Effect of Optional Assessments on Student Engagement, Learning Approach, Stress, and Perceptions of Online Learning during COVID-19

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Abstract

Due to the COVID-19 pandemic, courses were forced into an online format as universities paused in-person learning and consequently, students were required to adjust to online learning. The objective of the current study was to determine the effect of optional assessments designed to promote engagement in a fourth-year asynchronous online nutritional science course. Seven optional engagement assessments were assigned and students' stress levels, learning approach, and perceptions of online learning were assessed via surveys at the start and end of the semester. A total of 79.8% (n=210) students completed all seven optional engagement assessments. Further, 56.6% (n=149) reported that the assessments helped them feel more engaged with course content. Perceived stress levels did not change during the semester. Surface learning approach scores increased from the beginning to end of the semester, whereas deep learning approach scores remained unchanged. Surface learning scores were positively correlated with experiencing more stress from organizing and maintaining a schedule, more stress associated with time management, and finding time management more challenging. Deep learning approaches were positively correlated with students feeling engaged in the course, comprehending the course content, and stimulating new ideas/perspectives. Collectively, this data demonstrates that optional engagement assessments can improve student perceptions of online learning, however, these outcomes are related to students' use of surface versus deep learning approaches.

Keywords: online learning, student stress, academic stress, learning approach, engagement, COVID-19, higher education

1. Introduction

The COVID-19 pandemic increased the prevalence of online learning in undergraduate programs due to the preclusion of in-person learning (Ali, 2020). This course format change (from in-person to online) can cause a significant disruption to student learning, as online courses can differ greatly from the in-person version (Cranfield, Tick, Venter, Blignaut, & Renaud, 2021; Zapata-Cuervo, Montes-Guerra, Shin, Jeong, & Cho, 2021). Self-regulation is an important component of student learning, and involves setting goals and the thoughts, feelings, and actions required to achieve those goals (Cohen, 2012; Zapata-Cuervo et al., 2021). Online courses tend to require a higher degree of student self-regulation, especially when the online course is presented in an asynchronous format with no set lecture time (Wang, Shannon, & Ross, 2013; Zhu, Mustapha, & Gong, 2020). Online learning can also have a negative impact on collaborative activities and discussion quality between students when conducted in a virtual setting compared to in-person learning, thereby reducing both student engagement with the course material and a deeper comprehension of course concepts (Dumford & Miller, 2018). Additionally, students may encounter obstacles in accessing the course website or virtual learning space due to technology problems such as internet connectivity or lack of computer literacy (Alqurashi, 2019). Despite these potential problems that students may face, there are identified benefits of online learning. Asynchronous or pre-recorded lectures allow students to learn at their own pace and return to lecture materials at any time (Landrum, Bannister, Garza, & Rhame, 2020; Stephens, 2012). Discussions between students, such as written discussion board activities, can be conducted at any time in online classes, thereby providing students with more opportunities to participate and connect with each other than it would be possible in a face-to-face learning environment with limited and structured time allotted for in-person discussions (Arkorful & Abaidoo, 2015; Hamann, Pollock, & Wilson, 2012). Academic performance, however, can be dependent upon factors such as engagement with the course, perceptions of the online learning environment, and student

familiarity with technology (Alvarez-Bell, Wirtz, & Bian, 2017; Gillis & Krull, 2020; Kemp & Grieve, 2014). Thus, ensuring that students have high levels of course engagement is important for success in online learning.

Student perceptions of learning can be a factor in their success and engagement with online courses. Fostering positive perceptions of the online learning environment and effectively using active learning strategies have been shown to improve student engagement with online courses (Alvarez-Bell et al., 2017; Cole, Lennon, & Weber, 2018). Further, a high degree of student-to-student and student-to-instructor communication fostered using discussion activities and increased instructor presence have been shown to improve student engagement (Cole et al., 2018; Song et al., 2004). Other factors that contribute to student engagement include comfort with online technology, self-motivation, and perceptions of course structure and content (Martin & Bolliger, 2018; Song et al., 2004). Perceptions of course structure and content can be affected by student interactions with peers, the instructor, and the content of the course itself (Martin & Bolliger, 2018). An inability to access the required technology for online learning or unfamiliarity with online learning tools can negatively impact student engagement (Adedoyin & Soykan, 2020; Song et al., 2004). Thus, student engagement is an important indicator of success in online learning and can be affected by enthusiasm, interest, and/or a feeling of belonging in the course environment (Kahu, 2011). Additionally, cognitive factors including a deeper approach to learning (Biggs, Kember, & Leung, 2001) and self-regulation (Wang et al., 2013) can also affect student engagement. Student behaviours such as time spent, effort, and interaction with the course material are also components of student engagement (Kahu, 2011; Robinson & Hallinger, 2008). Engagement with the course can be improved using small online learning activities or other active learning strategies (Beauchamp, Newton, & Monk, 2021; Hamann et al., 2012). For example, problem solving in small groups or group discussion activities, have been demonstrated to reduce academic stress by engaging students with the course content and encouraging collaboration between students (Cardozo et al., 2020; Venton & Pompano, 2021). Allowing students to choose to participate in assignments has been demonstrated to further improve engagement (Gillis & Krull, 2020; Hanewicz, Platt, & Arendt, 2017). Flexibility in assignment deadlines and choice in completing assignments have been demonstrated to be an important part of online learning, as this approach provides students with autonomy and can reduce barriers to student success in online learning, such as an unconducive learning environment at home or lack of motivation (Gillis & Krull, 2020). Students have been shown to exhibit a preference for assignments that are relevant to real-world situations instead of assignments addressing theoretical problems (Hanewicz et al., 2017; Martin & Bolliger, 2018). Further, inclusion of optional assignments in online courses have been demonstrated to improve student engagement (Holmes, 2014). Therefore, by including approaches such as assignment flexibility, student-to-student discussion, and real-world applicability in assignment design, student engagement in online learning could be improved.

