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RESEARCH ARTICLE

Impact of proctored examinations on students' performance in an online undergraduate pharmacology course

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Abstract

Background: Previous studies on assessment techniques in education have observed that students tend to take longer and score higher on unproctored exams than proctored exams in some disciplines. **Objective:** To investigate the impact of a post-pandemic return to proctored examinations on student performance in undergraduate pharmacology education**. Methods:** This was a quantitative, retrospective, observational study in which exam scores and time spent data were collected for two sections – one unproctored and one proctored – of an online 2000-level introduction to pharmacology course. Data between the two groups was compared using independent two-sample t-tests to investigate any statistically significant differences. Cohen's d was calculated for effect size. **Results:** In aggregate, exam scores were statistically higher in the unproctored group than in the proctored group. Student time spent on exams was significantly longer in the unproctored group than in the proctored group. **Conclusion:** These findings support the consideration that students score higher and spend more time on unproctored exams than proctored exams in undergraduate pharmacology similar to many other disciplines. The explanation for this observation is likely multifactorial and may warrant further investigation.

Introduction

Administration methods that reliably maintain the integrity and validity of exam results in online education have been extensively debated. Various examination techniques exist, ranging from completely unproctored tests in the private home setting to traditional in-person proctored exams in a testing centre with numerous scenarios in between. Determining which assessment method is best for a particular examination often varies from course to course and typically includes an evaluation of many variables such as proctoring access, cost, convenience, and practicality. A review of recent data on the integrity of unproctored versus proctored exams can be informative regarding whether or not to proctor.

Certain studies have observed that students take longer and score higher on unproctored exams as compared to proctored exams casting some speculation regarding the academic integrity of unproctored exams (Brallier & Palm, 2015; Alessio *et al.*, 2017; Daffin & Jones, 2018; Goedl & Malla, 2020; Howard, 2020). These studies appear to indicate this observance spans multiple disciplines, including medical terminology, sociology, accounting, psychology, and mathematics, at course levels ranging from introductory to advanced. Interestingly, and possibly alarmingly, Daffin and Jones (2018), in a study of 1,694 psychology students, observed that students took twice as long and performed 10-20% better in unproctored exams than in proctored exams.

Not all evidence, however, mirrors these findings. Hollister and Berenson (2009) reported no significant difference in performance between proctored and unproctored exams for students enrolled in an introduction to computers in business course. Yildirim

et al. (2023), in their study of students taking an information technology course, also noted no significant difference in proctored versus unproctored exam scores; however, they still observed a significant difference in total time spent on exams with longer times associated with unproctored exams.

Meta-analysis appears to support the concept that online unproctored and proctored exams are not to be considered equal, with data confirming the trend of significantly higher scores on exams in unproctored settings as compared to proctored settings based on a review of 49 studies (Steger *et al.*, 2017). Anecdotally, it is often presumed in the online education community that proctored exams add a layer of academic integrity and student rigour compared to unproctored exams. Nevertheless, the extent to which this is applicable may vary from discipline to discipline or institution to institution; therefore, additional studies that can add to the collective knowledge on the subject are often welcome.

Before August 2023, exams in a 2000-level introduction to pharmacology course offered at a university in the western United States were administered as unproctored assessments. Starting with the Fall 2023 semester, a post-pandemic course policy shift was made to require proctored exams in the online offering of this course. This was identified as an opportunity to investigate whether trends of longer exam times and higher scores on unproctored exams previously observed in other subjects – accounting, mathematics, medical terminology, etc. – would be similarly observed for undergraduate pharmacology.

Analysis of the impact of such a transition from unproctored to proctored assessments was determined to be of significant interest to the department offering this course, informing further ongoing review of its departmental proctoring policies. However, it was also considered that this information would benefit the international scientific community by adding useful knowledge regarding the impact of exam proctoring on student performance in pharmacy education courses. The study's primary objective was to investigate any statistically significant effect of proctoring status – unproctored versus proctored – on exam performance as measured by time spent and exam scores for examinations in online undergraduate pharmacology instruction.

