**Protecting Academic Integrity in the Online Era**

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Abstract

Institutions of higher education are concerned that academic honesty violations undermine the integrity of their online degree programs (D’Souza & Siegfeldt, 2017). In an effort to combat cheating, many institutions are requiring remote proctoring software for online course exams. The College of Business from a mid-size, regional university in the southeast tried several online proctoring solutions over the past few years, including automated proctoring, recorded proctoring, and live proctoring. This study focused on one aspect--the relationship between student exam means and online proctoring solutions as vehicles to protect academic integrity and to better ensure that student test scores more accurately reflect knowledge gains. Current research suggests that as the level of proctoring increases the level of academic dishonesty decreases (Hylton, Levy, & Dringus, 2016). However, the relevance of this research is in showing that recorded proctoring, with the assistance of artificial intelligence, can be just as effective as live one-on-one proctoring.

*Keywords: Online exams, online exam proctoring, exam proctoring, academic integrity, academic honesty*

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Introduction

According to a study conducted by the International Center for Academic Integrity, 17% of graduate students admitted to cheating on tests while 39% of undergraduate students admitted to cheating on tests (ICAI, 2015). Institutions of higher education are concerned that academic honesty violations undermine the integrity of their online degree programs (D’Souza & Siegfeldt, 2017). Shyles (2002) stated that lack of academic integrity may damage an institution’s credibility and reputation, as well as challenge its accreditation.

In an effort to combat cheating, many institutions are requiring remote proctoring software for online course exams. Vendors market remote proctoring as assurance that online testing conditions are as secure as in-person testing. Remote proctoring of online exams can record a student taking the exam, record their screen, detect attempts at searching for answers online, prevent additional applications from opening during an exam, prevent the use of dual-monitors, and prevent using features such as copy/paste and print, and more. Additionally, verification options are available to capture a student’s ID and photo, as well as a 360-degree scan of the exam environment. Some companies even use biometric verifications, such as retina or fingerprint scans.

This study provides a framework for institutions to consider when choosing an online proctoring solution. The framework identifies effectiveness and cost as the key variables when choosing an online proctor, with effectiveness being the focus. Current research suggests that as the level of proctoring increases the level of academic dishonesty decreases (Hylton, Levy, & Dringus, 2016). However, the relevance of this research is in showing that recorded proctoring, with the assistance of artificial intelligence, can be just as effective as live one-on-one proctoring.

Literature Review

Academic Integrity in the Information Age

In 2008, Sileo & Sileo described violations of academic integrity as “cheating, plagiarizing, falsifying sources or bibliographies, knowingly helping other students cheat, working together on school assignments and projects that should be completed independently, and other attempts to obtain credit for academic work through fraudulent, deceptive, or dishonest means” (p. 57). In 2016, Wolverton expanded the description of academic integrity violations to include paying a stranger to take an entire course for you.

Hinman (2005) suggests that the Internet has had a huge impact on ethics in the academic world. Townley & Parsell (2004) argue that because of the freedom people feel while engaging with the Internet, “questions of community, responsibilities to others, and binding norms of conduct fade into the background” (p. 271). Sileo & Sileo (2000) agree that the Internet makes it easier to violate academic integrity. According to Karim, Kaminsky, & Behrend (2014), it is more difficult to prevent cheating and verify student identity in an online exam environment.

The issue of academic dishonesty is so prevalent, particularly in an online class environment, that the U.S. Department of Education’s Accreditation Handbook, Section 602.17 (g) now ensures that an accrediting agency:

*(g) Requires institutions that offer distance education or correspondence education to have processes in place through which the institution establishes that the student who registers in a distance education or correspondence education course or program is the same student who participates in and completes the course or program and receives the academic credit (U.S. Department of Education, 2019, pp. 11-12).*

The accrediting agency meets this requirement if it:

*(1) Requires institutions to verify the identity of a student who participates in class or coursework by using, at the option of the institution, methods such as –(i) a secure login and pass code; (ii) proctored examinations; and (iii) new or other technologies and practices that are effective in verifying student identity… (U.S. Department of Education, 2019, pp. 11-12).*

Institutions seeking to obtain or maintain their accreditation are feeling pressure to prove the academic integrity of their online programs (Baker Bemmel, 2014). Remote proctoring has been identified as highly effective for monitoring online exams (Bedford, Gregg, & Clinton, 2011). Until this study, a comparison of live proctoring vs AI vs a mix of live and AI proctoring has not been offered, particularly as to efficacy and cost effectiveness.