Increased student stress from adapting to online learning is a concern in higher education (Biber, Melton, & Czech, 2020). Academic stress is often derived from tests and examinations that can be self-imposed or driven by external pressure to succeed and achieve higher grades (Bedewy & Gabriel, 2015). Moreover, academic stress can contribute significantly to students' overall feelings of stress (Bedewy & Gabriel, 2015). Elevated student stress can decrease engagement in courses (Kahu & Nelson, 2018) and can be mitigated by adaptive strategies such as accessing social support from friends or family, effective time management skills or the students' capacity to achieve their own goals without outside motivation (i.e., self-regulation) (Coffman & Gilligan, 2002; Cohen, 2012; Häfner, Stock, & Oberst, 2015; Misra & McKean, 2000). Higher academic stress levels have been shown to negatively impact student self-efficacy, which is important for success in online courses (Rossi, Krouse, & Klein, 2021; Wang et al., 2013). Due to the COVID-19 pandemic and the majority of students learning remotely, stress mitigation strategies such as social support were either no longer available to students or had reduced availability to help students cope with academic stress (Clabaugh, Duque, & Fields, 2021; Rogowska, Kuznierz, & Bokszczanin, 2020). Sudden course delivery changes, the transition to online-only learning, and the lack of social interactions collectively contributed to higher levels of academic stress and student anxiety related to their courses (Biber et al., 2020). Changes in outside factors such as employment status, employment opportunities, and overall health are also reported to have had negative impacts on student academic stress levels (Rogowska et al., 2020). The continued uncertainty around the duration of the pandemic and its effects on undergraduate academics remains another source of stress experienced by students (Mushquash & Grassia, 2021). Lowering student academic stress using smaller, lower-stakes assessments could represent an approach to increase student engagement, encourage a deeper approach to learning, and improve students' perceptions of online learning. Therefore, the objective of this study was to determine if optional engagement assignments can encourage students to adopt a deeper learning approach, reduce academic stress and improve their perceptions of online learning.

2. Methods

2.1 Participants, Online Course Delivery and Assessment Structure (Optional and Required Assessments)

Participants in this study (n=263) were third- and fourth-year undergraduate students enrolled in a fourth-year nutritional science course in the Winter 2021 semester. Due to the COVID-19 pandemic, the course was delivered online in the standard 12-week format with two asynchronous video lectures uploaded to the course website each week. Assessments in the course were either required or optional (worth 80% and 20% of the final grade, respectively), wherein the value of any missed optional assessment was added to the weight of the final exam. The required assessments included i) a scientific literature critical assessment (10%), ii) midterm exam (35%), and iii) final exam (35%). Additionally, there were eight optional assessments in the course, which included i) five online discussion board activities wherein students were assigned to groups (n=8/group) to discuss and apply course concepts presented in case studies and primary literature assessments (5 x 1%), ii) two practice exam question development assessments wherein students interacted with each other to design practice exam questions for both the midterm and final exams, thereby contributing to a class generated practice exam for both the midterm or final exam in the course (2 x 2.5%), and iii) a primary literature data extraction assignment on a topic related to the course content of their choice (10%). A total of seven of the eight optional assessments in the course were student-discussion based (online discussion board activities and practice exam question development assessments) and designed to be low-stakes interactive discussion opportunities to promote student engagement via interactions between students and applying the course content using case studies with real-world applicability (Hanewicz et al., 2017; Martin & Bolliger, 2018). In this connection, online discussions have been demonstrated to improve critical thinking skills and encourage a deep learning approach (Afify, 2019) and short, low-stakes assignments similar in design to the ones used in this course have been shown to improve undergraduate student engagement and retention in courses (Beam, 2021; Meer & Chapman, 2014).

