



Maximizing Academic Integrity While Minimizing Stress in the Virtual Classroom

Peter A. Novick,^a Jacqueline Lee,^b Sujun Wei,^c Emily C. Mundorff,^d Jessica R. Santangelo,^e
and Timothy M. Sonbuchner^f

^aDepartment of Biological Sciences and Geology, Queensborough Community College, City University of New York,
Bayside, New York, USA

^bDepartment of Biology, Nassau Community College, Garden City, New York, USA

^cDepartment of Chemistry, Queensborough Community College, City University of New York,
Bayside, New York, USA

^dDepartment of Chemistry, Hofstra University, Hempstead, New York, USA

^eDepartment of Biology, Hofstra University, Hempstead, New York, USA

^fDepartment of Chemistry, Adelphi University, Garden City, New York, USA

The article documents students' experiences with the shift online at the onset of the COVID-19 pandemic and provides informed recommendations to STEM instructors regarding academic integrity and student stress. Over 500 students were surveyed on these topics, including an open-ended question. Students experienced more stress and perceived a greater workload in online courses and therefore preferred in-person courses overall. Personal awareness of cheating during online exams is positively correlated with the proportion of cheating a student perceives. Fear of getting caught is the best cheating deterrent while getting a better grade makes cheating most enticing. Randomization of questions and answer choices is perceived as a highly effective tool to reduce cheating and is reported as the least stress-inducing method. Inability to backtrack and time limits cause students the most stress. Students report that multiple choice questions are the least effective question type to discourage cheating and oral exam questions cause the most stress. Use of camera and lockdown browser or being video- and audio- recorded caused the majority of student stress. Yet, nearly 60% agree that the combination of camera and lockdown browser is an effective deterrent. Recommendations: (i) Be transparent regarding academic dishonesty detection methods and penalties. (ii) Use online invigilating tools. (iii) Synchronize exams and (iv) randomize exam questions. (v) Allow backtracking. (vi) Avoid converting in-person exams to online exams; instead, explore new ways of designing exams for the online environment.

KEYWORDS academic integrity, exams, stress, virtual classroom, cheating, online exams

INTRODUCTION

From the onset of the COVID-19 pandemic, students were sent home and classes went online (1). Professors worldwide needed to learn new methods and techniques quickly to make their material accessible to students remotely. For STEM (Science, Technology, Engineering, Mathematics) classes, exams, an important assessment method for instructors, also needed to go virtual. During the initial pivot, many instructors, new

to the online modality, struggled to implement new methods of testing while at the same time, ensuring academic integrity. Meanwhile students also needed to adapt to their own challenges in the online environment. Students struggled with anxiety induced by the pandemic, new methods of learning, and a sense of isolation from their classmates (2). Students with greater stress are known to be more likely to cheat (3).

This paper describes and analyzes the results of a student survey about their experiences in these online courses and the interplay between academic honesty and student stress. The authors have included student comments from an open-ended question in the survey to understand their perspective as an aggregate and individually. For example, one student described the transition: "it's hard to teach online courses but much harder to learn [online]." Some students also lacked private places to study with their families at home, while others still needed to work, exposing them to possible infection. Disconnected from

Address correspondence to Department of Chemistry, Adelphi University, Garden City, New York, USA. E-mail: tsonbuchner@adelphi.edu.

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classmates, family, and friends, many students felt like their professors did not understand their situations. As one student put it, “some professors . . . were just not that understanding about students’ situations and just assumed that because we are home all the time, that means we have more time to do work and study.” In short, students had trouble learning in the virtual environment.

In 2006, prior to the COVID crisis, it was reported that approximately 82% of engineering majors and 71% of natural science majors admitted to some form of cheating while in college, well before online classes were considered common (4). When all students shifted online, unprepared students, using new formats for exams, with greatly reduced monitoring, coincided with a significant rise in cheating (5).

Reported cases of academic dishonesty more than doubled in the 2019–20 academic year at one university, with the biggest uptick as students made the transition to online testing (6). Not all cases could be detected and reported, but Wiley (7) conducted a survey with 789 instructors responding, and 93% believe students are more likely to cheat in an online learning environment. By another measure, dramatic increases in contract cheating via Chegg by STEM students increased 196.25% in the April–August 2020 period compared to the same months in 2019 (8).

After the first online exams were given in spring 2020, professors exchanged notes on how to maintain academic integrity while students discussed ways to scrape by with passing grades. One jaded student shared, “The WhatsApp study groups that are made, are mostly to cheat and not to study.” An evolutionary arms race ensued as professors invoked stricter methods to deter cheating and perceived students tried to devise methods to get around them. Critically overlooked by some was that while instructors implemented roadblocks to maximize academic integrity, testing environments with significantly greater levels of stress resulted. As one student described, “since the pandemic, exams have increased exponentially in their difficulty making it hard for students to do well even if they use notes.”

Presently, most colleges and universities have returned to in-person classes. One benefit of the pandemic is that many professors have gained new skills in online pedagogy. Importantly, faculty traditionally trained in online course design often avoid academic honesty issues by using project-based assessments. Since project-based assessments may be impractical in high enrollment STEM classes, our recommendations focus on optimizing virtual exams. Going forward, more and larger classes are likely to be offered online (9). Therefore, it is useful to identify testing methods that will maximize academic integrity while minimizing student stress. Summed up by one student, “being under pressure [can] literally make you blank out. I know so many students who panic and start freaking out [and] it happens more than professors think.” To assess the best way to help professors and students alike, hundreds of students were surveyed at both 2-year and 4-year institutions to identify testing methods that students find stressful, and what methods make them less likely to cheat. From this feedback, we formulated recommendations for how to best implement virtual exams in STEM classes.

METHODS

Statement of ethics and disclosure

This research was approved by the Institutional Review Boards of all five colleges and universities involved in this study. The research has complied with all relevant federal guidelines and institutional policies.

Survey design

The (STEM)² Network (10) is a cohort of STEM faculty from five colleges and universities in New York. Assembled in 2020 through the NSF RCN-UBE Program, participants in the (STEM)² Network hail from three senior colleges: Adelphi, Hofstra and St. John’s Universities, and two community colleges: Queensborough Community College (QCC), City University of New York (CUNY) and Nassau Community College (NCC), State University of New York (SUNY). Neither QCC nor NCC have dormitories on campus; therefore, all students commute to campus, many using public transportation. Significant portions of their campus populations include students who are first generation college attendees, work full-time, are economically disadvantaged, and/or have dependents. As public institutions, professors are limited by state policies. Relevant here is that neither is allowed to require students to turn on cameras during class or examinations. The average 2-year student only attends school full-time for, at most, 2 years, or part time, with a busy schedule, for sometimes several years (11). These schools contrast with the senior colleges in our study, all of which are private institutions. The average 4-year student attends full-time for four consecutive years and does not have dependents or a full-time job. Most senior college students either live on campus or can commute by car (11).