Methods

Design

This was a quantitative, retrospective, and observational study analysing scores and time spent data collected from examinations completed in an online 2000-level introduction to pharmacology course at a university in the western United States. The course from which data was collected was an undergraduate pharmacology course taught to students aspiring for admission to various professional programs such as nursing, dental hygiene, clinical laboratory science, respiratory therapy, radiological science, physician assistant medicine, medical school, and pharmacy school. The course covered pharmacokinetic and pharmacodynamic principles of various drug classes, emphasising medications used in diagnosing and treating common diseases.

The course content was divided into six units with six corresponding exams. Exams consisted of approximately 50 questions and were required to be completed within a 45-minute time limit. Question sets were generated randomly from question banks corresponding to each unit using a randomisation feature available via the course's learning management system, Canvas (https://www.instructure.com/canvas). As such, individually generated exams were designed to cover identical learning objectives and to be of similar difficulty from student to student within each respective unit.

During the Summer 2023 semester, exams in the online offering of this course were unproctored. Students were asked to acknowledge and follow a written honour code statement prohibiting activities such as exam collusion and using any external resources or notes. However, this was accompanied by no objective method for instructors to confirm the honour code was adhered to by exam takers. Starting with the Fall 2023 semester, a post-pandemic policy shift required proctored exams in the course. Under this new policy, students were requested to take exams using a traditional in-person proctor in a university testing centre; distance learners located outside the university's primary geographical service area were provided with the additional option of online remote proctoring via the university's contracted proctoring software, Proctorio (https://proctorio.com/).

One online section of the course was taught during the Summer 2023 semester (unproctored) and one online section during the Fall 2023 semester (proctored). Course content and delivery were not considered to be meaningfully different between the two semesters except for the proctoring policy being intentionally investigated. Different instructors moderated the courses, one during the Summer of 2023 and another during the Fall of 2023, but both followed a

predetermined curriculum designed to allow for asynchronous online delivery. The textbook, pre-recorded lectures, exam question banks, and learning management system were consistent for each course between the semesters investigated.

Data for time spent and scores were collected using the learning management system's export and review features for all exam attempts in the assessed courses. Time spent and scores for completed attempts of Exam One during the Summer 2023 semester (unproctored) were compared with time spent and scores for completed attempts of Exam One during the Fall 2023 semester (proctored) and so on for all six unit exams to investigate the presence of any statistically significant differences in these variables between the unproctored and proctored groups. An exploratory sub-analysis was also conducted to nascently investigate performance differences based on the proctoring method used, in-person versus online, in the Fall 2023 cohort. Results were presented using descriptive statistics, and independent two-sample t-tests were utilised to make statistical comparisons regarding time spent and scores between corresponding exam pairs. Cohen's d was calculated for effect size.

Ethics approval

The research was approved by the institutional review board of Weber State University upon its determination that it qualified for exemption status (#IRB-AY23-24-368).

Results

Analysis of time spent on examinations

Time spent on examinations was significantly higher across all exams in the unproctored group compared to the proctored group. Collectively, students spent an average of about 10 minutes longer on unproctored exams (M = 35.11, SD = 9.45) as compared to proctored exams (M = 25.24, SD = 9.66), $t(617) = 12.49$, $p < 0.001$. Comparisons remained statistically significant when appropriately disaggregated into distinct unit exam comparisons. Calculated Cohen's d indicated a large effect size overall. Complete data for the time spent comparisons analysed are provided in Table I.

Table I: A comparison of time spent (minutes) between unproctored and proctored exams

Exam	Unproctored (Summer 2023)			Proctored (Fall 2023)			*T*	*p*	Cohen's d
	n	M	SD	n	M	SD			
1	41	29.61	9.41	64	23.30	8.54	3.55	< 0.001	0.710
2	40	35.95	9.05	64	26.16	10.25	4.95	< 0.001	0.998
3	41	36.22	9.61	63	26.29	9.84	5.08	< 0.001	1.018
4	39	36.85	9.37	63	25.21	9.41	6.08	< 0.001	1.238
5	40	37.08	8.41	61	24.95	10.22	6.24	< 0.001	1.270
6	40	35.13	9.22	61	25.57	9.69	4.94	< 0.001	1.004
All	241	35.11	9.45	376	25.24	9.66	12.49	< 0.001	1.030