2.2 Online Surveys

Two identical online surveys were conducted during the 12-week semester using the Qualtrics Insight Platform (Provo, UT, USA), distributed using private link sent to students' university email address. Survey 1 was available during week 1 of the course, and survey 2 was available during week 12 of the course. Survey questions assessed i) learning approach (i.e., surface versus deep) using the validated two-factor Revised Study Process Questionnaire (RSPQ-2F) (Biggs et al., 2001), ii) perceived student stress levels using the validated Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), and iii) researcher-generated questions adapted from Aucejo et al. (2020) to assess students' perceptions of online learning. A 2% participation bonus was added to students' midterm exam grades (for Survey 1) and a 2% bonus was added to student's final exam grades (for Survey 2). Alternative assignments were provided for students to earn the participation bonus while abstaining from the surveys. Only students who completed both surveys were included in the analysis. Out of the 293 students enrolled in the course, 263 completed both surveys, reflective of 89.8% participation in the study. This study was approved by the University of Guelph Research Ethics Board (REB#20-10-026).

2.3 Statistical Analysis

Statistical analysis was conducted using IBM SPSS Statistics software (Armonk, NY, USA). For all data, the predefined upper limit of probability for statistical significance was $P<0.05$. Values are presented as mean values with the standard error of the mean (SEM). Paired t-tests were used to determine significant changes over the semester (i.e., Survey 1 vs. Survey 2) in perceived student stress, learning approach, and influences on student stress. GraphPad Prism software (San Diego, CA, USA) was used to determine correlations between student learning approach, stress levels, and perceptions of the online engagement assessments.

3. Results

3.1 Participation and Students' Perceptions of Optional Engagement Assessments

Of the seven optional student discussion board-based engagement assessments in the course the average number of assessments completed (i.e., the assessment engagement score) was 6.2 out of 7. Engagement was high, wherein 79.8% (n=210) of students completed all seven optional assessments and all students participating in the study (n=263) completed at least one of the optional assessments (**Figure 1**).

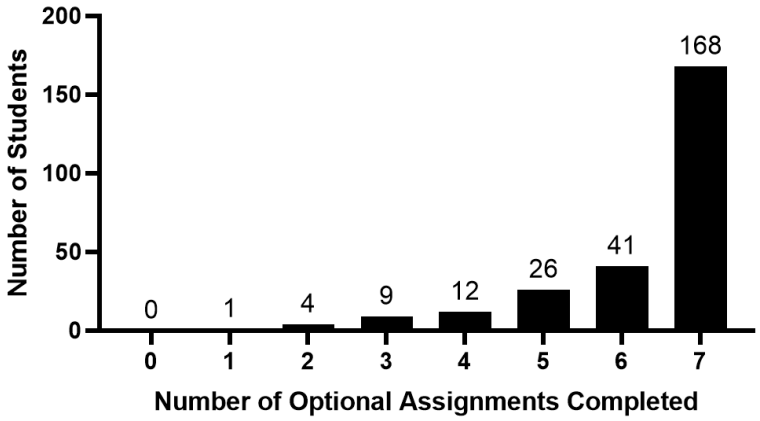

Figure 1. Student Engagement Score. The total number of optional engagement assessments that were completed by students (out of 7 total during the semester).

There was a positive correlation between the total number of optional assessments completed (i.e., the assessment engagement score) and achieving a higher final grade in the course (r=0.37, $P<0.0001$). Students' perceptions of the optional engagement assessments determined that 79.5% (n=209) had a positive experience. Additionally, 56.6% (n=149) of students reported that the discussion assessments helped them feel more engaged with the course and 64.6% (n=170) of students reported that the assessments helped to improve their understanding of the course content. Finally, 71.5% (n=188) of students in the course agreed that engaging with students in the online discussion assessments stimulated them to think about new ideas.

3.2 Perceived Student Stress

Perceived student stress assessed using the Perceived Stress Scale (Cohen et al., 1983) did not change during the semester (**Figure 2**) and remained slightly above the median stress score value of 28, however, this score is not indicative of elevated stress levels.

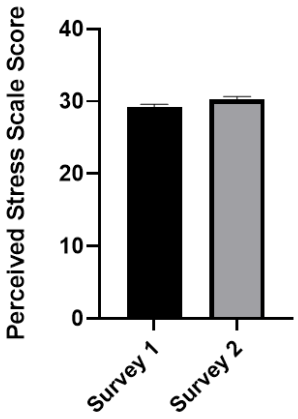

Figure 2. Perceived stress scale score at the beginning (Survey 1) and end (Survey 2) of the semester. Data are presented as means ± SEM and the maximum score of 56 was possible.