During the COVID-19 pandemic, five faculty from four of the participating institutions constructed a student-centered survey on perceptions of stress and academic honesty during online examinations in STEM courses (Appendix 1.). The survey was developed from the authors’ experiences in remote testing after the switch to emergency remote learning, as well as from literature (12–14). During the fall semester of 2020, the survey was piloted by student volunteers, the faculty, PIs of the (STEM)² Network and the external evaluator of the grant before being finalized and distributed. Thirteen unique questions were designed for this survey using surveymonkey.com which keeps responses anonymous and does not collect IP addresses. These questions were designed to (i) identify limited student demographics, (ii) acquire information on students’ awareness/perception of cheating and reasons why students may or may not be academically dishonest and (iii) understand which roadblocks that faculty construct during the examination process that students find stressful and/or effective in maintaining

TABLE I
Majors of survey respondents (N = 502)^a

Reported major	Percent of respondents		
	2-year	4-year	Total
Pre-Medical	25.8%	39.7%	31.5%
Non-STEM	36.9%	7.8%	25.1%
Biology	15.4%	34.8%	23.3%
Chemistry	5.7%	9.3%	7.2%
General Science	6.0%	2.5%	4.6%
Other	10.1%	5.9%	8.4%

^a“Other” category includes Computer Science, Engineering, Forensic Science, Math and nondegree majors, each representing less than 3% of respondents.

academic honesty. Regarding the sensitive nature of asking students to admit to cheating, the survey instead asked if students were “personally aware” of various forms of cheating. This freed students from self-incrimination by making it unclear if students referred to themselves or their peers in responses.

The finalized surveymonkey.com link was sent to STEM students at the five campuses at the end of the spring 2021 semester (May 11–June 1, 2021). In an effort to maximize participation, links were shared through list serves of STEM students by departmental chairs, emailed by individual faculty, shared on course management systems, and posted in chat messages during synchronous classes. Only responses from students who completed the entire survey and affirmed that they took at least one STEM course between Spring 2020 and Spring 2021 were included in this study. Student responses to open-ended prompts were used to better understand their experience both individually and in aggregate. Quotes related to the themes of the survey questions, for example, about stress, perception of cheating, and in-person versus virtual experiences were identified and are used to contextualize the discussion of the quantitative survey results.

All statistical analyses were run in SPSS (15). Chi-Square Goodness of Fit tests were used to compare the observed number of agree/disagree/neither agree nor disagree or in-person/virtual/no preference responses to the number expected under the null hypothesis. Chi-Square and Fisher’s Exact Tests were used to determine if differences existed between responses from 2-year and 4-year students. All tests were two-tailed. The percentage of peer respondents perceived to be cheating online versus in-person were not normally distributed and had unequal variances. Therefore, a related-samples Wilcoxon Signed Rank Test was used to test the hypothesis that students perceived different levels of cheating on virtual relative to in-person exams. Mann-Whitney U tests were used to test the hypotheses that 2- and 4-year students differed in perceived levels of cheating on virtual and in-person exams.

RESULTS

Demographics

Five hundred and two students completed the survey: 59.4% were students at 2-year colleges and 40.6% were students at 4-year universities. Most of the students surveyed were STEM majors, including premedical majors (premed, nursing, and health sciences), biology, chemistry, and general science. Non-STEM majors also completed the survey (Table I).

Virtual versus in-person

Overall, students preferred in-person to online learning (Chi-Square Goodness of Fit Test: $N = 502$, $\chi^2 = 123.159$, $df = 2$, $P < 0.001$; Fig. 1). Students indicated that while online courses had a higher workload relative to in-person classes (Chi-Square Goodness of Fit Test: $N = 502$, $\chi^2 = 112.833$, $df = 2$, $P < 0.0001$), they put forth more effort for in-person relative to online courses (Chi-Square Goodness of Fit Test: $N = 502$, $\chi^2 = 78.602$, $df = 2$, $P < 0.001$; Fig. 1). More students also reported experiencing stress during online relative to in-person courses (Chi-Square Goodness of Fit Test: $N = 502$, $\chi^2 = 43.534$, $df = 2$, $P < 0.001$; Fig. 1). When asked specifically about anxiety related to exams, students were more likely to report that in-person exams caused anxiety relative to online exams (Chi-square Goodness of Fit Test: $N = 502$, $\chi^2 = 47.645$, $df = 2$, $P < 0.001$; Fig. 1).

Preferred course modality was related to perceived stress (Fig. 2). Students who preferred online courses reported that they experienced more stress in face-to-face than in online courses (Chi-Square Goodness of Fit Test: $N = 169$, $\chi^2 = 98.568$, $df = 2$, $P < 0.001$). Likewise, students who preferred in-person courses reported experiencing more stress in virtual than in-person courses (Chi-Square Goodness of Fit Test: $N = 268$, $\chi^2 = 156.925$, $df = 2$, $P < 0.001$).

Perceived cheating and awareness of cheating

Overall, students perceived cheating to be more prevalent on virtual exams relative to in-person exams (Related-Samples

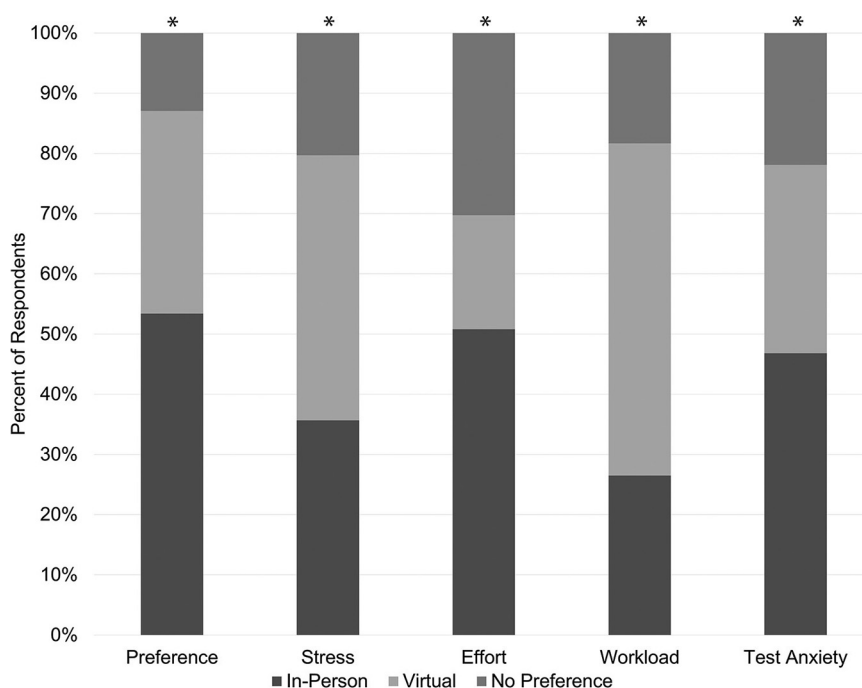


FIG 1. Student's (N = 502) perceptions of in-person versus virtual courses. Students were asked which modality: they preferred, caused more stress, for which they put forth more effort, had a greater workload, and caused more test anxiety. Asterisks indicate a difference among the three answer choices available to survey respondents (in-person, virtual, no preference) relative to the expected percentages under the null hypothesis (Chi-square Goodness of Fit Tests: $P < 0.001$ for all tests).

