Educational Assessment Experiences of College Students during COVID-19

Teresa M. Ober, Ying Cheng, Maxwell R. Hong, & Kathleen Morse

University of Notre Dame

Please address correspondence to: Dr. Ying Cheng, University of Notre Dame, 390 Corbett Family Hall, Notre Dame, IN 46556; Email: ycheng4@nd.edu; Phone: (574) 631-7649

CREDiT: M. Ober: Conceptualization, Methodology, Analysis, Writing - Original Draft, Funding acquisition; **Maxwell R. Hong:** Methodology, Writing - Review & Editing; **Kathleen Morse:** Preliminary analysis, Writing - Review & Editing; **Ying Cheng:** Supervision, Conceptualization, Methodology, Writing - Review & Editing, Funding acquisition

Acknowledgments: The authors would like to acknowledge the Institute for Scholarship in the Liberal Arts of the University of Notre Dame for providing financial support for the research described in this manuscript. Gratitude is also owed to members of the Learning Analytics and Measurement in Behavioral Science (LAMBS) Lab of the University of Notre Dame for their contributions to the broader discussion of the issues raised in this manuscript.

Data Availability Statement: The data that support the findings of this study are openly available through <https://doi.org/10.17605/osf.io/e263n>.

Statements and Declarations: The authors have no competing interests to declare.

Abstract

(178 / 200)

To better understand the impact of the coronavirus disease 2019 (COVID-19) on today's college students and tomorrow's workforce, a survey was administered to 992 U.S. college students ($Mean_{age}=22.36$ years, $SD_{age}=5.24$; $\%female=53.3$) between February and June 2021 on academic assessment practices they experienced before and after COVID-19. Though classroom assessment formats appeared to change minimally, exam administration changed markedly during the pandemic-affected period. Untimed and open-book exams became more common. Assessments administered and proctored in-class became less frequent. Interestingly, during spring 2021, as many colleges returned to in-person instruction, open-book, outside of class, and exams proctored online or unproctored remained common, suggesting a persistent shift in exam administration practices. Students generally did not feel that exams covered any less content, however, cheating was a concern. Most reported minimal changes to long-term academic plans. Those who did pointed to frustrations with educational experiences or concerns over future job prospects. These results give insight into the modifications in evaluating student learning, the experiences of students during this time, and the choices made in light of efforts to reduce disruptions to learning.

keywords: online and remote learning; national survey; COVID-19; assessment format; exam administration

Educational Assessment Experiences of College Students during COVID-19

Introduction

From a pedagogical perspective, assessment is intertwined with learning (Black & Wiliam, 2018). However, due to the circumstances surrounding COVID-19, instructors lacked the essential time to adequately plan for adjusting their assessment practices. Assessments were administered without a rigorously controlled environment, leaving many students apprehensive about being evaluated amidst such stressful circumstances (Elsalem et al., 2020), instructors unsure how to administer and interpret exams (Cutri et al., 2020), and K-12 educational institutions advised against administering end-of-year assessments (National Academy of Education, 2021). Existing construct irrelevant factors - sometimes referred to as “test pollution” (Messick, 1984) - plague uncontrolled exam administration contexts and are concerning in normal circumstances (Haladyna & Downing, 2005; Wise, 2019). During the pandemic this has been compounded by additional complications, including students’ heightened stress, anxiety, illness, learning in a drastically different modality than taught ever before, and an increased likelihood for falling behind due to lack of access to adequate course material or internet-enabled devices (Middleton, 2020). Given recommendations of the U.S. Center for Disease Control for contingency planning to prepare for the uncertainty of future emergency teaching contexts (Anderson, 2020), as well as anticipated shifts toward online and remote educational practices (Tesar, 2020), instructors are encouraged to prepare for the possibility of online instruction in future semesters (see Bhagat & Kim, 2020). However, there have been few investigations into how classroom assessment practices have changed as a consequence of the pandemic, e.g., adjusting assessment format, changing exam administration from paper-based, proctored, to online, at home, without proctoring, and what challenges or concerns such changes entail,

particularly in postsecondary education. Especially considering the lapses in the quality of classroom assessment and gaps in standardized testing programs, it may be difficult to gauge learning loss. As such, the lack of research on online remotely administered assessments and their prevalence during the pandemic is concerning (James, 2016; Pagram et al., 2018).

Difficulty Gauging the Long-term Impact of “Learning Loss”

Basic cognitive skills, particularly in math and science, are not only significantly associated with the financial stability of individual students, but in aggregate are also long-term determinants of a nation's economic growth and thus of the long-term prosperity of a society (Hanushek & Woessmann, 2008, 2012). The equivalent of one year of learning loss is projected to result in a 4.3% reduction in a nation's future discounted GDP, with a long-run GDP decrease of 7.5% in the year 2100 (Hanushek & Woessmann, 2020).

Many college students appear to be aware of missed opportunities in making academic progress, with research indicating that fear of academic learning loss was significantly associated with students' psychological distress (Hasan & Bao, 2020). Finding ways to remediate the learning loss is imperative. However, understanding the magnitude and scope of learning loss requires accurate assessment of student learning, which necessitates clear understanding of how learning has been assessed since the pandemic broke out. At present, there is little understanding of how assessment practices have changed under COVID-19, and whether the changes further marginalize students from underserved groups. On the other hand, it has been reported that online assessment, a trend that has been observed amidst the COVID-19 pandemic (Auxier & Anderson, 2020; Horowitz, 2020), is most likely to negatively affect students who are already socially or economically disadvantaged (Hanushek & Woessmann, 2020; Heckman, 2006), due partly to the so-called “digital divide” between individuals on certain key demographic

characteristics (Hansen & Reich, 2015; Tsetsi & Rains, 2017; Zhao et al., 2010). Students who are already academically motivated are likely to have been more resilient to the circumstances surrounding the transition to online and remote instruction during the pandemic-affected period (Tam, 2021).

While equitable administration of remote and online exams remains dubious, other factors threaten the integrity of such exams. Concerns over academic dishonesty appear to be a dominant issue faced by instructors (Guangul et al., 2020). Some instructors have relied on commercial proctoring services, which have been used to a lesser extent prior to the pandemic (Daffin & Jones, 2018; Francavilla et al., 2018) and may be effective in partly mitigating instances of academic dishonesty (Dendir & Maxwell, 2020). However, the use of online proctoring services is costly to the institutions, and moreover, comes with the expense of students' privacy and a likely increase in their anxiety from being surveilled (Balash et al., 2021). Furthermore, some research suggests differences in the quality of the experience of in-person compared to online virtual proctored examinations, with students completing exams in-person tending to receive higher scores (Wuthisatian, 2020).