Consistently, the majority of students reported that academic stress was the primary source of stress in their lives [Survey 1: 68.6% (n=181) and Survey 2: 67.3% (n=177)]. Students' academic stress frequency at both the start and end of the semester is shown in **Figure 3**. There was no change over the semester in students' frequency of experiencing academic stress ($P>0.05$), which remained high with 60.5% (n=159) of students experiencing a high frequency of academic stress (>4 times weekly) at the beginning of the semester (Survey 1), and 62.0% (n=163) of students experiencing this same stress frequency at the end of the semester (Survey 2). When asked to compare the

academic stress experienced between online and in-person course formats, 46.4% (n=122) of students reported that online courses were more stressful compared to in-person courses.

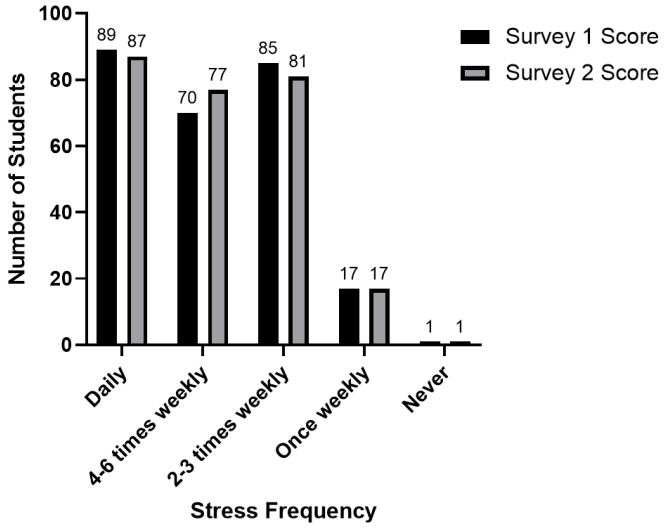

Figure 3. Frequency of students' self-reported stress experienced per week between Survey 1 (start of the semester, black bars) and Survey 2 (end of the semester, grey bars).

We developed questions to determine if the online active learning and engagement assessments affected student academic stress perceptions and coping behaviours, which could influence students' overall perceived stress levels and/or their engagement with course material (**Table 1**). There was a significant decrease in students self-reported difficulty with time management in online courses between the beginning to the end of the semester (P<0.05) and students reported needing less help and clarification regarding course content during the semester (P<0.05). All other measures did not show any change between the beginning and end of the semester.

3.3 Changes in Students' Learning Approach

Student learning approach was measured using the RSPQ-2F developed by Biggs, Kember, and Leung (2001) and the change in students' surface and deep learning approach scores during the semester are shown in **Figure 4**. Overall surface learning approach scores modestly increased between Survey 1 and Survey 2 (P<0.05; **Figure 4A**), while deep learning approach scores remained unchanged (P>0.05; **Figure 4B**). Higher deep learning approach scores were correlated with higher final grades in the course (r=0.31, P<0.05), indicating that a deeper learning approach was associated with higher academic achievement. Conversely, there was no significant relationship between surface learning scores and final grades in the course (P>0.05).

Learning approach was further analyzed according to surface and deep subcategories of i) learning motive scores, and ii) learning strategy scores. Both surface and deep learning motive scores were unchanged over the semester (i.e., no change between Survey 1 and Survey 2, P>0.05; **Figure 4C** and **4D**). Conversely, surface learning strategy scores were higher at the end of the semester (i.e., on Survey 2, P<0.05; **Figure 4E**), whereas deep learning strategy scores did not change over the semester (P>0.05; **Figure 4F**). Higher final grades in the course were positively correlated with both higher deep learning strategy scores (r=0.31, P<0.05) and higher deep learning motive scores (r=0.28, P<0.05), indicating that students who adopted a deeper learning approach and were more engaged in the course content and achieved higher grades. Conversely, surface learning motive scores were negatively correlated with final grades in the course (r=-0.19, P<0.05), whereas there was no relationship between surface learning strategy scores and final course grades (P>0.05).