Wilcoxon Signed Rank Test: $T = 86321$, $P < 0.001$; Fig. 3A). Four-year students perceived more cheating on virtual exams relative to 2-year peers (Mann-Whitney U: $U = 37612$ $P < 0.001$; Fig. 3B). There was no difference in perceived cheating during in-person exams of 2-year or 4-year students (Mann-Whitney U: $U = 27847.5$, $P = 0.110$; Fig. 3C).

All cheating strategies listed in the survey were strategies that students were personally aware of being used during virtual exams. Using notes and looking up answers

were the most frequently cited strategies (Fig. 4). 2-year and 4-year students differed with respect to whether they were personally aware of cheating (Chi-square: $N = 502$, $\chi^2 = 51.867$, $df = 2$ $P < 0.001$). The majority of 2-year students were not personally aware of any kind of cheating (71.5%) as opposed to the majority of 4-year students who were personally aware of cheating (60.8%). The number of cheating strategies students were personally aware of being used was positively correlated with their perception of how many of their

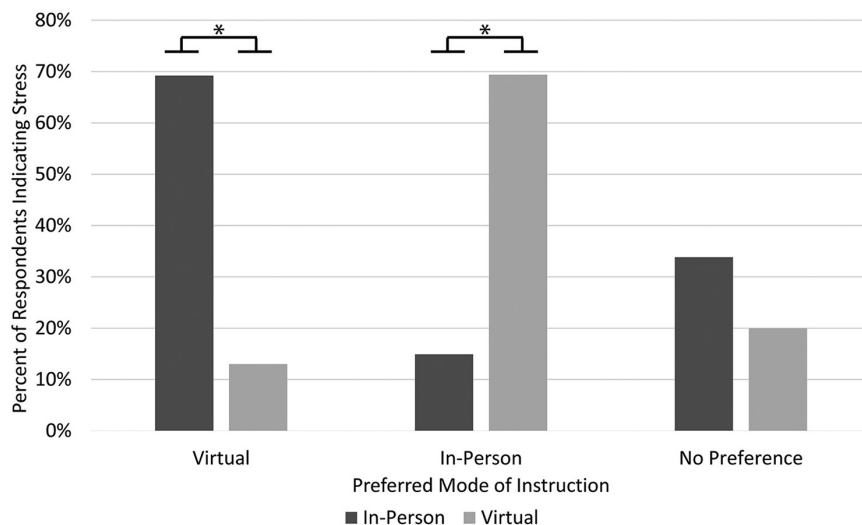


FIG 2. Percent of respondents indicating stress in virtual and in-person courses based on preferred mode of instruction. Asterisks indicate significant differences between observed and expected percentages based on a null hypothesis of no relationship between course modality and perceived stress (Chi-Square Goodness of Fit Tests: $P < 0.001$).

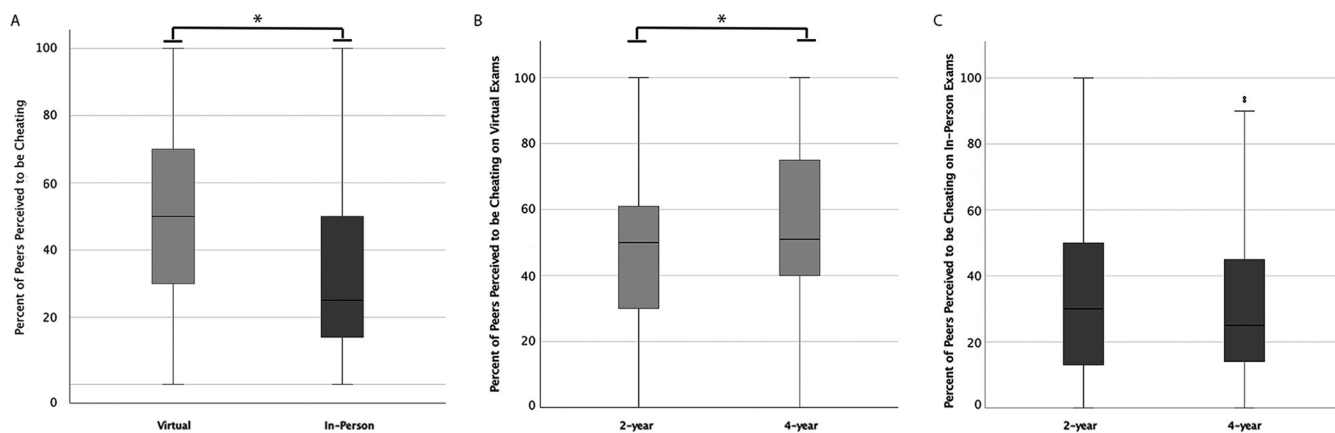


FIG 3. (A) Respondents’ perception of cheating occurrences during virtual and in-person exams. Overall, students indicated that they perceived that academic dishonesty occurs more frequently during virtual relative to in-person exams (Related-Samples Wilcoxon Signed Rank Test: $T = 86321$, $P < 0.001$). (B) 4-year students perceived more peers cheating on virtual exams relative to 2-year peers (Mann-Whitney U: $U = 37612$, $P < 0.001$). (C) 2-year and 4-year students perceived similar levels of cheating on in-person exams (Mann-Whitney U: $U = 27847.5$, $P = 0.110$).

peers were violating academic integrity rules (Spearman’s rank correlation: $N = 502$, $r_s = 0.499$, $P < 0.001$; Fig. 5).

Factors that encourage or discourage cheating

In order to address what might motivate or inhibit academic dishonesty, students were queried as to which factors incentivize or disincentivize cheating. Overwhelmingly, students reported that grades are the main incentive, whether that is to get a better grade or because they perceive the instructor is a tough grader (Fig. 6A). Students further indicated that exam time allotment being too short encouraged cheating (Fig. 6A). The perception that lots of other students cheat was the least frequently cited incentive to cheat (Fig. 6A). A larger proportion of 4-year students (36.8%) indicated that lots of other students cheating

encourage them to cheat relative to 2-year peers (19.8%) (Fisher’s Exact Test: $P < 0.001$). Fear of getting caught and personal integrity were the most commonly cited factors that discouraged cheating (Fig. 6B).