Research Aims

To better understand the challenges students have faced during the pandemic in terms of classroom assessment experiences, and their plans for taking standardized exams (e.g., GRE, MCAT, and professional licensure/certification exams), we surveyed students about their experiences prior to (Fall 2019) and during the initial pandemic-affected semesters (Spring 2020-Spring 2021). This investigation provides insight into the modifications in evaluating student learning, the experiences of students during this time, and the choices made considering disruptions to learning. Such information helps us understand the longer-term impact of COVID-

19 on educational assessment practices and the future of today's college students. In particular, we sought to address the following questions about assessment practices before and during the pandemic. Note that we use the term “tests” or “exams” to distinguish from the broader category of “assessments.” While “test” or “exam” was used on the survey to refer to more conventionally structured assessment formats, “assessment” was used in a more encompassing manner to include these in addition to essays, capstone projects, etc. (see Table 3).

1. **RQ1:** Did common assessment formats change between Fall 2019 to Spring 2021?
2. **RQ2:** Did methods of exam administration change between Fall 2019 to Spring 2021?
3. **RQ3:** How did the pandemic affect students’ attitudes towards educational exams?
4. **RQ4:** How did the pandemic affect students’ long-term educational or professional plans?

Methods

Participants

Participants ($N=992$; Mean age=22.36 years, SD age=5.24; %female=53.3) resided in the U.S. and identified as current college/university students. Key demographic variables for the sample of participants are reported in Table 1. Most of the sample (82.6%) fell between the ages of 18-24, an age range common among college-age students within the U.S. Over one-third of students indicated their maternal (35.9%) or paternal (36.2%) caregiver had not received a college degree or above. This is on par with recent estimates of the proportion of first-generation college students in the U.S. (NCES, 2018). The sample included students who identified as White/European American (49.3%), Asian/Asian American (23.0%), Black/African American (7.8%), Hispanic/Latinx (7.4%), Middle Eastern or North African (0.8%), Native Hawaiian or other Pacific Islander (0.2%), or a member of another group (0.3%).

Table 1. *Participant demographics (N=992)*

Variable	Count	Percent
Gender		
Female	529	53.3%
Male	425	42.8%
Other	38	3.8%
Age (Years)		
18	79	8%
19	176	17.7%
20	205	20.7%
21	169	17%
22	102	10.3%
23	52	5.2%
24	36	3.6%
25	18	1.8%
26	21	2.1%
27	12	1.2%
28	18	1.8%
29	15	1.5%
30	15	1.5%
31	12	1.2%
32	4	0.4%
33	9	0.9%
34	6	0.6%
35	7	0.7%
36 and older	36	3.6%
Race/Ethnicity		
American Indian or Alaska Native	0	0%
Asian/Asian American	228	23%
Black or African American	77	7.8%
Hispanic/Latinx	73	7.4%
Middle Eastern or North African	8	0.8%
Native Hawaiian and Other Pacific Islander	2	0.2%
White or European American	489	49.3%
Other	3	0.3%
Multiple	112	11.3%

Note: “Race/ethnicity” is a variable reflecting non-exclusive categories and thus percentages total more than 100%.

Approximately three-quarters (73.2%) of the sample were enrolled in the Fall 2019 semester and thus the majority could draw comparisons to pre-pandemic college instruction (see Table 2). Given that students were recruited to reflect on their instructional experiences during the Spring 2020 semester and its aftermath, most students (87.6%) were enrolled in their second-to-fourth year of college. The vast majority (78.3%) had not yet attained a college degree, and nearly all (95.0%) had not previously received a 4-year undergraduate degree. All students were

completing coursework associated with a degree program, seeking either a 2-year (10.3%) or 4-year college degree (89.7%), though a small percentage (0.2%) indicated they were non-matriculated students. To ensure broad representation of the student experience, we also attempted to recruit a minimum of roughly 30 students from across the varied disciplines (NCES, 2019).

Table 2. *Participant enrollment and educational experience*

Variable	Count	Percent
Semester Enrolled		
Fall 2019	726	73.2%
Spring 2020	790	79.6%
Fall 2020	940	94.8%
Spring 2021	902	90.9%
Highest Degree Attainment		
High school diploma or equivalent (GED/GCSE/A-levels/etc.)	777	78.3%
Technical/community college (AA/etc.)	166	16.7%
Undergraduate degree (BA/BS/etc.)	49	4.9%
Degree Seeking		
Technical/community college (AA/etc.)	102	10.3%
Undergraduate degree (BA/BS/etc.)	890	89.7%
Class Standing		
Non-degree seeking	2	0.2%
Freshman or first-year and equivalent	108	10.9%
Sophomore or second-year and equivalent	290	29.2%
Junior or third-year and equivalent	299	30.1%
Senior or fourth-year and equivalent	281	28.3%
Beyond fourth-year	4	0.4%
Discipline of Degree Currently Seeking		
Biological and biomedical sciences	126	12.7%
Business	142	14.3%
Communication and Journalism	42	4.2%
Computer Science and Information Technology	162	16.3%
Education	40	4%
Engineering	123	12.4%
Environmental sciences	26	2.6%
Health professions and related programs	110	11.1%
Humanities	103	10.4%
Math and statistics	60	6%
Social sciences	181	18.2%
Visual and performing arts	89	9%
Undeclared	10	1%

Note: “Semester Enrolled” and “Discipline of Degree Currently Seeking” are variables reflecting non-exclusive reflect non-exclusive categories and thus percentages total more than 100%.

Data Collection

Institutional Review Board approval was granted prior to any data collection. Participants were recruited via Prolific, an online recruitment platform. The surveys, de-identified data, and analysis script and output associated with this manuscript are available in an online repository (Ober et al., 2022¹).

Eligible participants were automatically screened based on key criteria, including: (a) residency within the U.S., (b) not having completed more than an undergraduate degree previously, (c) being a current student, and (d) currently enrolled in courses at the community college/undergraduate degree level to ensure that participant profiles were accurate, and thus participants who could enroll in the study most closely met eligibility criteria. Respondents were asked to indicate whether they were enrolled in the semester (or equivalent) of college coursework corresponding to Fall 2019, Spring 2020, Fall 2020, and Spring 2021 semesters. For each semester enrolled, respondents were asked to provide information about their experience completing classroom assessments specifically during that semester.

Data were collected during three separate phases. A first-round of data collection ($n_1=277$) occurred between February 23 and March 2, 2021, a second-round of data collection ($n_2=317$) occurred between April 6 and April 12, 2021, and a third and final round of data collection ($n_3=398$) occurred between June 6 and June 30, 2021. Given that participants were screened based on specific eligibility criteria, minimal data cleaning was conducted.

Analytic Procedures

Multiple methods of data analyses were employed to interpret trends in the data. Responses to checklist or multiple-choice questions were summarized as counts and frequencies.