Table 1. Changes in Students' Online Learning Perceptions and Academic Stress Experiences Between Beginning and End of the Semester[1]

Question	Beginning of Semester (Survey 1)	End of Semester (Survey 2)	Mean Change During the Semester	*P*-value
I find that I need more help and clarification in online courses compared to in-person courses.	4.81 ± 0.10	4.36 ± 0.10	- 0.45*	0.001
I feel that I have more independence with my learning in online courses compared to in-person courses.	5.97 ± 0.06	6.00 ± 0.06	+ 0.03	0.72
I find completing assignments for online courses more stressful than during in-class courses.	4.21 ± 0.09	4.32 ± 0.09	+ 0.11	0.38
In online learning I experience more stress as a result of trying to organize and maintain a schedule.	5.00 ± 0.10	4.73 ± 0.11	- 0.27	0.08
In online courses I experience more stress as a result of the academic workload compared to in-person courses	4.84 ± 0.09	4.84 ± 0.09	± 0.00	0.98
Time management is more challenging in online courses compared to in-person courses.	5.07 ± 0.11	4.76 ± 0.12	- 0.31*	0.05
I experience more stress as a result of challenges with time management in online courses compared to in-person courses.	4.84 ± 0.11	4.60 ± 0.11	- 0.24	0.11

[1]Data are presented as means ± SEM. Responses were measured using a Likert scale (1-7), wherein 1 corresponded to "Strongly Disagree" and 7 corresponded to "Strongly Agree". Statistically significant differences between the mean change in responses to each survey question during the academic semester (i.e., Survey 2 – Survey 1) are denoted with an asterisk (*).

Interestingly, a higher overall deep learning score at the end of the semester (Survey 2) was positively correlated with students' positive perceptions of the impact of the optional online discussion board engagement assessments (r=0.26, $P<0.001$). Moreover, higher deep learning approach scores were positively correlated with higher student perceptions of i) feeling engaged in the course (r=0.18, $P<0.05$), ii) comprehending the course content (r=0.18, $P<0.05$), iii) the impact of the engagement assessments stimulating new ideas (r=0.23, $P<0.05$), and iv) having a positive overall opinion of the course assessments (r=0.26, $P<0.05$). Higher surface learning scores were inversely correlated with students' perceptions of the online engagement assessments helping to stimulate new ideas (r=-0.14, $P<0.05$), and having a less positive experience engaging in the online group discussions (r=-0.18, $P<0.05$). Thus, students that take a deeper learning approach perceived the optional engagement assessments as more valuable versus students that utilize a surface learning approach.

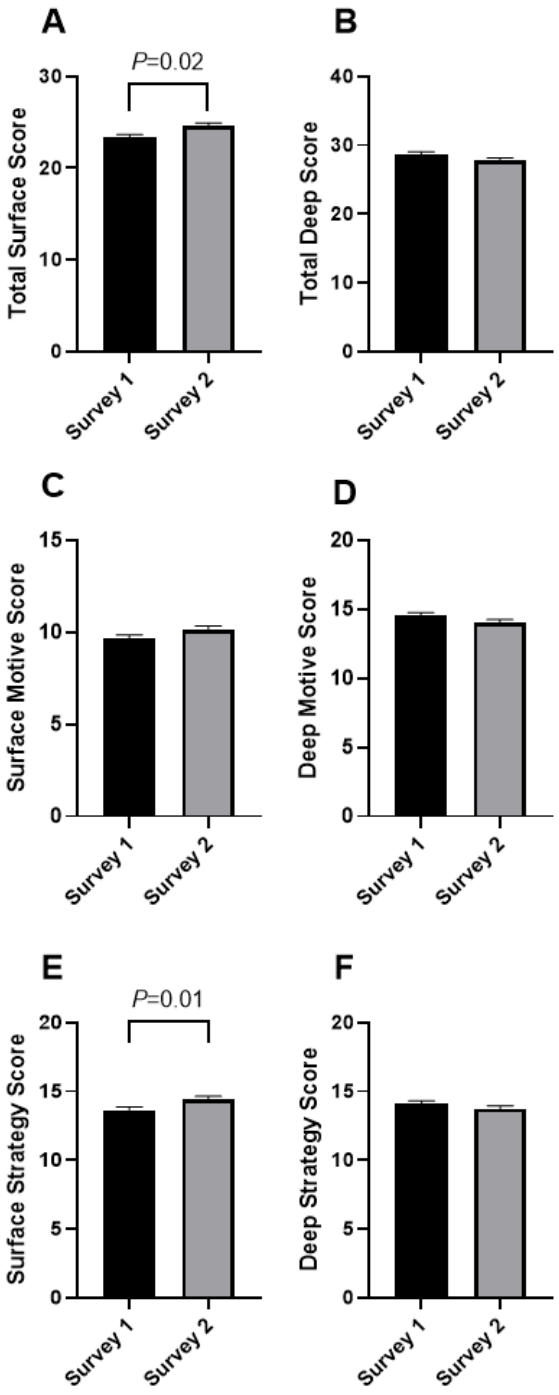

Figure 4. Changes in learning approach between Survey 1 (start of the semester, black bar) and Survey 2 (end of the semester, grey bar) including Total Score: Surface (A) and Deep (B), Motive Score: Surface (C) and Deep (D), and Strategy Score: Surface (D) and Deep (F). Data are presented as means ± SEM and statistically significant differences (P<0.05) between Survey 1 and Survey 2 are denoted with their respective P-values.