Causes of stress online

With the switch to remote learning, instructors implemented a number of strategies to decrease the probability that students would cheat during online exams. Students were asked which strategies, intended to deter cheating, within three broad categories (exam logistics, exam question types, and technology requirements), caused stress.

Exam logistics. Inability to backtrack and having a time limit both caused more than 70% of students stress (Fig. 7A). Furthermore, 43.6% of students indicated a visible timer

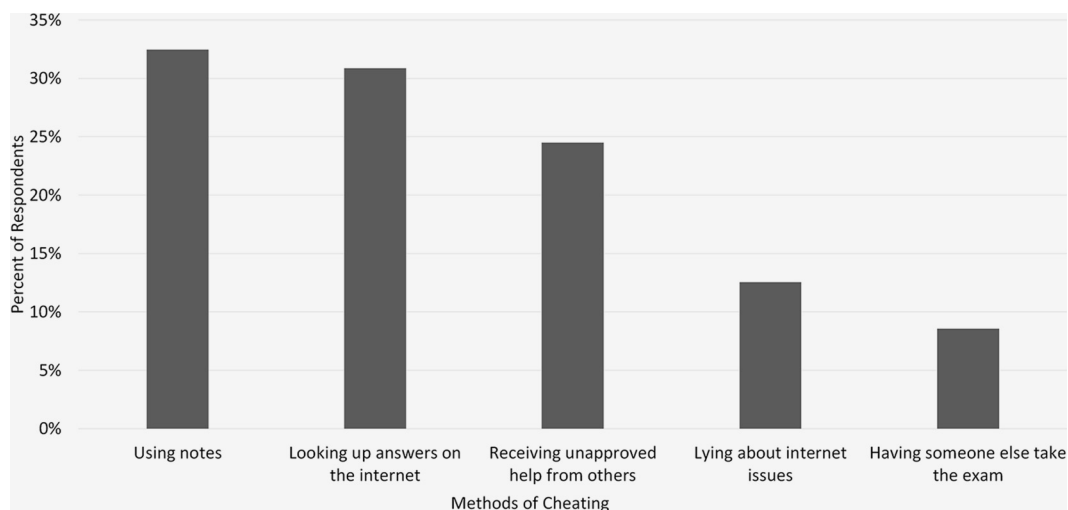


FIG 4. Percent of respondents indicating they were personally aware of a strategy being used during a virtual exam. Respondents were able to select more than one response.

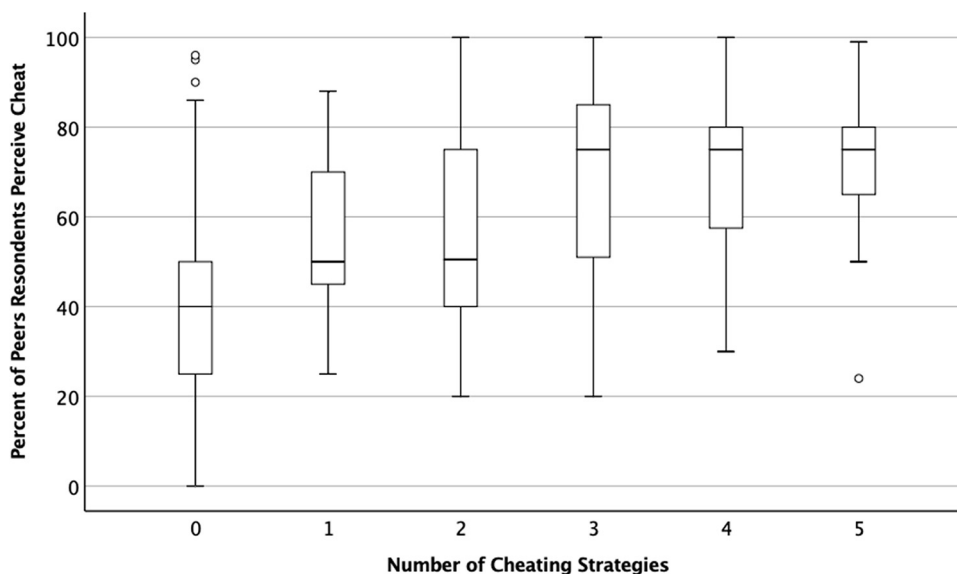


FIG 5. The number of cheating strategies respondents were personally aware of peers using during virtual exams was positively correlated with the percentage of peers the respondents perceived to be cheating on virtual exams (Spearman's rank correlation: $N = 502$, $r_s = 0.499$, $P < 0.001$).

during virtual exams was stress inducing. Randomized questions and synchronous exams, by comparison, induced stress in fewer respondents.

Question type. Students reported that all types of questions caused stress (Fig. 7B). Multiple choice questions were least and oral exams were most frequently cited as causing stress (Fig. 7B).

Technology requirements. Requiring student cameras to be on, recording students during the exam, and lockdown browsers that prevent students from accessing anything other than the exam, are available as remote invigilating tools. These tools can be used alone or in combination. Students reported that all the technological tools caused stress (Fig. 7C). Being recorded during the exam, which also necessitates having a camera on, was most often reported as being stressful (Fig. 7C). The lockdown browser alone was perceived as stressful for 29.1% of students. However, 55% of students perceived a lockdown browser paired with having a camera on as stressful. More 4-year students reported stress related to the technological tools of having cameras on in combination with lockdown browsers and being recorded relative to 2-year peers (Chi-square Tests: $P < 0.001$; Fig. 7D). Fewer 4-year students reported stress related to lockdown browsers relative to 2-year peers (Chi-square test: $P = 0.002$; Fig. 7D).

Maximizing academic integrity (from the student perspective)

Students were asked which strategies within each category they thought would discourage cheating.

Exam logistics. Randomized questions were the most frequently selected method that respondents felt reduces the likelihood of cheating (Fig. 8A). Inability to backtrack, one of the

methods most students indicated as stressful (Fig. 7A), was the least frequently selected method to reduce cheating.

Question type. Of exam question types, respondents were most likely to indicate that oral exam questions reduce cheating while multiple choice questions are least likely to reduce cheating (Fig. 8B).

Technology requirements. Cameras in combination with lockdown browsers were most frequently indicated as technological requirements that would reduce the likelihood of cheating (Fig. 8C). The frequency of 2-year and 4-year students indicating that specific technology requirements limited cheating varied with college type. 4-year students were more likely to indicate that lockdown browsers, cameras in combination with lockdown browsers, and being recorded would reduce the likelihood of cheating relative to 2-year peers (Chi-square: $P = 0.049$, $P < 0.001$, and $P = 0.001$, respectively; Fig. 8D).