Why Students Cheat

Current research offers numerous reasons as to why students cheat and how students justify cheating. Students are more likely to cheat when they believe that their peers are also cheating (Scrimpshire, Stone, Kisamore, & Jawahar, 2016; McCabe, Trevino, & Butterfield, 2002). When they think their peers are cheating, students will then justify cheating as a means to equalize grades being earned on exams (Scrimpshire et al., 2016). Students may cheat, even when they know it is not ethical, in an effort to achieve better positioning for a job (Meng, Othman, D’Silva, & Omar, 2014). Students may cheat because they do not see a need to actually learn or memorize the information. As asked by Hippensteel (2016) “Why, from a student’s perspective, should they have to memorize basic stratigraphic principles when their phone can produce a list of them in a matter of seconds?” (para. 8).

According to Meng et al. (2014), there are several reasons why a student may feel justification to cheat, such as:

1. They deflect the blame to coursework that is too difficult, a professor who grades too harshly, or a professor who is ineffective at teaching.
2. They work full-time and have little to no time for studying.
3. They feel it is a victimless activity, that doesn’t hurt anyone else.
4. They feel no threat of punishment.
5. They perceive that all of their peers are doing the same.

Some researchers suggest that students may cheat because they do not see it as wrong (Solmon, 2018; Hutton, 2006). Peterson (2019) agrees that generational differences between college-age students and their instructors affect their views of cheating, indicating that the younger generation perceives the internet as public information and, therefore, does not think utilizing this public information during assignments or exams is deceitful. Mills (2010) believes that today’s generation of students “characterize cheating as a socially acceptable behavior” (p. 11). Morgan (2018) agrees that this generation “demands the same technology and flexibility in online education as they experience in other aspects of their lives” (para. 4).

How Students Cheat

We know the typical cheating patterns, such as students working together on assignments that should be completed individually; or students passing around answers for an assignment or exam. Today’s technology offers new ways to cheat. Students can purchase papers, test banks, and solution manuals from various websites, such as [www.coursehero.com](http://www.coursehero.com), [www.testbankster.com](http://www.testbankster.com), etc. (Solmon, 2018; Bain, 2015). Students can keep a digital device, such as a cell phone, in their possession to look up answers during the exam (Morgan, 2018). In one institution, students opened a shared Google doc during an exam to share answers (Contributor, 2014). Students can find YouTube videos that provide instructions on how to cheat, such as “Cheat online exams like a boss” (Tec4Tric, 2017). Students can take pictures of exam questions with their cell phones or other digital devices and share them via text or messaging (Peterson, 2019; Solmon, 2018). In 2016, two different institutions caught students “using spy cameras in their glasses to transmit exam questions to remote accomplices, who then sent corresponding answers to the students’ smart watches” (Chandler, 2019, para. 6). One website, [spystudy.com](http://www.spystudy.com/), specializes in selling spy equipment for the purpose of cheating on exams. The website’s homepage advertises the “Wireless Spy Ear is a part of the spy set which is produced for covert communication in business presentations, exams, test, or personal protection” (SpyStudy.com, n.d., para. 2). Towards the bottom of the page the website declares that this is part of a set that is the “world’s best method to cheat a test!” (SpyStudy.com, n.d., para. 4). Other devices include ultraviolet pens used to write “invisible” notes on scratch paper, smart calculators that can store notes input by the student, special glasses that enable students to see things hidden from the instructor, and ear buds linked to audio devices loaded with course content (Solmon, 2018).

