-19 pandemic, students were forced to adjust their learning method in an urgent manner which was likely to create a higher level of stress and anxiety. It is necessary to take this into consideration when designing future online lectures and/or learning programs.

Education Quality

When testing for education quality, almost half of the participants (46.0%) perceived that the quality of online education has decreased compared to traditional in-person courses (see Figure 8). This is worth noting since the quality of course content is a valuable determinant of students' motivation levels (Im & Kang 2019). When motivation levels were tested, most participants felt their motivation levels were negatively affected by online classes, allowing us to conclude that motivation has been negatively impacted by online learning. This shows that our findings, the reported decrease in education quality paired with participants' lower motivation levels, aligns with Im & Kang's (2019) research. This is further supported as our results show motivation was statistically significant with education quality and education satisfaction, allowing us to further conclude that participants' decreased education quality and decreased motivation levels lead to decreased education satisfaction overall. Although it is important to note, results might also be due to extraneous variables such as the increased strain that the pandemic has had on the global community, which should be taken into consideration in further studies.

As the literature suggests, motivation is a salient measurable factor because it directly affects both in-person and online learning outcomes (Yeh et al., 2019; Chang et al., 2013). With the general negative impacts students have been experiencing, the results and literature point to a lack of motivation fueling the negative learning outcomes in students. Furthermore, students expressed that they were unimpressed with the quality of their online education, which raises the question: could this be the reason why students are less motivated? Considering how the literature supports the relationship between motivation and learning outcomes, it is clear that motivation plays a big role in the analysis of student well-being. Hence, it is probable that the general negative impacts of online learning experienced by McMaster students are, in part, due to waning motivation, or the increased amount of extrinsic motivation being used. Additionally, research by Im & Kang (2019) states that students' achievement goal orientation can affect motivation levels. Students expressed in the quantitative portion of the study that they are not putting in

more effort for online school, thus this could also reflect being less motivated for online school.

Academic Achievement Satisfaction

When surveyed on academic achievement satisfaction, the opinions of the participants were evenly distributed with a minor incline towards feeling dissatisfied with academic achievements since being in online school, compared to in-person classes (see Figure 9). Learning/academic satisfaction involves the level of joy and satisfaction students feel during their learning experience (Topala & Tomozii, 2014). Previous research by Im & Kang (2019) discloses that the most prominent determinant for academic achievement is learning satisfaction. Additionally, course satisfaction is also frequently connected to motivation (Chen & Jang, 2010). Dissatisfaction with academic achievements indicates that BPNT's three components of psychological needs are not being met (Fang et al., 2019). It is important to consider when discussing academic satisfaction, the possibility that students are not feeling contentment with their academic achievements due to the transition to online learning.

On the other hand, when asked if participants had any recommendations for improvement in the delivery of online courses, 8.1% recommended a different kind, or removal of anti-cheating software (see Figure 11). Although these results are insignificant, they are worth noting as participants reported concerns of privacy invasion. If students feel uncomfortable with proctoring technology, it may have implications on their academic satisfaction. We also know that a student's sense of satisfaction affects their level of motivation (Im & Kang, 2019) which is supported in our research as we had a statistically significant relationship between motivation and academic satisfaction. Motivation can also be affected by autonomy, however, we failed to measure this variable, so it would be beneficial for future research to focus on this area. Further online learning-related studies are suggested to examine whether there is a notable impact of anti-cheating software on students' well-being.

Academic Performance/Grades

Majority of participants (37.8%) reported that their academic performance/grades was unaffected by the switch to online learning, although for some students there was a decrease in academic performance (24.6%) and for some an increase (27.9%) (see Figure 10). Students' performance levels directly reflect their motivation levels, specifically the extrinsic motivation that comes from completing schoolwork for a grade reward, which is also mentioned in the literature review (Deci & Ryan, 2008a). Our data shows that almost half of our participants reported an increase in using extrinsic motivation (47.5%) (see Figure 13). Another factor influencing students' motivation levels is achievement goal orientation (Im & Kang, 2019). Since achievement goal orientation is the main factor affecting the individual's decision of how and why they should participate in specific learning activities, students might be reluctant to go above and beyond in virtual learning assessments due to decreased levels of motivation, or rather, increased levels of extrinsic motivation (Im & Kang, 2019).

Furthermore, students would be more likely to experience difficulty achieving academically while learning online if their psychological needs of autonomy, competence and relatedness are not met (Van den Broeck et al., 2016). For online learning to be

comparable to in-person lectures, more effort needs to be devoted towards education quality and improvement by instructors and/or the institution. Our data reflects that most of our participants were either neutral or satisfied with their academic achievements since online learning and their performance had been similar since online learning compared with the past. This could in part be due to the worsened education quality of online learning and the need for improvement.

To conclude, academic-related measures appear to be one of the crucial determinants that contribute to the negative impact of online learning on McMaster's undergraduate students' well-being, especially cognitive wellness. This section highlighted the following academic themes: preferences for education delivery, time consumption, education quality, academic achievement satisfaction and academic performance/grades.

Conclusion

Overall, the effects of online learning due to the COVID-19 pandemic on the well-being of undergraduate students at McMaster University have been overwhelmingly negative. The impacts of switching to online learning during the COVID-19 pandemic have been explored as they pertain to each facet of well-being: cognitive, physical, interpersonal, and academic. Firstly, the cognitive wellness of students has been negatively affected by the unexpected change to online learning. The results of our questions measuring cognitive wellness evidently display struggles with identity segregation, lack of motivation, increased stress levels, and mental fatigue. Additionally, most students perceived having unimproved cognitive wellness. BPNT guided us in finding a link between cognitive wellness and academic success, also highlighting a significant relationship found in our results that allows us to conclude that improved online learning mediates the negative effects of online learning. Using SDT and identity theory, we discovered that the non-segregation of identities observed in the student population could have additional negative implications on cognitive wellness.