DISCUSSION

The responses to the survey illuminated the thoughts and opinions predominantly held by students in the new, pandemic-induced, environment. While there were some differences between students at public 2-year and private 4-year institutions, our final recommendations to maximize academic integrity and minimize student stress are applicable across institution types.

Virtual versus in-person

The results reported here should be interpreted in the context of the environment in which they were collected. The stress students and faculty felt from the pandemic

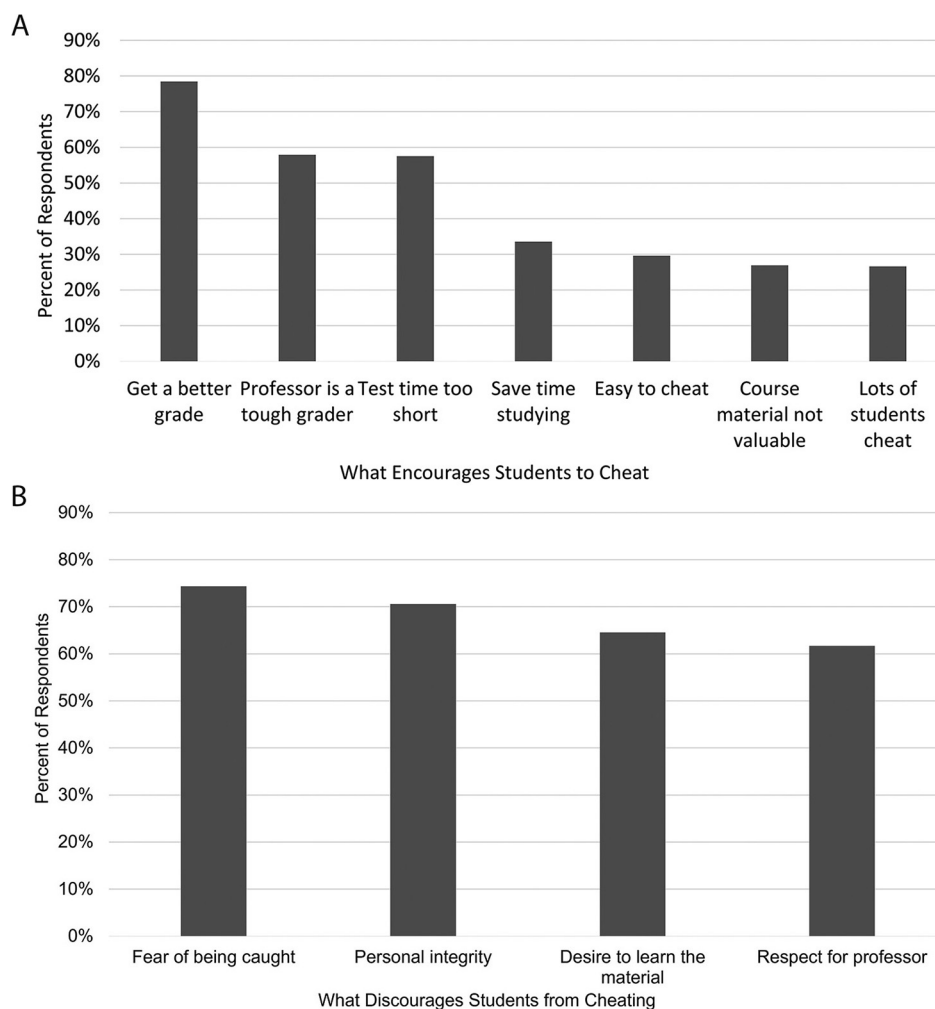


FIG 6. Percent of respondents indicating what (A) encourages and (B) discourages students to cheat. Respondents were able to select more than one response.

cannot be decoupled from the stress of being forced to take courses online when students originally registered for in-person classes (2). Faculty, many of whom were not instructed in online course design, were obligated to learn new technologies, and were unprepared for what to expect from students. By the time students were surveyed in May 2021, most classes were still virtual.

In this context, students preferred the course modality in which the least stress was experienced (Fig. 2). The data show that students experience more stress from online courses, perceive a greater workload in online courses and thus prefer in-person courses overall (Fig. 1). This is in line with previous research on modality preference (16). One student related, “in-person is more effective for the learning process which translates to better preparedness for exams.”

What can explain the perception that online classes have a greater workload, but that in-person classes require more effort? A big workload with less effort could be caused by professors who, feeling disconnected from their students, assign busy work. One student lamented, “most professors make tests and assignments harder [be]cause they think online

schooling is easier.” An alternative possibility is that students might put in more effort for the same assignment in class with a professor watching over them, but online, they can copy answers from a friend and submit it for credit. Yet another possibility is that students do not put in as much effort online because they feel lost, or unmotivated and simply resort to cheating when exam time comes. One student bristled, “I feel like people don’t want to take the time to study since [online] cheating is very easy.”

While some students indicated a preference for online courses, none expressed ease of online classes for their lifestyle, easier learning online, less stress online, or any similar sentiment in the free response question at the end of the survey. On the other hand, over a dozen quotes from students stated the opposite, including the one above citing ease of online cheating. It cannot be ruled out whether or how much this might be a motivating factor for those who prefer online courses.

In spite of in-person preference, more students reported that in-person exams caused them anxiety relative to virtual exams (Fig. 1). In-person exams are often closely monitored, timed, and in cramped classrooms that might lead to more