Analysis of examination scores

In aggregate, exam scores were statistically higher in the unproctored group (M = 79.51, SD = 12.26) as compared to the proctored group (M = 75.28, SD = 14.64), $t(617) = 3.73$, $p < 0.001$. However, when more appropriately disaggregated into distinct unit exam comparisons, a statistically significant difference was only found for Exams One and Six. Exam One scores in the unproctored group (M = 84.44, SD = 8.54) were significantly higher than scores in the proctored group (M = 78.78, SD = 13.23), $t(105) = 2.43$, $p = 0.017$. Similarly, Exam Six scores in the unproctored group (M = 79.58, SD = 11.78) were significantly higher than scores in the proctored group (M = 72.62, SD = 13.96), $t(101) = 2.60$, $p = 0.011$. Calculated Cohen's d indicated small-to-moderate effect sizes. Complete data for the exam score comparisons analysed are provided in Table II.

Table II: A comparison of exam scores (percentage) between unproctored and proctored exams

Exam	Unproctored (Summer 2023)			Proctored (Fall 2023)			*T*	*p*	Cohen's d
	n	M	SD	n	M	SD			
1	41	84.44	8.54	64	78.78	13.23	2.43	0.017	0.486
2	40	78.30	10.00	64	77.16	13.30	0.47	0.641	0.094
3	41	77.22	14.41	63	73.46	14.65	1.29	0.201	0.258
4	39	80.37	11.77	63	76.25	15.63	1.42	0.160	0.288
5	40	77.11	14.97	61	73.15	16.36	1.23	0.222	0.250
6	40	79.58	11.78	61	72.62	13.96	2.60	0.011	0.529
All	241	79.51	12.26	376	75.28	14.64	3.73	< 0.001	0.308

Sub-analysis of time spent and scores by proctoring method

Collectively, time spent on exams taken via an in-person proctor in a university testing centre (M = 23.73, SD = 8.74) was significantly shorter compared to exams taken using online remote proctoring (M = 28.71, SD = 10.77), $t(376) = -4.72$, $p < 0.001$. However, when properly disaggregated into distinct unit exam comparisons, a statistically significant difference was only observed for Exams Three and Six. Calculated Cohen's d indicated small-to-moderate effect sizes. Complete data for the time spent comparisons based on the proctoring method employed are provided in Table III.

Table III: A comparison of time spent (minutes) between in-person and online remotely proctored exams

Exam	In-person proctoring (Fall 2023)			Online remote proctoring (Fall 2023)			*T*	*P*	Cohen's d
	n	M	SD	n	M	SD			
1	48	22.50	7.91	16	25.69	10.12	-1.30	0.198	-0.375
2	43	24.44	9.69	21	29.67	10.72	-1.96	0.055	-0.521
3	44	24.64	8.47	19	30.11	11.84	-2.08	0.042	-0.570
4	44	24.09	8.60	19	27.79	10.88	-1.44	0.154	-0.396
5	42	23.40	9.55	19	28.37	11.07	-1.79	0.079	-0.495
6	41	23.41	8.52	20	30.00	10.65	-2.61	0.012	-0.711
All	262	23.73	8.74	114	28.71	10.77	-4.72	< 0.001	-0.530

Overall, scores for exams taken utilising an in-person proctor (M = 74.41, SD = 14.91) were not significantly different compared to exams taken using online remote proctoring (M = 77.27, SD = 13.86), $t(376) = -1.74$, $p = 0.082$. Calculated Cohen's d indicated a small effect size. Complete data for the exam score comparisons based on the proctoring method employed are provided in Table IV.