¹ https://osf.io/e263n/?view_only=8ae35a1c46e94374846cc4ea11422144

Responses to the open-ended questions were analyzed based on content or in the case of one free-response item, text responses were analyzed using topic modeling (Blei et al., 2003). Pre-processing of text data involved multiple steps, which included: (1) correction of misspellings; (2) removal of stop-words (e.g. the, and, etc.); (3) word-stemming; and (4) removal of words from question stem (e.g. exam). The final topic model was selected using out of sample perplexity, a common metric used to select the number of topics.

Results

We first wanted to understand the scope of the impact of the COVID-19 pandemic on the students included in the sample. Though most respondents indicated they neither tested positive nor had symptoms of COVID-19 (83.2%), more than three-quarters indicated that their physical or mental health suffered because of the pandemic (76.8%). Just over half of the students indicated that they knew someone who had lost a loved one due to complications arising from COVID-19 infection (51.5%). Respondents who completed the survey during the second and third waves of data collection were also asked to indicate whether they were quarantined during the semester, with over half (52.2%) indicating that they were.

We were subsequently interested in understanding what percentage of respondents experienced a transition from in-person to online and remote instruction during the spring 2020 semester. Respondents who indicated they were enrolled in the spring 2020 semester were asked to provide information about their experience both prior to and after the transition to online and remote instruction amidst the outbreak of the pandemic. Over three-quarters of the respondents (76.2%) indicated that at least one of their courses transitioned to hold more online meetings, while 19.8% indicated there was no change given their courses were already taught online. Only 3.9% indicated that their course continued to meet on an in-person basis.

Pandemic-related Changes to Assessment Formats

Next, we examined changes in the format of classroom assessments students completed (RQ1). During the Fall 2019 semester, more than half of the students enrolled reported completing at least one multiple-choice exam (92.2%), a short-answer/written exam (84.0%), as well as other less conventional assessment formats such as essays (89.1%), final or capstone projects (71.6%), or even a series of multiple projects (66.6%). About 6% of respondents indicated they did not complete an exam or test in their classes during the Fall 2019 and pre-pandemic Spring 2020 period, whereas nearly twice that (11.9%) indicated they did not complete an exam or test during the post-pandemic Spring 2020 period. That percentage remained relatively high even during the Fall 2020 semester, with 9.8% indicating they did not complete an exam or test during that semester. However, by Spring 2021, only 6.9% indicated they did not complete an exam or test during that semester, suggesting a return to a pre-pandemic norm.

Table 3. *Assessment formats disaggregated by semester/period*

	Fall 2019		Spring 2020 (Pre-COVID)		Spring 2020 (During COVID)		Fall 2020		Spring 2021	
	n	%	n	%	n	%	n	%	n	%
Conventional Formats										
Multiple-choice exams	623	92.2%	674	92.7%	485	94%	780	93.6%	756	93.8%
Short-answer/written exams	568	84.0%	599	82.4%	411	79.7%	671	80.6%	642	79.7%
Other Type of exam	31	4.6%	20	2.8%	11	2.1%	24	2.9%	21	2.6%
Other Formats										
Essays	602	89.1%	616	84.7%	439	85.1%	733	88%	662	82.1%
Final project/capstone	484	71.6%	440	60.5%	337	65.3%	558	67.0%	544	67.5%
Multiple projects	450	66.6%	461	63.4%	318	61.6%	527	63.3%	501	62.2%
Portfolios	110	16.3%	92	12.7%	58	11.2%	127	15.2%	135	16.7%
Problem-sets	303	44.8%	338	46.5%	244	47.3%	405	48.6%	384	47.6%
None of the Above	16	2.4%	23	3.2%	21	4.1%	25	3.0%	26	3.2%

Note: Percentages are based on the number of students enrolled in that semester. Respondents could select multiple answers and thus percentages may amount to greater than 100.

Table 3 shows the number and percentage of students who indicated they were enrolled in each semester and the types of assessments they completed during that semester. Multiple-

choice and short-answer/written exams in addition to essays remained relatively common both before and after the pandemic-affected periods. About 80% of respondents and above reported such assessment formats were assigned in at least one of their classes. Though it may seem reasonable to expect that instructors, wary of the potential for cheating on certain assessment formats that were administered in a remote and online format, may assign other alternative assessments; however, our data suggest that changes in assessment formats were relatively minimal. We further probed for differences in assessment formats between the Fall 2019 to Fall 2020 semesters among students enrolled in STEM and non-STEM majors, the results of which are shown in Table S1 in Supplementary Materials (Ober et al., 2021). Students in non-STEM majors were slightly more likely to report “other types” of assessment formats before the pandemic than after the pandemic ($\chi^2(df=1)=6.27, p=.012$).

Pandemic-related Changes in Methods of Exam Administration

We were also interested in examining whether the methods of exam administration changed amidst the pandemic (**RQ2**). Respondents were asked to provide information about the administration of exams for the semesters they were enrolled in from Fall 2019 to Spring 2021. Respondents who were enrolled in the Spring 2020 semester and indicated they completed an exam were asked to provide answers reflecting on their experience both before and during the pandemic period of that semester. As is evident based on the summary of responses in Table 4, the percentage of students who indicated exams were administered on an untimed, open-book, or outside of class time basis increased sharply in the Spring 2020 semester during the outbreak of the pandemic. In addition, the administration of exams proctored either online or not proctored at all increased. Unlike the changes in exam format, which suggested a slight return to pre-pandemic levels in the Spring 2021 semester, certain changes in the administration of exams

appear more stable. In particular, the percentage of students completing closed-book and proctored in-person exams still appears relatively low compared with pre-pandemic levels.

Table 4. *Assessment administration disaggregated by semester/period*

Assessment Administration	Fall 2019		Spring 2020 (Pre-COVID)		Spring 2020 (During COVID)		Fall 2020		Spring 2021	
	n	%	n	%	n	%	n	%	n	%
Timing										
Timed	573	84.8%	608	83.7%	381	73.8%	644	77.3%	625	77.5%
Not timed	99	14.6%	110	15.2%	130	25.2%	183	22.0%	158	19.6%
Other	4	0.6%	8	1.1%	5	1.0%	6	0.7%	5	0.6%
I don't know	-	-	-	-	-	-	-	-	18	2.2%
Open-book										
Open-book	179	26.5%	193	26.6%	314	60.9%	442	53.1%	424	52.6%
Closed-book	488	72.2%	523	72.0%	195	37.8%	379	45.5%	338	41.9%
Other	9	1.3%	10	1.4%	7	1.4%	12	1.4%	15	1.9%
I don't know	-	-	-	-	-	-	-	-	29	3.6%
Context										
During class time	433	64.2%	477	65.7%	189	36.6%	336	40.3%	309	38.3%
Outside of class time	229	34.0%	233	32.1%	316	61.2%	472	56.7%	457	56.7%
Other	12	1.8%	16	2.2%	11	2.1%	25	3.0%	23	2.9%
I don't know	-	-	-	-	-	-	-	-	17	2.1%
Proctoring										
Proctored (in-person)	368	54.6%	384	52.9%	30	5.8%	89	10.7%	58	7.2%
Proctored (online)	129	19.1%	155	21.3%	199	38.6%	332	39.9%	313	38.8%
Not proctored	174	25.8%	179	24.7%	282	54.7%	405	48.6%	400	49.6%
Other	0	0.0%	8	1.1%	5	1.0%	7	0.8%	7	0.9%
I don't know	-	-	-	-	-	-	-	-	28	3.5%