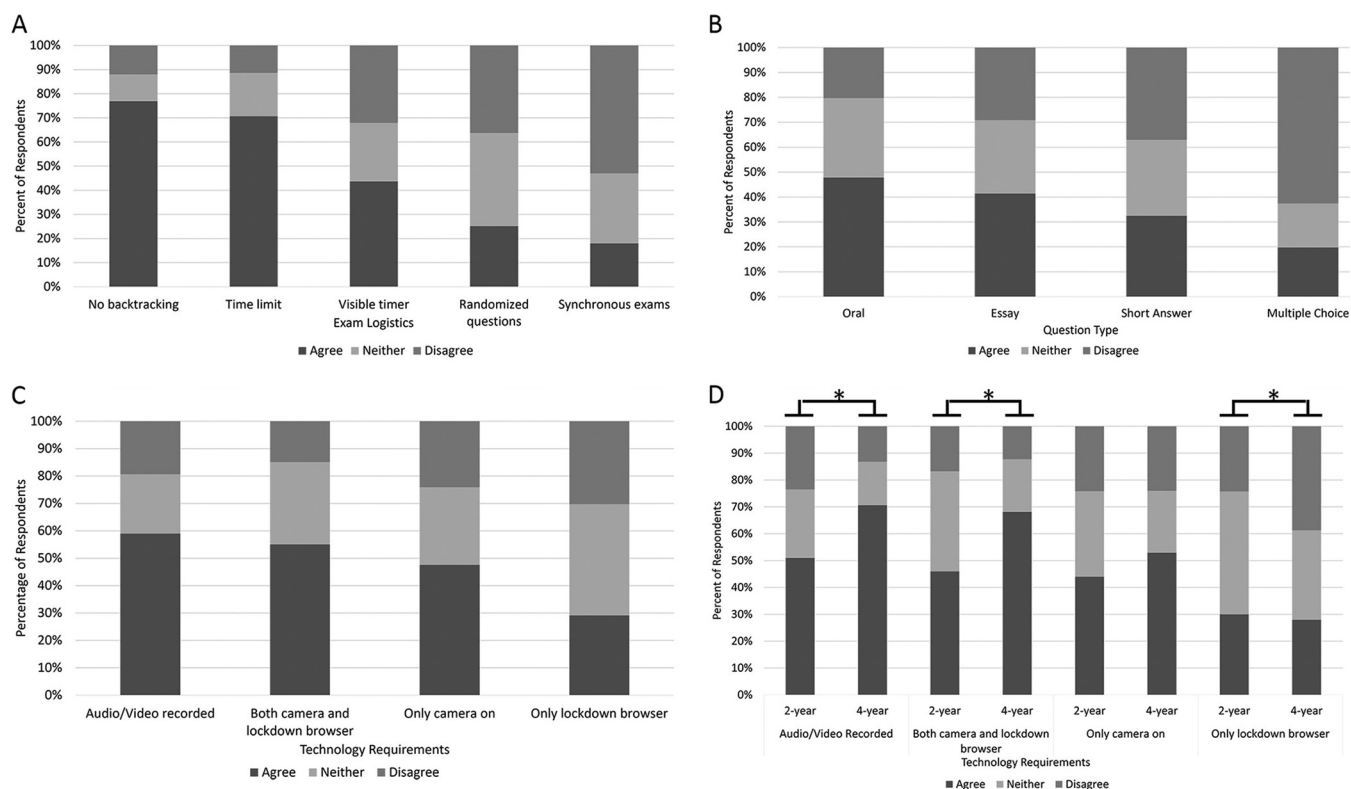


FIG 7. Percent of respondents agreeing, disagreeing, and neither agreeing nor disagreeing that each of (A) five exam logistics (B) four question types and (C) four technology requirements caused stress during virtual exams. (D) There were differences between the percentage of 2-year and 4-year respondents indicating that various technological requirements caused stress during virtual exams. More 4-year students reported stress related to having cameras on in combination with lockdown browsers and being recorded relative to 2-year peers (Chi-square Tests: $P < 0.001$). Fewer 4-year students reported stress related to lockdown browsers relative to 2-year peers (Chi-square test: $P = 0.002$).

anxiety over spacious home desks, a familiar environment, and limited monitoring.

Perceived cheating and awareness of cheating

The vast majority of 2-year students were not personally aware of the use of any of the cheating methods referenced in the survey, while most 4-year students were personally aware of these cheating methods being used. The number of methods a student was aware of was positively correlated with the percentage of peers a student perceived to be cheating during online exams (Fig. 5). Together, these two findings explain why the 2-year students perceived fewer peers were cheating online compared with the 4-year students. Previous work has shown that the more and closer relationships students have, the more likely they will be aware of cheating among their peers, and that this affects how acceptable this practice is among the group (17). Four-year students who know each other longer (from having more years in the same school together), and form closer bonds (for example, from living in the same dorm) may therefore be more likely to be aware of cheating.

Factors that encourage or discourage cheating

Motivations to cheat vary among students. Students indicated that getting a better grade encouraged cheating while fear

of being caught discouraged cheating (Fig. 6). Instructors may inadvertently contribute to motivations to cheat during online exams by making the test time too short and being perceived as a tough grader. While most students report that personal integrity helps them maintain academic honesty (Fig. 6B), if students believe a professor is unjust in any way (for example, by setting time limits that are too short or grading harshly, etc.), this may make students feel that cheating is now fair game. In particular, if a student believes that a professor grades too tough or does not give him or her enough time to complete an exam, then what choice does a student have but to cheat? As one student explained, “having a short time limit makes students want to cheat on exams.” This view might be supported by the fact that over 60% of all students (Fig. 6B) said they do not cheat out of respect for their professor. While that may initially be the case, what happens when that respect is lost?

Based on the survey free response question, not everyone agrees with this view. One student noted, “I believe cheating does not stem from an area of . . . disrespect, but out of feeling lost.” And still another student contributed, “maybe they cheat because they do not understand the information correctly and are too afraid to ask for help.” The survey did not assess whether students cheat because they feel lost and do not understand the material.

Surprisingly, “lots of students cheat” was not a big motivator for cheating and was the least reported reason students