Time management is a critical component influencing students' preference for a surface versus deeper learning approach (Bickerdike et al., 2016; Biggs et al., 2001). Thus, with respect to time management capabilities, higher surface learning scores were positively correlated with i) experiencing more stress from organizing and maintaining a schedule during online learning (r=0.13, P<0.05), ii) finding time management more challenging in online courses

(r=0.14, P<0.05), and iii) experiencing more stress from challenges with time management in online courses (r=0.16, P<0.05). This indicates that surface learning approaches are related to lower time management and scheduling capabilities, which are important skills for success in online learning and determinants of self-efficacy (Wang et al., 2013). No significant relationships were found between deep learning scores and i) stress from organizing and maintaining a schedule during online learning, ii) time management difficulty in online learning, and iii) stress from time management in online learning (P>0.05). Overall, finding time management more challenging during online learning was moderately positively correlated with having an overall lower opinion of online learning (r=0.50, P<0.05), indicating that time management is an important determinant of students' opinion of online learning.

Table 2. Students' Perceptions of the Online Learning Environment Between the Beginning and End of the Semester[1]

Question	Beginning of Semester (Survey 1)	End of Semester (Survey 2)	Mean Change During the Semester	*P*-value
I find myself more distracted in online lectures compared to in-person lectures.	5.49 ± 0.10	5.49 ± 0.10	± 0.00	0.98
Compared to in-person lectures, I find online lecture content harder to understand.	3.75 ± 0.09	3.75 ± 0.08	± 0.00	1.00
When compared to in-person lectures, I feel that the inability to ask questions during an online lecture causes me to learn less.	4.56 ± 0.05	4.65 ± 0.05	+ 0.09	0.23
I feel that having recorded lectures available, even when the class is synchronous, helps me manage stress in online learning.	6.47 ± 0.05	6.37 ± 0.06	- 0.10	0.17
Compared to in-person courses, the volume of assignments during online learning has increased in online learning.	5.47 ± 0.07	5.61 ± 0.07	+ 0.14	0.16
Compared to in-person learning, overall, I find online learning to be worse.	4.50 ± 0.09	4.51 ± 0.09	+ 0.01	0.95

[1]Data are presented as means ± SEM. Responses were measured using a Likert scale (1-7), wherein 1 corresponded to "Strongly Disagree" and 7 corresponded to "Strongly Agree". Statistically significant differences between the mean change in responses to each survey question during the academic semester (i.e., Survey 2 – Survey) are denoted with an asterisk (*).

3.4 Students' Perceptions of Online Learning and Optional Engagement Assessments

Students' perceptions of online learning were assessed using both researcher-generated questions and questions adapted from Aucejo et al. (2020). Students' perceptions of online learning did not change during the semester (i.e., no difference between Survey 1 and Survey 2) as shown in **Table 2**. Overall, 76.8% (n=202) of students reported being more distracted in online learning compared to in-person learning. Comprehension of lecture content online was perceived to be more difficult compared to in-person learning by 40.3% (n=106) of students and 48.7% (n=128) of students agreed that the inability to ask questions online caused them to learn less in online courses. There was a strong consensus amongst students (97.3%, n=256) that recorded lectures were an additional resource that helped them manage their stress levels. With respect to workload, 83.2% (n=219) of students agreed that the volume of

assignments was higher in online courses compared to in-person courses, and 50.6% (n=133) of students found completing several smaller assignments instead of one large assignment to be more stressful. Overall, 58.9% (n=155) of students perceived that online learning was worse compared to in-person learning. Student perceptions of lecture speed and volume of material covered during lecture are shown in **Table 3.** These two indicators did not change significantly over the semester. There was a weak negative correlation between students finding more assignments stressful and the student engagement score (r = -0.14, *P*=0.03), indicating that students who experienced more stress from a higher number of assignments completed fewer of the optional assignments.

Table 3. Student Perceptions of the Online Lecture Environment Between Beginning and End of the Semester[1]

Question	Beginning of Semester (Survey 1)	End of Semester (Survey 2)
Compared to in-person learning, the volume of material covered per lecture in online courses is:		
Slower	0.8% (n=2)	0.8% (n=2)
The same	66.9% (n=176)	66.9% (n=176)
Faster	32.3 % (n=85)	32.3 % (n=85)
Compared to in-person learning, the speed of lectures in online courses is:		
Slower	5.7% (n=15)	4.9% (n=13)
The same	59.3% (n=156)	58.9% (n=155)
Faster	35.0% (n=92)	35.7% (n=94)

[1]Data are presented as frequency of responses.