Note: Percentages are based on the number of students enrolled in that semester. Response option “I don't know” was only available for questions pertaining to Spring 2021.

We again further investigated the possibility of differences in exam administration from Fall 2019 to Fall 2020 semesters among students enrolled in STEM and non-STEM majors. The results are shown in Table S2 in Supplementary Materials (Ober et al., 2021). While proportion of students who indicated they encountered timed exams seemed comparable before the pandemic in Fall 2019 among students enrolled STEM (86.9%) and non-STEM (82.8%) majors, the proportion of timed exams was significantly lower among students in non-STEM majors (72.8%; $\chi^2(df=1)=10.33, p<.001$) in the pandemic-affected Fall 2020 semester.

Pandemic-related Effects on Students' Attitudes towards Exams

We next sought to better understand how students felt about the changes to the format and administration of their exams during the pandemic-affected period (**RQ3**). Participants were asked to respond to Likert-scale questions about their general attitudes towards exams (3-questions), their ability to concentrate on exams during the pandemic (3-questions), the changes to exam content and rigor (4-questions), and the purpose and fairness of exams administered during the pandemic-affected semesters (7-questions).

The majority of students (62%) felt so familiar with taking exams that they felt it would be odd not to take one during a given academic year (see Figure 1). Nearly half of the respondents (49%) also agreed that taking exams was important for students (such as themselves) to demonstrate understanding of a topic, while only 35% disagreed with this sentiment. Despite the fact that many respondents felt familiar or recognized the importance of taking exams to demonstrate mastery, the majority (52%) also felt that they were not good measures of learning and should not be administered.

Figure 1. General attitudes towards exams

Ability to Concentrate on Taking Exams amidst the Pandemic

To better understand students' stress due to exam-taking during the pandemic, four Likert questions were included in the survey. Figure 2 provides a summary of responses to these questions. Most respondents (82%) indicated that it was especially difficult to concentrate during the pandemic and the majority (62%) expressed that the idea of taking an exam during the pandemic was stressful. However, students appeared still relatively optimistic about their performance on exams, with 58% disagreeing with the notion they would not do well on an important exam because of intrusive pandemic-related thoughts. Students were more divided about how important taking a exam was to them during the pandemic, with 46% indicating that taking an exam felt unimportant given all that they had to worry about, and 39% indicating the contrary.

Figure 2. Attitudes towards exam-taking during the pandemic

Pandemic-related Changes to Exam Rigor

Reflecting on the changes to exams during the pandemic-affected semesters, about the same percentage of students felt the exams were either more or less rigorous, suggesting that students may have had a variety of experiences in this regard (see Figure 3). The majority of students (58%) appeared to feel that their exams did *NOT* cover less material than before the pandemic. Concerns over academic integrity appeared to be commonly expressed by students' instructors, with 72% indicating that their instructors were outspoken about taking measures to ensure academic integrity while administering exams.

Figure 3. Attitudes towards pandemic-related exam changes

Purpose and Fairness of Exams amidst the Pandemic

Respondents were asked to reflect on their attitudes towards taking exams considering the pandemic-related changes (see Figure 4). Many students felt that the administration of exams was likely to have advantaged certain classmates over others (66%) or believed that there was concern about the fairness in the administration of exams (52%). Even so, less than one-third (32%) of students felt it was more challenging for them to complete exams at home compared with classmates due to resource limitations. More than half of students also expressed a preference for the cancellation of exams, with 56% agreeing with such a preference and only 17% indicating they would have preferred that canceled exams be held. Students appeared largely evenly split in terms of how they felt about the effect of exam changes on their academic progress, with about an equal percentage of students agreeing (45%) or disagreeing (41%) that

the changes to course exams affected their academic progress. However, whereas only 36% felt that the changes to course exams affected their post-degree future, 44% did not feel that it had an effect.

Figure 4. Attitudes towards current pandemic-affected exams

Additional Concerns

We were also interested in understanding other concerns that students may have had about completing course exams that may not have otherwise been captured in the forced-response survey questions previously described. Students were also asked to provide a written response to the question, “*What concerned you most about the changes to your course exam(s)?*”. We used topic modeling to identify overarching themes in the responses. Taking into consideration both the most frequently used terms and the context of the students’ responses with values reflecting a greater association with one of the topics, a three-topic solution was found to

be most appropriate based on a smaller perplexity value and content. Common concerns included those related to (1) online environment (topic 1), (2) learning materials and resources (topic 2), and (3) academic integrity (topic 3). Figure 5 shows the 10 most frequent terms (i.e., unigrams) associated with each topic. Given that topic modeling can model words that are polysemic (terms that possess multiple meanings) or homonymic (terms that possess multiple unrelated meanings), the same term may be present in multiple topics (Kjell et al., 2019). Larger beta values indicate a word is more relevant to that particular topic.

Figure 5. Ten most frequent terms used to describe three topics in response to the question, “What concerned you most about the changes to your course exam(s)?”.

Table 5 provides quoted excerpts of responses indicative of the three themes. The topics largely appeared to reflect many of themes we attempted to inquiry about in the forced-choice questions, though an examination of the actual responses associated with each topic appeared to highlight some of the more nuanced aspects of themes. For instance, responses associated with

aspects of the *online learning environment* (topic 1) tended to refer to some of the challenges they faced learning in a fully online modality, including the difficulty focusing with other distractions at home, as well as technical difficulties. In contrast, responses associated with the *learning materials and resources* (topic 2) referred to dimensions of the learning experience such as the open-book nature of exams, misalignment of the exam with course learning goals, and lack of personal accountability to learn course content. Finally, concerns over *academic integrity* (topic 3) also comprised another dominant theme in the responses. While students acknowledge that cheating was a widespread issue, students also conveyed that the methods of surveillance via online proctoring added additional and undue stress to their course exam experience.