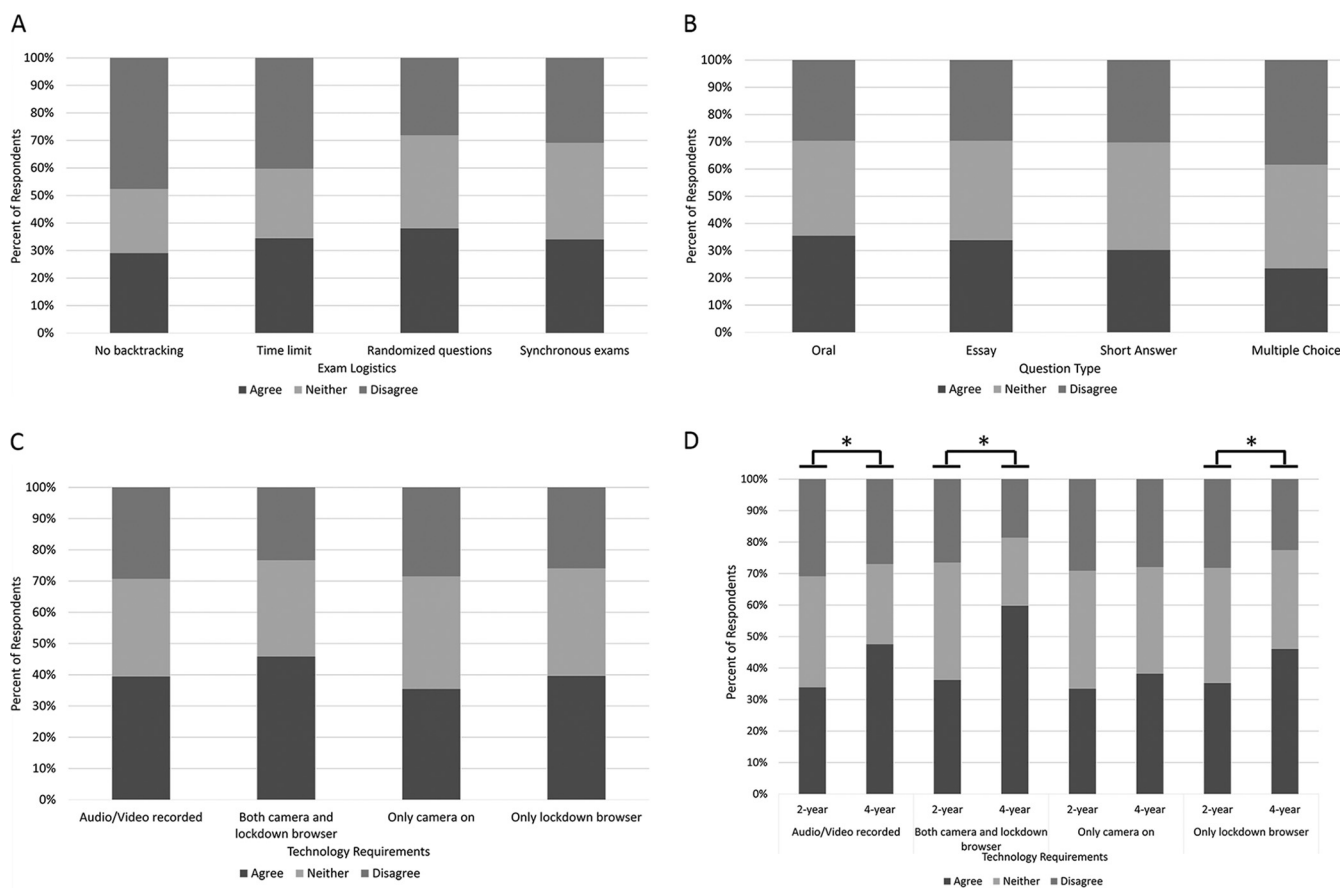


FIG 8. Percent of respondents agreeing, disagreeing, and neither agreeing nor disagreeing that each of (A) five exam logistics (B) four question types and (C) four technology requirements were effective at maximizing academic integrity during virtual exams. (D) There were differences between the percentage of 2-year and 4-year respondents indicating that various technological requirements maximized integrity. Four-year students were more likely to indicate that lockdown browsers, cameras in combination with lockdown browsers, and being recorded would maximize integrity relative to 2-year peers (Chi-Square Tests: $P = 0.049$, $P < 0.001$, and $P = 0.001$, respectively).

cheat (Fig. 6A). As expected based on student perceptions, this reason was reported more frequently for 4-year relative to 2-year students (36.8 versus 19.8%).

Maximizing integrity and minimizing stress

Instructors have a variety of tools to choose from to maximize academic integrity during online exams. Many of these are different than the tools available for face-to-face exams, but even the tools that are the same, may be perceived differently when employed online. These tools were grouped into three categories for analysis.

Exam logistics. One option especially applicable to online exams is the ability to randomize question order, question choices, and even numeric variables within a mathematical question. Students perceive randomizing questions and answers as the most effective exam logistic to reduce cheating (Fig. 8A) and report that it is among the least stress-inducing methods a professor can use (Fig. 7A). Using randomized questions, one student cannot ask another for the answer to a particular question number; instead, the student would have to ask about a specific question using keywords, which the other student may not have yet encountered.

Some professors wanted to stay one step ahead and instituted another new online tool: no backtracking. One student derided this method: “We waste time on questions we don’t know because we know we cannot go back as we would in-person where we answer everything we know first and move on. [That is] how we were taught to take exams.” Nothing else causes students more stress than when students cannot backtrack (Fig. 7A). This is not surprising as it is contradictory to deeply ingrained test-taking strategies, and could even promote a feeling of injustice committed by the professor. At the same time, students indicated that inability to backtrack is not an effective method to discourage cheating (Fig. 8A). These findings reproduce the results of a 2020 study that showed over 65% of medical students reported no backtracking as a factor that causes stress during online exams (18). What’s more, limiting backtracking may be discriminatory to differently abled students (19).

The second most reported stressor for students is having a time limit (70.7%; Fig. 7A), a result that was almost identical to a 2020 study concluding time limits caused 70.56% of students stress (18). Regarding the time limit, one student stated, “because of this added stress . . . I believe more students are motivated to cheat.” This response makes sense in light of a study that used

EEGs to show time limits increase stress levels and lead to reduced performance on exams (20). While time limits are not unique to online environments, one student suggested, “The timed exams being so short to try to make cheating not occur which is actually shorter than an in-person exam caused stress/test anxiety.” Professors making shorter online exams than in-person exams could be quite common. This could happen by accident if professors directly convert in-person exams to online exams when they do not translate well. For example, students may first need to solve problems involving math on scratch paper, and then transfer their answers and work online, a process, which may take more time than if the exam was given in-person. Additionally, not all students may be proficient at using a keyboard or students may have slow internet causing further time issues.

Question type. Students report that multiple choice are the least effective exam question to discourage cheating (Fig. 8B), and no one type of question was far more effective than others (Fig. 8B). This may be due to not all students having experience with all question types, or that students could conceive of ways to cheat regardless of the question type. As expected, oral exam questions were thought to cause the most stress (Fig. 7B).

Technological tools. The majority (over 65%) of 4-year students said cameras and lockdown browser or being video and audio recorded caused them stress (Fig. 7D). In spite of that, nearly 60% of 4-year students agree that having cameras on with lockdown browser is an effective cheating deterrent (Fig. 8D). One student’s advice, “lockdown of browsers preventing people from cheating will be and should be the method across all online testing systems since the tool is in front of the person.” While the survey shows significantly more 4-year students find these deterrents effective than 2-year students (Fig. 8D), it must be restated that neither of the 2-year schools that participated in this survey have policies that allow a professor to require cameras on during exams. Therefore, the substantial number of 2-year students that agree with these methods being effective, could only do so without personal experience.

Our recommendations

Maximizing integrity. (i) Be transparent regarding academic dishonesty. Fear of getting caught was reported as the foremost deterrent to cheating (Fig. 6B). Therefore, faculty making an explicit commitment to promoting academic honesty, including being forthright about the mechanisms in place to detect as well as the consequences of academic honesty violations, may be strong deterrents. (ii) Having cameras on with a lockdown browser is the greatest deterrent to students cheating during online exams. This provides the most in-person-like environment for students to take exams. While this causes stress for some students, these same students recognize that these methods work. While this is not allowed at all schools, the authors recommend that (a) policies change so that this can be applied to all students taking online exams, and (b) institutions ensure student access to technology to facilitate these methods that maximize academic integrity.