4. Discussion

In an online asynchronous course, optional engagement assessments requiring student-to-student discussions via the online discussion board (n=8 students/group) were utilized as an engagement and active learning component. The assessments were designed as low-stakes interactive discussion opportunities between students to connect with each other and to apply their knowledge of course content using case studies with real-world applicability to promote student engagement (Hanewicz et al., 2017; Martin & Bolliger, 2018). Previously, online discussions have been demonstrated to improve critical thinking skills and encourage a deep learning approach (Afify, 2019) and short, low-stakes assignments, similar in design to the ones used in the current study, have been shown to improve undergraduate student engagement and retention in courses (Beam, 2021; Meer & Chapman, 2014). Therefore, the current study aimed to determine if participation in these optional engagement assessments influenced students' i) perceived academic stress associated with online learning, ii) learning approach through fostering a deeper approach to learning, and iii) overall perceptions of online learning. Student stress is a significant factor affecting student learning (Misra & McKean, 2000), and can influence factors such as anxiety, time management capabilities, and satisfaction with their academic life (Lee & Jang, 2015; Misra & McKean, 2000). Students with high deep learning approach scores have demonstrated higher engagement and satisfaction with course material (Biggs et al., 2001). Fostering a deep learning approach among students in online courses is especially important as engagement and student satisfaction can be lower in online courses (Biggs et al., 2001; Dumford & Miller, 2018; Platow, Mavor, & Grace, 2013). Students' perceptions of the learning environment are important to ensure academic success and to maintain engagement (Alvarez-Bell et al., 2017; Cole et al., 2018). Student perceptions of the educational quality of online courses have been shown to vary more than their perceptions of traditional, in-person courses (Lowenthal, Bauer, & Chen, 2015). Ultimately, student engagement is important for their retention in courses, and therefore, promoting and prioritizing student engagement in online learning is a critical consideration given that online courses exhibit significantly higher dropout rates compared to in-person courses (Gay & Betts, 2020; James, Swan, & Daston, 2016).

Our findings demonstrate that despite high engagement with the optional online assessments, students' overall stress levels did not change over the semester. Students' perceived stress remained constant during the semester (**Figure 2**), and average stress scores (30.3 out of 56) were similar to pre-COVID-19 pandemic scores in medical, nursing, and pharmacy students (28-29 out of 56) (Alkatheri et al., 2020). These similar scores could indicate that students are coping well with the changes brought by online learning. Most students reported that academic stress was the greatest source of stress they were experiencing, with 68.3% (n=181) reporting this on Survey 1 and 66.8% (n=177) reporting this on Survey 2. This finding is consistent with other studies reporting that academic stressors, including evaluation performance and workload, are the primary causes of academic stress in undergraduate students (Bedewy & Gabriel, 2015). However, students overwhelmingly reported that having access to recorded lectures reduced their academic stress perceptions (**Table 1**). This is again in line with other research that demonstrates the benefits of access to recorded lectures on student stress (Pilarski et al., 2009). Some strategies for effective stress management, such as social support, have been more difficult or impossible during the COVID-19 pandemic (Clabaugh et al., 2021; Rogowska et al., 2020), which could provide another explanation for the proportion of students identifying the contribution of academic stress to their overall stress levels. Other studies have demonstrated that active learning strategies, including group learning or a flipped classroom, can be used as an intervention to reduce student stress (Cardozo et al., 2020; Venton & Pompano, 2021). In the current study, however, perceived student stress remained unchanged despite the use of an active learning strategy (i.e., online discussion board engagement assessments using case studies). Future studies identifying the effectiveness of academic stress coping strategies utilized by students are required. As online course offerings become more common in higher education, analyzing the effects of academic stress in an online learning environment is important. Previously, time management skills and self-regulation have been identified to affect student stress (de la Fuente, Martinez-Vicente, Lopez-Garcia, Zapata, & Mariano-Vera, 2017; Misra & McKean, 2000). Our study did not inquire as to the sources of academic stress. In the current study, poor time management ability was positively correlated with lower opinions of online learning ($r=0.50$, $P<0.05$). Weaker time management capabilities are associated with higher levels of anxiety in students, thus, ensuring that student stress is well managed is important as students transition back into in-person learning and continue in online learning (Misra & McKean, 2000).