Table 5. *Themes and quoted excerpts of responses to the question, “What concerned you most about the changes to your course exam(s)?”*

Theme	Example Response
Online Environment	<i>The only change for my exams was the fact that I was taking them at home. Something that concerned me was telling my family that I needed the house to be quiet for an hour or two so I could focus. It was a little difficult at first since my dog would bark and my mother would have to help him calm down. These instances distracted me during my first online exam.</i>
	<i>Technical difficulties. Also, I have an old phone with no data and only a wired internet connection to my laptop, so I was at a disadvantage relative to most other students in both the quality of pictures I could take and the ease/speed I could upload them. Additionally, since there was not a standard format for online tests, the experience varied wildly over all of my classes; i.e. some exams were poorly designed or implemented.</i>
	<i>It's harder to focus when I cannot take the test with ample time in a low-distraction environment, which my home is not.</i>
Learning Materials and Resources	<i>The questions were more broad and open-ended rather than specific since the exams were open book. This meant that our answers could vary by quite a bit so I was worried how professors would grade us. There were stricter word counts and we needed in-text citations for every answer.</i>
	<i>My greatest concern was the lack of in person classes so teachers could gauge the knowledge base of their students and provide a test that adequately meets and challenges their current knowledge level based on the teacher's teachings. In an online environment, it is easy to generalize a whole class as understanding something, leaving many of the stragglers too shy to ask a question in the dust.</i>

	<i>I wasn't holding myself accountable to thoroughly learn the material since most exams were open note</i>
	<i>I don't think remote learning is equal to in-person. My classes aren't that important this year, but for serious STEM classes especially, it is difficult to truly learn anything. The exams are easy when you can use notes and the internet so there is little learning</i>
Academic Integrity	<i>How easily people will find ways to cheat. Some people in my class got caught cheating through GroupMe, so our exam scores were thrown out, and a new test was made. I just don't like that some professors will punish everyone for what a few people did, and in reality, if those professors are that worried about cheating then they should take extra steps to make the exam secure.</i>
	<i>The strictness of the eye-tracking software used. I have ADD, and I know some people who were flagged for review by the software from common ADD behaviors such as briefly looking away from the screen.</i>
	<i>The strict proctoring and monitoring of actions added a lot of stress and anxiety. I have taken proctored online exams before, but they were not as strict with what they required to be monitored.</i>

Future Educational and Professional Plans

Aside from understanding the impact of changes on classroom assessments on students, we also wanted to better understand how the pandemic was likely to have affected students' plans for completing standardized exams such as the GRE, MCAT, LSAT, GMAT, etc. (RQ4). Between 3.6-5.3% of respondents indicated they planned to take a standardized exams between the Spring 2020 to Fall 2022 semesters, with the GRE being the most frequently cited exam. Most students indicated that the pandemic had *not* affected their plans for completing a standardized exam (89.9%) or their decision to apply for a degree/licensure program (95.0%).

Changes to Plans for Taking Standardized Exams

Students who indicated that their plans had changed were asked to elaborate on the changes to their plans for taking a standardized exam (N=70). Table 6 in Supplemental Materials provides additional quoted excerpts of responses. Multiple students indicated that they had either rescheduled their exams or decided to postpone taking the exam, if at all. Several respondents

wrote that their plans had changed in light of many post-baccalaureate programs waiving certain exam requirements. Other respondents indicated their financial circumstances had changed, which made it difficult to justify paying to register for the exam.

Table 6. *Themes and quoted excerpts of responses to the question, “If you responded “yes” to the previous question [Has your plan to complete a standardized exam changed because of the pandemic?], in what ways have your plans changed?”*

Theme	Example Response
Post-baccalaureate programs waiving certain exam requirements	<i>Since all of the grad programs I applied to waived the GRE requirement, I decided not to take it.</i>
	<i>Originally, to get into this program you had to take the GRE as a part of the application process. However, they waived the requirement due to COVID-19 so I applied and was accepted without having taken the GRE.</i>
Difficulty to justify paying to register for the exam:	<i>I did not have the money and I did not see the need to, as many graduate schools had waived their requirement. Also, my intended master’s program did not require it.</i>
	<i>I was planning on taking one during the summer of 2020 but decided not to because of loss of job (could not put for exam and studying material) and not having many resources to study for it on</i>
Exam completion unnecessary	<i>In Spring 2020, I decided that I didn’t want to go to medical school because the pandemic gave me a lot of time to introspect about my life. So, I no longer need to take the MCAT.</i>
Changes in the standardized exam administration or scheduling	<i>My MCAT got rescheduled multiple times last Spring. When I finally got a test date, I had been rescheduled 3 hours away. I also had to wear a mask the whole time even though we were seated across the room, which I understand, but I had to keep wiping the fog off my glasses.</i>
	<i>The processing time for NCLEX testing applications is delayed leaving many new graduates such as myself to wait for our license</i>
Not able to complete requisite exams to enroll in certain coursework	<i>I planned to take the CLEP test in Spring, but they only offered in-person exams. I only need one more class to complete my major, and I need to take the CLEP test to determine which level of the class I take before I register. Because of this, I’ve had to put my schooling on hold.</i>
Increased stress due to the online exam format	<i>The LSAT is now offered online, which has increased my test-taking anxiety because of the online proctoring component so I had a panic attack during the first exam and now am retaking it this semester. I have never had test-taking anxiety before the pandemic</i>
Some positive change	<i>I was able to move my plans up by almost a full year. I was not allowed to work at my normal job as I have a heart condition that puts me at risk of lethal infection from COVID19. Using my free time I completed more work</i>

	<i>than usual and took on more courses. In some ways, COVID19 has been a positive development for my future</i>
--	---

Other students indicated they had decided to change their academic plans during the pandemic, making exam completion unnecessary. Some respondents expressed that there were changes in the standardized exam administration or scheduling beyond their control that prevented them from sticking to their academic plans. Another respondent similarly experienced delays because they were not able to complete requisite exams to enroll in certain coursework. While certain exams such as the LSAT (a law school entrance exam) were administered online even prior to the pandemic, at least one respondent felt increased stress due to the online exam format amidst the pandemic circumstances. Though by and large, most respondents expressed challenges that had delayed their academic plans, at least one respondent expressed that some positive outcomes had emerged noting that the circumstances had enabled them to complete more courses in the same amount of time. For example, this respondent wrote: “

I was able to move my plans up by almost a full year. I was not allowed to work at my normal job as I have a heart condition that puts me at risk of lethal infection from COVID19. Using my free time I completed more work than usual and took on more courses. In some ways COVID19 has been a positive development for my future.