Maximizing integrity and minimizing stress. (iii) Students found synchronization of exams and (iv) randomization of exam questions to be least stress inducing (Fig. 7). These are effective methods of limiting cross talk between students. Also, if questions can be randomized for both order presented to students, and for what values appear in a question, getting help from classmates or looking up answers online during an exam can be minimized.

Minimizing stress. The use of no backtracking techniques during exams is antithetical to testing methods students have learned for years and causes students stress. While it may reduce some forms of cheating, it may also reduce student scores since students need to adjust their test taking strategies. (v) The authors therefore recommend allowing backtracking during exams. (vi) To address the issue of stress caused by time constraints, it is recommended that professors not simply convert in-person exams to online exams, but rather to experiment with technology and find new ways of designing exams for the online environment. Professors should begin surveying students after each exam to determine if the time given for the exam was adequate. Until one becomes as proficient online as in-person, it may be better to give students a little too much time rather than too little. For more ideas, Chen et al. (21) provides helpful information on designing online STEM courses.

None of these recommendations depends on the others, and all can help to maximize academic integrity and minimize student stress even if school policy or technology prohibits some of these options.

Final thoughts

Stress has been more prominent in everyone’s lives since coronavirus entered our vocabularies. In particular, students will do what they must in order to decrease their stress, whether this means taking an in-person class, or cheating during an online exam. As one student provided a hard to hear insight, “cheating therefore, eases the students fear of failing and having to retake a class and in a way makes the student feel less stressed.” A balance must be achieved between maximizing academic integrity and minimizing student stress. Failure to achieve this balance may counterintuitively increase the cheating we seek to eliminate in online courses. While the majority of students preferred in-person courses, a very large segment of students still preferred online courses. Another recent survey indicates that, going forward, a large segment of students may be clamoring for more classes to be online (5). Faculty may have adapted their courses out of necessity for the pandemic, but the result of the pandemic will likely be more online courses.

Limitations

Although there was a sample size of 502, the survey was not exhaustive in the variables evaluated. The few demographic questions were purposeful so that students could be sure they would remain anonymous and feel open to share. Both 2-year schools were public, and all 4-year schools were private which may confound results that indicated a difference between the two.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, PDF file, 0.1 MB.

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REFERENCES

- Mervosh S, Swales V. 2020. Colleges and universities cancel classes and move online amid coronavirus fears. *The New York Times*.
- Wang X, Hegde S, Son C, Keller B, Smith A, Sasangohar F. 2020. Investigating mental health of US college students during the COVID-19 pandemic: cross-sectional survey study. *J Med Internet Res* 22:e22817. <https://doi.org/10.2196/22817>.
- McCabe D. 2015. Cheating and honor: lessons from a long-term research project. In: Bretag T. (ed) *Handbook of Academic Integrity*. Springer, Singapore.
- Passow HJ, Mayhew MJ, Finelli CJ, Harding TS, Carpenter DD. 2006. Factors influencing engineering students' decisions to cheat by type of assessment. *Res High Educ* 47:643–684. <https://doi.org/10.1007/s1162-006-9010-y>.
- Hobbs T. 2021. Cheating at school is easier than ever - and it is rampant. *The Wall Street J*. <https://www.wsj.com/articles/cheating-at-school-is-easier-than-everand-its-rampant-11620828004>.
- Newton D. 2020. Another problem with shifting education online: a rise in cheating. *The Washington Post*, August 7. https://www.washingtonpost.com/local/education/another-problem-with-shifting-education-online-a-rise-in-cheating/2020/08/07/1284c9f6-d762-11ea-aff6-220dd3a14741_story.html.
- Academic Integrity in the Age of Online Learning. Wiley, 2020. <https://www.wiley.com/network/featured-content/is-student-cheating-on-the-rise-how-you-can-discourage-it-in-your-classroom>.
- Lancaster T, Cotarlan C. 2021. Contract cheating by STEM students through a file sharing website: a Covid-19 pandemic perspective. *Int J Educ Integr* 17. <https://doi.org/10.1007/s40979-021-00070-0>.
- McKenzie L. 2021. Survey reveals positive outlook on online instruction post-pandemic. *Inside Higher Edu* <https://www.insidehighered.com/news/2021/04/27/survey-reveals-positive-outlook-online-instruction-post-pandemic>.
- Santangelo J, Hobbie L, Lee J, Pullin M, Villa-Cuesta E, Hyslop A. 2021. The (STEM)² Network: a multi-institution, multidisciplinary approach to transforming undergraduate STEM education. *Int J STEM Educ* 8. <https://doi.org/10.1186/s40594-020-00262-z>.
- Gierdowski DC. 2019. ECAR Study of Community College Students and Information Technology, 2019. Research report. Louisville, CO: ECAR.
- Academic Integrity Survey. Gettysburg College 2021. <https://www.gettysburg.edu/offices/academic-advising/honor-code/honor-code-data-archives/IntegritySurveyClassof2021.pdf>.
- University of Maryland Baltimore County, Academic Integrity Survey Report. 2003. <https://oir.umbc.edu/files/2013/04/UMBC-AI-Survey-Report-S2003.pdf>.
- Florida State University Academic Integrity Survey. 2015. <https://provost.gsu.edu/document/florida-state-university-academic-integrity-survey-spring-2015/>.
- SPSS Statistics for Macintosh, Version 25.0. 2019. Armonk, NY: IBM Corp.
- Flowers LO, Raynor JE, White EN. 2012. Evaluation in online STEM courses. *Int J Business and Social Science* 18:16–20.
- Hutton PA. 2006. Understanding student cheating and what educators can do about it. *College Teaching* 54:171–176. <https://doi.org/10.3200/CTCH.54.1.171-176>.
- Elsalem L, Al-Azzam N, Jum'ah AA, Obeidat N, Sindiani AM, Kheirallah KA. 2020. Stress and behavioral changes with remote Exams during the Covid-19 pandemic: a cross-sectional study among undergraduates of medical sciences. *Ann Med Surg (Lond)* 60:271–279. <https://doi.org/10.1016/j.amsu.2020.10.058>.
- Raje S, Stitzel S. 2020. Strategies for effective assessments while ensuring academic integrity in general chemistry courses during COVID-19. *J Chem Educ* 97:3436–3440. <https://doi.org/10.1021/acs.jchemed.0c00797>.
- Hafeez MA, Shakil S, Jangsher S. 2018. Stress effects on exam performance using EEG. 14th International Conference on Emerging Technologies (ICET), 1–4. <https://doi.org/10.1109/ICET.2018.8603652>.
- Chen B, Bastedo K, Howard W. 2018. Exploring design elements for online STEM courses: active learning, engagement & assessment design. *Olj* 22:59–75. <https://doi.org/10.24059/olj.v22i2.1369>.