Further, the effects of online learning resulted in a decrease in physical well-being among our participants. Although the results show our participants have been sick less during online school in comparison to in-person classes, this may be attributed to the over simplicity of this question or difficulties with recall undermining the reliability of this question. Regardless of these factors, most of our participants indicated a decrease in physical well-being, as demonstrated by most of our participants experiencing physical strains due to online learning (eye strain, neck/back strain & headaches). Through the perspective of BPNT, we examined physical well-being in connection to cognitive well-being, and discussed the lack of direct connection between the discussed theories, the literature, and physical well-being.

To continue, the effects of online learning due to COVID-19 on interpersonal relationships and well-being have been overall negative. In general, students are feeling less connected to peers, friends, and family. Moreover, most of our participants supposed that they are communicating less with others including peers, friends, and family, which we argue may be due to perceived stress, as well as isolation and the mundane lifestyle caused by the pandemic. We use BPNT to further explain these results, as the decrease in interpersonal well-being can be explained by the psychological need for relatedness not being met due to the constraints of online education due to the pandemic.

Furthermore, since transitioning from in-person classes to online learning, students' academics at McMaster University have been negatively impacted overall. Students are having more difficulty staying on task, spending more time completing online schoolwork, reporting decreased motivation levels, decreased education quality, and decreased overall education satisfaction. Additionally, we found that students ultimately prefer traditional in-person classes to online classes. Online learning during the COVID-19 pandemic has had a negative impact on overall levels of motivation, including an increase in the use of extrinsic motivation. We conclude that lower levels of motivation lead to worse well-being among students in our sample. SDT and BPNT were used as frameworks guiding this area of study to determine the types of motivation being utilized by students and the impact that these have on well-being. The increase in controlled motivation observed in our data denotes additional negative outcomes under the categories of cognitive wellness and academics.

Limitations

Despite our study being very relevant to the current moment in time and yielding some significant results, there were limitations to our research. Three main limitations were identified as a lack of generalizability, issues with the survey questions, and a failure to properly measure autonomy and competence. Additionally, we found that some relationships between variables were statistically significant, but these findings are limited by the reality that just because there is a significant relationship does not mean there are real effects between variables. For example, our significant relationship between gender and interpersonal relationships was discounted due to the small sample of male participants, since it is not representative of the male undergraduate population at McMaster University.

The theme of lacking generalizability is apparent across our findings and in our research. Overall, our sample was skewed to represent the perspectives and experiences of female fourth year students who are twenty-one years of age in an undergraduate program at McMaster University in one of the following faculties: Social Sciences, Science, DeGroote School of Business or Health Sciences. The size of our sample also served as a limitation. With only 61 participants, it is difficult to generalize these results to even the general population of undergraduate students at McMaster University, let alone the general population of undergraduate students in Canada. The confinements of completing this research within the post-secondary institution of McMaster University also undermines the generalizability of our results to the larger population. Though, understanding the first-hand experiences of these students is still valuable and significant as it provides useful insights into this area of research and its impacts on well-being.

Secondly, there were a few issues with some of the questions in our survey. For example, some questions yielded seemingly random results as they did not significantly lean one way or the other. One question that was meant to measure interpersonal well-being was asking about time spent with family, while the other was meant to measure physical well-being and was asking if participants have been sick less than the previous year. In both cases, the terms "family" and "sick" are quite ambiguous, therefore participants may have interpreted the questions differently, which may explain the irregular results. Moreover, we failed to properly measure the effects of disability on well-being with the additional barrier of online education as the results had many *neutral*

responses and non-responses (*N/A*). We believe this was due to the possibility that most participants may not experience disabilities, therefore, did not feel comfortable answering this question. Furthermore, the way in which some of the questions were worded to avoid bias made it difficult, at times, to determine the direction and strength of correlations during data analysis.

Lastly, our research failed to adequately measure the psychological need for autonomy and competence. In our initial plan for our survey, we intended to include measures for autonomy and competence, but during data analysis we determined that our measures were not sufficient to measure our predictions. Our speculation for autonomy stated that an increase in this variable would also improve the cognitive wellness of students, and the competence speculation expressed the same relationship should occur. After analyzing our survey results, we noticed that our measures for these variables did not accurately reflect the effects of these factors. As a result of this discrepancy, our predictions on autonomy and competence were not able to be proven or disproven.

Future Recommendations

Lastly, our recommendations for future research primarily fall into three areas. Firstly, including a generalizable sample size to ensure the validity and reliability of the research as well as the ability to conduct hypothesis testing. This may be done by including an evenly distributed diverse sample and conducting similar research in various settings, since the sample for the current study is based on undergraduate students at McMaster University. Secondly, physical health is rarely addressed in online learning-related research. Since a limited amount of literature currently outlines the impacts of online learning on physical health, future research should include physical health as a measure in online learning studies. Finally, there is still an existing gap in disability-related research on the impacts of online-learning; therefore, more research needs to be done in the future to fulfill this need in related studies.

More accurate measures for autonomy and competence should also be included in future research to explore them as determinants of students' wellness during online learning. Further, some statistically significant relationships, such as those between motivation and students' cognitive wellness, are suggested to be further examined and strengthened in later studies as well. In summary, the future of online learning research should include a generalizable sample in terms of size and diversity. It should also address and strengthen the shortcomings and findings of this study in terms of physical health, disability-related research, autonomy, competence, and the relationship between motivation and students' cognitive wellness.

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