Learning approach is an important measure of student engagement with course content (Biggs et al., 2001). Between the beginning and end of the semester, students' surface learning approach score increased, specifically within the surface strategy subcategory (**Figure 4**). Conversely, deep learning approach scores did not change over the semester, despite high participation with the online engagement assessments (79.8% of students completing all seven assessments). Previous studies have demonstrated a link between poor time management capabilities and a surface learning approach (Bickerdike et al., 2016). Approach to learning has also been linked to students' perceptions in higher education, with students who utilize deeper approaches perceiving the course more positively (Floyd, Harrington, & Santiago, 2009). In the current study, surface learning scores were positively correlated with factors influencing stress, such as an increased difficulty in organizing and maintaining a schedule for online learning, greater difficulties with time management in online courses, and increased stress associated with time management challenges in online courses. High surface learning scores have been demonstrated previously to correlate with lower self-efficacy, which is vital for online learning (Hu & Yeo, 2020; Song et al., 2004). The surface learning approach may be reflective of students completing the minimum amount of work required to complete the course without engaging with the course content in a deeper or more comprehensive way (Biggs et al., 2001). Despite the implementation of active learning activities, such as online group discussion board engagement assessments in the current study, it is possible that other courses that were taken concurrently were transitioned to the online format without the inclusion of assessments to help promote student engagement within the online learning environment. The discussion activities used in this study were designed to have real-world applicability and a high level of peer-to-peer interaction, which are both linked to increased student engagement and satisfaction (Alvarez-Bell et al., 2017) and are also factors associated with a deep learning approach (Biggs et al., 2001). Courses that lack active engagement strategies, especially in online learning, have been shown to have low student satisfaction and engagement in the online environment (Alqurashi, 2019; Croxton, 2014), particularly when student-student interaction is low (Alqurashi, 2019). The increase in surface learning scores observed in the current study could reflect students becoming disinterested in online courses after two semesters that were comprised of exclusively online courses prior to the semester when this study was conducted. Additionally, emotional exhaustion is linked to adapting a surface learning approach, which may be experienced by students during the COVID-19 pandemic (Gonzalez-Ramirez et al., 2021; Hu & Yeo, 2020) but was not assessed in the current study. Some research has suggested that students may perceive themselves as feeling more stressed over time and that they will do poorer on examinations in an online course (Knowles & Kerkman, 2007). A surface learning approach has been linked to

higher levels of academic stress in students, particularly in relation to examinations (de la Fuente et al., 2017). It is possible that the academic stress students experienced during pandemic-associated online learning promoted the adoption of a surface learning approach.

Most student perceptions of online learning did not change significantly over the semester. Perceptions of online courses are more varied than perceptions of in-person classes and tend to be more negative if the courses are required (versus elective courses) (Lowenthal et al., 2015). In the current study, students reported feeling more distracted and unable to ask questions in learning online compared to in-person (**Table 2**). This aligns with reports of students' experiences during pandemic-associated online learning, wherein students reported feeling more distant and less connected to instructors and peers (Robb & Shellenbarger, 2021). Students also reported requiring more help and clarification in online courses compared to in-person lectures, although this improved significantly (i.e., was reduced) as the semester progressed (**Table 1**), which may be reflective of accumulated experience and familiarity with online learning over time. Familiarity with online learning has been shown to improve course satisfaction and engagement (Astani, Ready, & Duplaga, 2010; Hamdan et al., 2021). Higher self-efficacy in online courses, specifically during the pandemic, has been linked to familiarity with online tools and the number of online courses taken previously (Hamdan et al., 2021). In this connection, students reported that time management was less challenging at the end of the semester (**Table 1**). Time management has been identified as an important part of student success in online learning (Song et al., 2004), and students with poorer time management skills have been reported to find online learning less satisfying than in-person lectures (Landrum et al., 2020). It is possible that the structure of the engagement assessments and how they were scheduled during the semester contributed to the improvement in students' perceptions of the difficulty of online course time management. This improvement in time management, however, was not found to be related to perceived student stress or feelings of academic stress. Improved time management skills have been linked to decreased student stress (Misra & McKean, 2000) although this was not observed in the current study.

A limitation of the current study was the inability to compare the outcomes between the online and in-person learning environments, which was not possible due to the COVID-19 pandemic. The results from the current study were collected during the COVID-19 pandemic, which may reflect a period of higher stress, and future studies should reassess these outcomes during non-pandemic associated online learning. The students included in the current study were third- and fourth-year STEM majors, and therefore further study is required, as it is possible that the outcomes of the current study may differ across disciplines/programs of study and undergraduate year of study. Finally, students' perceptions of the optional engagement assessments will be specifically related to their experience in the course associated with this study, however, since students were concurrently enrolled in other courses their overall perceptions of online learning will vary based on the combined experiences from all online courses.

This study provided insight into how optional online engagement assessments could influence students' perceptions of online learning, perceived stress, and assist in developing deeper approaches to learning among students. This study demonstrates that online engagement activities may be a useful tool to promote student time management capabilities and independence in online courses. However, regarding students' perceptions and learning approach, more active learning strategies in addition to the online engagement assessments may need to be included in course designs to help foster a deeper learning approach. As undergraduate education shifts to accommodate more course provided in an online learning format, it is important to consider the inclusion of assessment strategies to promote student engagement and to balance course expectations with student stress and the overall learning experience.

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