Changes to Plans for Applying to a Post-baccalaureate Degree/Licensure Program

Those students who indicated their post-graduate plans had changed in terms of applying to a degree or licensure program were also asked to elaborate on those changes (N=37). Some respondents indicated they simply changed their mind, with one writing:

I was planning on attending Med school, but after some reflection during quarantine, as well as changes in what courses I could take, I changed my path to just being Computer Engineering.

Another expressed that the COVID-19 pandemic had more directly influenced a change of plans, writing:

My student lab closed down because of Covid and I stopped caring about my future career path and am currently seeking to change it. I lost interest in my field.

Other students expressed that they had simply lost interest in pursuing further education, writing:

I am not sure if I wish to continue in higher education. My performance in school suffered as a result of the pandemic.

And others simply expressing:

This past year has burnt me out when it comes to schooling.; and

I am less motivated to do more schooling after this.; and

I no longer want to go to school after I get my BA because of the sheer stress of completing this degree.

By contrast, other students, weighing the alternative of entering a foreseeably competitive job market, expressed an increased desire to apply to programs for graduate school, writing:

Put more pressure to go to grad school because the job market is scary right now.; and

I am for sure applying to a Ph.D. program, the job market is scary.

These responses, though reflecting a relatively small subset of students, indicate a variety of experiences and differing perspectives on the impact of the COVID-19 pandemic, with some reporting a greater severity of change than others.

Discussion

We sought to better understand the challenges students faced in assessment and in making educational progress during the COVID-19 pandemic. The findings hold significance in helping to understand the immediate impact on students as well as areas that necessitate attention

in educational assessment, particularly given a drive towards online educational practices and the known “digital divide” based on gender and SES. Long-term, understanding the current assessment practices may help precisely capture the magnitude and scope of “learning loss” and inform a response to mitigate it.

Our findings indicate that though relatively few students reported having the illness or symptoms of it, over three-quarters reported that COVID-19 had an impact on their physical or mental health. These estimates appear consistent with research on college students’ mental health, which suggests significant decreases in well-being (Spiegel & Nivette, 2021; Woolston, 2020) and increases in attention problems amidst the pandemic (Copeland et al., 2021; Coughenour et al., 2020). We also found that assessment formats appeared to have changed minimally, though the administration of the assessments actually changed considerably to adapt to the new online mode of instruction. These findings appear to be consistent with other results from survey research which found that instructors reported primarily focusing on translating existing in-person exams into an online format as opposed to changing the exam composition or grading scheme (Slade et al., 2021). The changes appear to linger, even as more institutions held in-person instruction during the Spring 2021 semester. For instance, open-book and online proctored exams appear more common than pre-pandemic levels. In terms of concerns students reported about the changes in their classroom exams, concerns related to the online environment, learning materials and resources, and academic integrity were commonly reported. These findings partly reflect themes noted from other investigations into students’ experience with pandemic-related changes to classroom assessment (Tam, 2021); however, with concerns about cheating more substantial in the present sample. Measures to mitigate the likelihood of cheating

which also safeguard students' privacy and security should be further considered in future academic settings involving online assessments (Gamage et al., 2020).

Regarding standardized exams, though a relatively small percentage of respondents indicated their intentions for taking them (roughly 10%) or post-graduation plans had changed as a result of the pandemic, students provided a rich set of reasons. Recent estimates suggest that students' concerns about entering a difficult job market are not unfounded, given a declining employment rate among recent college graduates. For example, a Pew Research Center analysis of federal labor data found that 31% of 2020 college graduates were unemployed by December of that year, a figure substantially above the 22% for 2019 graduates (Barroso & Sechopoulos, 2021). Common themes pointed to changes in program admission requirements, delays in scheduling exams, discomfort taking a high-stakes exam under social distancing and masking restrictions or in an online format. While most students indicated their plans had not changed, several conveyed that the college experience amidst the pandemic had deterred them from pursuing further educational attainment, while others were more fearful of entering a competitive job market.

Implications

There are several implications of these findings. First, in response to the pandemic, instructors generally stuck to the usual format of assessments but opted to change the method of exam administration. During emergency remote teaching circumstances, such changes make sense, yet also point towards a need for greater innovation in classroom assessments that draw from a variety of formats without compromising the validity and fairness of the exam. Second, students were attuned to the limitations of classroom assessments during this period, echoing commonly cited concerns related to the rigor and coverage of the exam and subsequent issues

around cheating, the suitability of the context for an examination (both with respect to time and internet connectivity), and the availability of instructional resources. Third, students were apparently either undecided or persistent in pursuing their educational plans, despite the pandemic circumstances. However, those that did report changes often referred to various stressors that either deterred or pushed them towards pursuing further educational attainment. Understanding how the needs and concerns of students have changed because of the pandemic, particularly in terms of how educational attainment now fits within students' long-term career vision, should be paramount.

Limitations

The potential impact of these findings notwithstanding, there are several important limitations to acknowledge. First, even though we made an effort to recruit across multiple disciplines, given the nature of the sample and sampling procedure used to obtain it, we are limited in drawing generalizations to the broader population of undergraduate students. Respondents were recruited via Prolific using a non-probability sampling procedure. Therefore, our sample may not be representative of the entire U.S. population of undergraduate students. Second, the responses were collected retrospectively and thus there is the potential for participants' recollections to have been influenced by more recent events. Third, the study is not to be misconstrued as a longitudinal study given that data reported for each semester is not necessarily drawn from the same sample of respondents. Data were only collected for each semester a respondent indicated they were enrolled. While there is some overlap in the samples from one semester to the next, we are limited in making definitive conclusions about trends in assessment formats and administration methods across the semesters.

Conclusions

The COVID-19 pandemic unleashed a complicated set of circumstances on today's college students, many of whom may already feel vulnerable in securing a financially stable future (see Hanushek & Woessmann, 2020). Though most of the college students in our sample were outspoken about the general discomfort in taking exams, most also felt that it was important for evaluating their academic progress. During the COVID-19 pandemic, instructors appeared to face challenges in adequately assessing student learning while students experienced difficulties in completing high-stakes standardized exams to pursue their intended career path. These results give insight into the modifications in evaluating student learning, the experiences of students during this time, and the choices made considering disruptions to learning. Such information provides an understanding of the long-term impact of COVID-19 on educational assessment practices and the future of today's college students.

References

- Anderson, A. (2020, March 11). COVID-19 outbreak highlights critical gaps in school emergency preparedness. *Education Plus Development Blog*. Brookings Institute. <https://www.brookings.edu/blog/education-plus-development/2020/03/11/covid-19-outbreak-highlights-critical-gaps-in-school-emergency-preparedness/>
- Auxier, B. & Anderson. M. (2020, March 16). As schools close due to the coronavirus, some U.S. students face a digital 'homework gap'. *Pew Research Center*. Retrieved 29 April 2020. From <https://www.pewresearch.org/fact-tank/2020/03/16/as-schools-close-due-to-the-coronavirus-some-u-s-students-face-a-digital-homework-gap/>

Balash, D. G., Kim, D., Shaibekova, D., Fainchtein, R. A., Sherr, M., & Aviv, A. J. (2021).