Table IV: A comparison of exam scores (percentage) between in-person and online remotely proctored exams

Exam	In-person proctoring (Fall 2023)			Online remote proctoring (Fall 2023)			*T*	*p*	Cohen's d
	n	M	SD	n	M	SD			
1	48	79.17	13.09	16	77.63	14.01	0.40	0.690	0.116
2	43	77.58	13.50	21	76.29	13.18	0.36	0.718	0.097
3	44	72.09	15.02	19	76.63	13.63	-1.13	0.262	-0.311
4	44	73.86	16.47	19	81.79	12.15	-1.88	0.064	-0.517
5	42	71.90	16.02	19	75.89	17.21	-0.88	0.382	-0.243
6	41	71.16	14.13	20	75.63	13.46	-1.18	0.244	-0.321
All	262	74.41	14.91	114	77.27	13.86	-1.74	0.082	-0.196

Post-hoc consideration

While all exams during Fall 2023 consisted of exactly 50 questions, it was discovered during data collection that some exams during Summer 2023 had more than 50 questions. Specifically, in the Summer 2023 unproctored group, Exam Four contained 52 questions, and Exam Five contained 57 questions; these extra questions were identified as still sourced from the appropriate exam question banks shared between the course offerings. The observation that scores remained better in this group despite the increased question count appears to confirm this did not add meaningful difficulty to the exams. However, the possibility is acknowledged that this could have impacted time spent.

Based on the time spent data collected, it was calculated that students spent an average of 42.5 seconds per question on Exam Four and 39 seconds per question on Exam Five in the Summer 2023 course. Even when a correction factor of a full 60 seconds per added question was subtracted from time spent data on these impacted exams, the analysis still indicated statistically longer time spent on exams in the unproctored group as compared to the proctored group at the $p < 0.01$ level. Details for this analysis are included in Table V.

Table V: Comparison of time spent (minutes) using a 60-second correction factor per added question for Exams Four and Five

Exam	Unproctored (Summer 2023)			Proctored (Fall 2023)			*T*	*p*	Cohen's d
	n	M	SD	n	M	SD			
4	39	34.85	9.37	63	25.21	9.41	5.03	< 0.001	1.026
5	40	30.08	8.41	61	24.95	10.22	2.64	< 0.010	0.537

Discussion

Overall, the results of the present study in undergraduate pharmacology appear to confirm observations from previous research in other disciplines demonstrating longer time spent and higher scores on unproctored exams as compared to proctored exams (Brallier & Palm, 2015; Alessio *et al*., 2017; Daffin & Jones, 2018; Goedl & Malla, 2020; Howard, 2020). Like Yildirim *et al*. (2023), this analysis did not reveal statistically significant differences in scores based on proctoring status for most exams but revealed that students spent significantly more time on unproctored exams than proctored ones.

Although the current study was not specifically designed to investigate the underlying reasons for this, the finding stimulates contemplation about what students in the unproctored group were doing with the extra time spent. While the existence of student exam malpractice or cheating cannot be definitively declared as an explanation for this observation, it also cannot be ruled out. Unfortunately, academic dishonesty remains a relevant concern at colleges and universities and cannot be ignored (Alessio *et al*., 2017; Dadashzadeh, 2021).

That a statistically significant difference in exam scores was only observed for the first and last unit exams and not others is interesting. Perhaps these exams were perceived as higher stakes by students and this perception more significantly influenced them to utilise unapproved resources or perhaps students just genuinely performed better on these exams in the unproctored group. It is difficult to ascertain. It is also possible that the time limit feature affixed to the exams made the exams somewhat more resistant to academic dishonesty which may have contributed to the lack of significant difference on exam scores between the unproctored and proctored groups for Exam Two through Exam Five.

Indeed, some researchers have suggested that appropriate exam time limits may be a useful mechanism for curbing certain methods of exam malpractice (Moten *et al*., 2013; Noorbehbahani *et al*., 2022). Under time-limit duress, a student is often forced to reconcile the opportunity cost of searching for an answer in a prohibited resource versus preserving adequate time to complete the exam. However, a certain balance must be exercised by educators as extremes in time limit imposition may conversely have an unintended negative impact on some honest students who genuinely require a little more time to think through exam items.