Examining the examiners: Students' privacy and security perceptions of online proctoring services. arXiv preprint. <https://arxiv.org/abs/2106.05917>

Barroso, A. & Sechopoulos, S. (2021, May 14). *College graduates in the year of COVID-19 experienced a drop in employment, labor force participation.*

<https://www.pewresearch.org/fact-tank/2021/05/14/college-graduates-in-the-year-of-covid-19-experienced-a-drop-in-employment-labor-force-participation/>

Bhagat, S., & Kim, D. J. (2020). Higher education amidst COVID-19: challenges and silver lining. *Information Systems Management*, 37(4), 366–371.

<https://doi.org/10.1080/10580530.2020.1824040>

Black, P., & Wiliam, D. (2018). Classroom assessment and pedagogy. *Assessment in Education: Principles, Policy & Practice*, 25(6), 551–575.

<https://doi.org/10.1080/0969594X.2018.1553695>

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *The Journal of Machine Learning Research*, 3, 993–1022.

<https://www.jmlr.org/papers/volume3/blei03a/blei03a.pdf>

Brancaccio-Taras, L., Mawn, M. V., Premo, J., & Ramachandran, R. (2021). Teaching in a Time of Crisis: Editorial Perspectives on Adjusting STEM Education to the “New Normal” during the COVID-19 Pandemic. *Journal of Microbiology & Biology Education*, 22(1), ev22i1-2679.

Copeland, W. E., McGinnis, E., Bai, Y., Adams, Z., Nardone, H., Devadanam, V., ... & Hudziak, J. J. (2021). Impact of COVID-19 pandemic on college student mental health and

- wellness. *Journal of the American Academy of Child & Adolescent Psychiatry*, 60(1), 134–141. <https://doi.org/10.1016/j.jaac.2020.08.466>
- Coughenour, C., Gakh, M., Pharr, J. R., Bungum, T., & Jalene, S. (2020). Changes in Depression and Physical Activity Among College Students on a Diverse Campus After a COVID-19 Stay-at-Home Order. *Journal of Community Health*, 1–9. <https://doi.org/10.1007/s10900-020-00918-5>
- Cutri, R. M., Mena, J., & Whiting, E. F. (2020). Faculty readiness for online crisis teaching: transitioning to online teaching during the COVID-19 pandemic. *European Journal of Teacher Education*, 43(4), 523–541. <https://doi.org/10.1080/02619768.2020.1815702>
- Daffin, Jr., L.W., & Jones, A.A. (2018). Comparing student performance on proctored and nonproctored exams in online psychology courses. *Online Learning*, 22(1), 131–145. <https://doi.org/10.24059/olj.v22i1.1079>
- Dendir, S., & Maxwell, R. S. (2020). Cheating in online courses: Evidence from online proctoring. *Computers in Human Behavior Reports*, 2, 100033. <https://doi.org/10.1016/j.chbr.2020.100033>
- Elsalem, L., Al-Azzam, N., Jum'ah, A. A., Obeidat, N., Sindiani, A. M., & Kheirallah, K. A. (2020). Stress and behavioral changes with remote E-exams during the COVID-19 pandemic: A cross-sectional study among undergraduates of medical sciences. *Annals of Medicine and Surgery*, 60, 271–279. <https://doi.org/10.1016/j.amsu.2020.10.058>
- Francavilla, N. M., Meade, A. W., & Young, A. L. (2019). Social interaction and internet-based surveys: Examining the effects of virtual and in-person proctors on careless response. *Applied Psychology*, 68(2), 223–249. <https://doi.org/10.1111/apps.12159>

Gamage, K. A., Silva, E. K. D., & Gunawardhana, N. (2020). Online delivery and assessment during COVID-19: Safeguarding academic integrity. *Education Sciences*, 10(11), 301.

<https://doi.org/10.3390/educsci10110301>

Georgiou Y., Ioannou A. (2019) Embodied Learning in a Digital World: A Systematic Review of Empirical Research in K-12 Education. In: Díaz P., Ioannou A., Bhagat K., Spector J. (eds) Learning in a Digital World. *Smart Computing and Intelligence*. Springer,

Singapore. https://doi.org/10.1007/978-981-13-8265-9_8

Guangul, F. M., Suhail, A. H., Khalit, M. I., & Khidhir, B. A. (2020). Challenges of remote assessment in higher education in the context of COVID-19: a case study of Middle East College. *Educational Assessment, Evaluation and Accountability*, 32(4), 519–535.

<https://doi.org/10.1007/s11092-020-09340-w>

Haladyna, T. M., & Downing, S. M. (2005). Construct-irrelevant variance in high-stakes testing. *Educational Measurement: Issues and Practice*, 23(1), 17–27.

<https://doi.org/10.1111/j.1745-3992.2004.tb00149.x>

Hansen, J. D., & Reich, J. (2015). Democratizing education? Examining access and usage patterns in massive open online courses. *Science*, 350(6265), 1245–1248.

<https://doi.org/10.1126/science.aab3782>

Hasan, N., & Bao, Y. (2020). Impact of “e-Learning crack-up” perception on psychological distress among college students during COVID-19 pandemic: A mediating role of “fear of academic year loss”. *Children and Youth Services Review*, 118, 105355.

<https://doi.org/10.1016/j.childyouth.2020.105355>

- Hanushek, E. A., & Woessmann, L. (2008). The role of cognitive skills in economic development. *Journal of Economic Literature*, 46(3), 607–668.
<https://doi.org/10.1257/jel.46.3.607>
- Hanushek, E. A., & Woessmann, L. (2012). Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. *Journal of Economic Growth*, 17(4), 267–321.
<https://doi.org/10.1007/s10887-012-9081-x>
- Hanushek, E. A., & Woessmann, L. (2020). The economic impacts of learning losses. OECD.
<https://www.oecd.org/education/The-economic-impacts-of-coronavirus-covid-19-learning-losses.pdf>
- Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science*, 312(5782), 1900–1902. <https://doi.org/10.1126/science.1128898>
- Horowitz., J. M. (2020, April 15). *Lower-income parents most concerned about their children falling behind amid COVID-19 school closures*. Retrieved 29 April 2020 from
<https://www.pewresearch.org/fact-tank/2020/04/15/lower-income-parents-most-concerned-about-their-children-falling-behind-amid-covid-19-school-closures/>
- James, R. (2016). Tertiary student attitudes to invigilated, online summative examinations. *International Journal of Educational Technology in Higher Education*, 13(1), 19.
<https://doi.org/10.1186/s41239-016-0015-0>
- Kjell, O. N. E., Kjell, K., Garcia, D., & Sikström, S. (2019). Semantic measures: Using natural language processing to measure, differentiate, and describe psychological constructs. *Psychological Methods*, 24(1), 92–115. <https://doi.org/10.1037/met0000191>

- Lashley, M., & McCleery, R. (2020). Intensive Laboratory experiences to safely retain experiential learning in the transition to online learning. *Ecology and Evolution*, 10(22), 12613–12619. <https://doi.org/10.1002/ece3.6886>
- Lederman, D. (2021). Detailing Last Fall’s Online Enrollment Surge. Inside Higher Ed. (16 Sept 2021). Retrieved from <https://www.insidehighered.com/news/2021/09/16/new-data-offer-sense-how-covid-expanded-online-learning>
- Messick, S. (1984). The psychology of educational measurement. *Journal of Educational Measurement*, 21, 215–237. <https://doi.org/10.1002/j.2330-8516.1984.tb00046.x>
- Middleton, K. V. (2020). The longer-term impact of COVID-19 on K–12 student learning and assessment. *Educational Measurement: Issues and Practice*, 39(3), 41–44. <https://doi.org/10.1111/emip.12368>
- National Academy of Education. (2021). Educational Assessments in the COVID-19 Era and Beyond. Retrieved from <https://naeducation.org/wp-content/uploads/2021/02/Educational-Assessments-in-the-COVID-19-Era-and-Beyond.pdf>
- Ober, T., & Cheng, Y. (2022, January 24). Educational Assessment Experiences of College Students during COVID-19. https://osf.io/e263n/?view_only=8ae35a1c46e94374846cc4ea11422144
- Pagram, J., Cooper, M., Jin, H., & Campbell, A. (2018). Tales from the exam room: Trialing an E-exam system for computer education and design and technology students. *Education Sciences*, 8(4), 188. <https://doi.org/10.3390/educsci8040188>

- Qiang, Z., Obando, A.G., Chen, Y., Ye, C. (2020) Revisiting Distance Learning Resources for Undergraduate Research and Lab Activities during COVID-19 Pandemic. *Journal of Chemical Education*, 97(9), 3446–3559. <https://doi.org/10.1021/acs.jchemed.0c00609>.
- Reynolds, J.A., Cai, V., Choi, J., Faller, S., Hu, M., Kozhumam, A., Schwartzman, J., Vohra, A. (2020) Teaching during a pandemic: Using high-impact writing assignments to balance rigor, engagement, flexibility, and workload. *Ecology and Evolution*, 10, 12573–12580. <https://doi.org/10.1002/ece3.6776>.
- Richter, C.F., Lortie, C.J., Kelly, T.L., Filazzola, A., Nunes, K.A., Sarkar, R. (2020) Online but not remote: Adapting field-based ecology laboratories for online learning. *Ecology and Evolution Early View*, 1–9. <https://doi.org/10.1002/ece3.7008>.
- Seaman, J., Allen, I. E., & Ralph, N. (2021). Teaching online: STEM education in the time of COVID. *Bayview Analytics Report*. <https://onlinelearningconsortium.org/read/teaching-online-stem-in-a-time-of-covid/>
- Sedaghatjou, M., Hughes, J., Liu, M., Ferrara, F., Howard, J., & Mammana, M. F. (2021). Teaching STEM online at the tertiary level during the COVID-19 pandemic. *International Journal of Mathematical Education in Science and Technology*, 1–17. <https://doi.org/10.1080/0020739X.2021.1954251>
- Slade, C., Lawrie, G., Taptamat, N., Browne, E., Sheppard, K., & Matthews, K. E. (2021). Insights into how academics reframed their assessment during a pandemic: disciplinary variation and assessment as afterthought. *Assessment & Evaluation in Higher Education*, 1–18. <https://doi.org/10.1080/02602938.2021.1933379>

- Spiegel, T. & Nivette, A. (2021). The relative impact of in-class closed-book versus take-home open-book examination type on academic performance, student knowledge retention and wellbeing. <https://doi.org/10.1080/02602938.2021.2016607>
- Tam, A. C. F. (2021). Students' perceptions of and learning practices in online timed take-home examinations during Covid-19. *Assessment & Evaluation in Higher Education*, 1–16. <https://doi.org/10.1080/02602938.2021.1928599>
- Tesar, M. (2020). Towards a post-Covid-19 'new normality?': Physical and social distancing, the move to online and higher education. *Policy Futures in Education*, 18(5), 556–559.
- Tsetsi, E., & Rains, S. A. (2017). Smartphone Internet access and use: Extending the digital divide and usage gap. *Mobile Media & Communication*, 5(3), 239–255. <https://doi.org/10.1177/2050157917708329>
- Villanueva, O., Zimmermann, K. (2020) Transitioning an Upper-Level, Integrated Laboratory Course to Remote and Online Instruction During the COVID-19 Pandemic. *Journal of Chemical Education*, 97(9), 3114–3120. <https://doi.org/10.1021/acs.jchemed.0c00740>.
- Wang, C., Bauer, M., Burmeister, A.R., Hanauer, D.I., Graham, M.J. (2020) College Student Meaning Making and Interest Maintenance During COVID-19: From Course-Based Undergraduate Research Experiences (CUREs) to Science Learning Being Off-Campus and Online. *Frontiers in Education*. <https://doi.org/10.3389/feduc.2020.590738>
- Weisberg, S. M., & Newcombe, N. S. (2017). Embodied cognition and STEM learning: Overview of a topical collection in CR: PI. *Cognitive Research: Principles and Implications*, 2(1), 1–6. <https://doi.org/10.1186/s41235-017-0071-6>

Wise, S. L. (2019). Controlling construct-irrelevant factors through computer-based testing: disengagement, anxiety, & cheating. *Education Inquiry*, 10(1), 21–33.

<https://doi.org/10.1080/20004508.2018.1490127>

Woolston, C. (2020) Signs of depression and anxiety soar among US graduate students during pandemic. *Nature*, 585, 147-148. <https://doi.org/10.1038/d41586-020-02439-6>

Wuthisatian, R. (2020). Student exam performance in different proctored environments: Evidence from an online economics course. *International Review of Economics Education*, 35, 100196. <https://doi.org/10.1016/j.iree.2020.100196>

Zhao, L., Lu, Y., Huang, W., & Wang, Q. (2010). Internet inequality: The relationship between high school students' Internet use in different locations and their Internet self-efficacy. *Computers & Education*, 55(4), 1405–1423.

<https://doi.org/10.1016/j.compedu.2010.05.010>