Regardless, due to the lack of formal supervision, it is largely interpreted that opportunities for cheating are more easily accessible and less detectable in unproctored exams than in proctored exams. This sentiment is not limited to instructors alone but is also acknowledged by students. In an assessment of student

attitudes on proctoring conducted by Milone *et al*. (2017), 70.43% of students agreed that exam proctoring is fairer, keeps all students on a more level playing field, and reduces cheating. Similarly, the near-majority of surveyed PharmD students in a separate cohort were observed to agree or strongly agree that exam proctoring is essential to maintaining academic integrity (Morgan *et al*., 2021).

And yet, perhaps unsurprisingly, when surveyed about proctoring preferences, students have reported a preference for unproctored, open-book exams over proctored, closed-book assessments (Morgan *et al.*, 2021). This creates a rather interesting dichotomy given that, while students appear to see the broader virtue in academic integrity preserved best by proctoring, they may gravitate preferentially toward unproctored exams when given the option. Conceptually, some students may even self-select into courses they know do not incorporate proctored exams opting for a perceived path of reduced academic rigour.

How educators navigate these and other concerns regarding academic integrity may be highly specific to a particular course or discipline and will understandably vary from instructor to instructor, department to department, and institution to institution. In certain cases, maintaining desirable academic integrity and rigour may depend on the instructor's choice of whether or not to proctor an exam. One pertinent factor in this choice will likely be whether the exam is intended to be summative or formative. Because unproctored exams may be more susceptible to score inflation resulting from increased access to prohibited resources (as compared to proctored exams), the authors would advocate for proctoring as a useful method to improve the reliability of summative assessments intending to be measures of independent content mastery in pharmacy education. For low-stakes formative assessments where the utility of external resources is encouraged or permitted, proctoring may not be as imperative.

The observation from this sub-analysis that there was no significant difference on exam scores based on proctoring method, in-person versus remotely online, in the Fall 2023 cohort appears to support that either proctoring method may increase academic integrity and rigour compared to unproctored exams. However, the finding that students generally spent longer on remotely proctored exams than in-person proctored exams seems to indicate that these methods may not be entirely equal in their impact. That said, it must be emphasised that this particular sub-analysis was only exploratory, and the present study was not designed to investigate nuance in this domain specifically. Moreover, it did not feel justified to extrapolate major conclusions from the subset of an already limited population.

Nevertheless, this does reveal an interesting area for further research. Future studies may consider investigating performance differences between in-person and remote proctoring methods more intentionally and in larger populations of pharmacology students. Information gathered in such studies would likely further assist educators in selecting an appropriate proctoring method most suitable to their assessment goals.

Limitations

It is recognised that population limitations may affect the generalizability of the results. What was observed here in a relatively small sample of students enrolled in undergraduate pharmacology courses across two semesters at a single institution in the western United States may not precisely reflect observations in other populations. A future multi-institutional study with a larger sample of students could improve upon this and provide broader insight.

Comparing cohorts from two semesters may also be perceived as a potential limitation. Some educators subjectively propose that summer students are more proactive and engaged learners. Conversely, others posit that summer learners may be less focused and more academically distracted due to season-competing travel and recreational pursuits. The potential impact of this factor on student performance in this study remains uncertain and speculative. Future studies randomising students from the same semester into proctored and unproctored cohorts may help better control for potential confounding.

As the analysed courses were led by two different instructors, variations in student interactions with them may have influenced student performance. This was estimated to be largely controlled since the courses were administered in a pre-developed, asynchronous format in which the major source of human instruction for all students was via the same on-demand, pre-recorded lectures. However, future studies may attempt to better regulate this possible variable by analysing data from cohorts taught by the same instructor.

Conclusion

The decision to administer proctored or unproctored exams in the online education environment remains complex. This analysis supports that students score higher and spend more time on unproctored exams in

undergraduate pharmacology than proctored exams. Future studies investigating the root causes for these observations in students taking pharmacology exams may be warranted. Instructors should acknowledge that higher scores on unproctored exams may not be reflective of superior content mastery among students due to the potential for increased access to unapproved external aids as compared to proctored exams. Educators may find it valuable to consider the implications for academic integrity and exam security when assessing the suitability of available evaluation methods in pharmacy education.

Conflict of interest

The authors declare no known conflict of interest.

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