For more extreme measures, students can even hire someone to take an entire course for them through various websites such as [www.takeyourclass.com](http://www.takeyourclass.com), [takemyonlineclass.com](https://takemyonlineclass.com/), and [www.boostmygrade.com](http://www.boostmygrade.com) (Wolverton, 2016). In 2015, Newton contacted [noneedtostudy.com](https://www.noneedtostudy.com/) to inquire about hiring someone from their company to take an online class for him and was told they would guarantee a grade of B or better for $1,225.15 and he quoted them as saying “We offer the services of a pool of experienced academic tutors to take classes and complete course work for our clients” (Newton, 2015, para. 3-5). A quick review of the [onlineclasshelp.com](https://www.onlineclasshelp.com/) site brags that the best way to cheat an online test is to “hire us” in which they claim they will “…complete one assignment or your whole class. We guarantee an A or B or your money back” (Black, 2016, para. 5).

How to Prevent Cheating

The myriad of methods to cheat raises the question of how do professors prevent or temper cheating. Promoting awareness of academic integrity and ethical behavior at the beginning of the term may lead to decreased incidences of academic dishonesty (Sullivan, 2016; Kusnoor & Falik, 2013). Educating students about the cheating detection techniques being used in a course may help to deter that student from risking dishonest behavior. Faculty who have a policy in place to addresses cheating, and who deliver consequences when cheating is detected, reinforce to students the seriousness of academic dishonesty (Solmon, 2018; Bain, 2015; Hutton, 2006). Research suggests that increasing the teacher presence in the online classroom, via systematic email, announcements, feedback, and frequent interactions, nurtures the student-teacher relationship and deters a student’s disposition to cheat (Solmon, 2018; Sullivan, 2016; Ashworth, Bannister, & Thorn, 1997). Faculty may also find it helpful to use randomized test banks, open notes/book exams, essay or application-type questions, regulations on exam time, etc. (Sullivan, 2016). Some faculty have opted to get rid of standardized exams and implement critical-thinking exercises for assessment purposes, such as discussion forums, project-based learning, etc. (Online Schools Center, 2019).

When it comes to giving standardized online exams, the focus of this study, faculty can implement online proctoring solutions, such as computer-automated proctoring, recorded proctoring, or live proctoring. Automated proctoring relies solely on artificial intelligence that studies “vision-based cues, audio cues, test data, and key-stroke patterns” (PR Newswire, 2015, para. 2) to detect potential dishonest behaviors. Some proctoring solutions include software that will scan web content and file copyright notices to take down test banks, and some will prevent users from opening additional browsers and applications during the exam (Online Schools Center, 2019). Recorded Proctoring uses a computer program to record both the audio and video of the student, and sometimes the student’s computer screen, throughout the duration of the exam. After completion of the exam, a live proctor may watch the video and flag it for suspicious behavior (if that service is included) and/or the video will be made available to the faculty-member to watch and review automated flags (Proctoring Services, 2019). Live Proctoring involves students taking an exam with a live proctor watching the student through their webcam, and listening via audio, in real time throughout the exam. The live proctor also has the ability to intervene when behavior seems suspicious (Proctoring Services, 2019).

The University’s Background with Preventing Academic Dishonesty

The College of Business at amid-sized, regional university in the southeast has used several online exam proctoring solutions over the past few years, including computer-automated proctoring, live proctoring, and recorded proctoring. Table 1 shows a summary each product’s usage, identified as Company A, Company B, and Company C.

The University’s Pilot for Online Proctoring Solutions

While the institution still had access to Company A, the College of Business began looking for an online proctoring solution that would verify student identities, as well as proctor the exams and notify faculty only when there was a possible exam violation. Company A captured student IDs but did not verify student identities and did not provide a summarized report. Faculty were required to watch the videoed testing sessions in order to identify potential exam violations. Both Company B and Company C offered student verification and sent notifications of potential exam violations to the respective faculty. With both companies, faculty had access to the recorded videos but would not need to watch those videos unless they wanted to confirm the suspicious behavior that was flagged in the received report.

For the purpose of this paper, we will use the following descriptions:

* Company A – computer-automated proctoring (artificial intelligence flags suspicious behavior)
* Company B – live proctoring (live proctor watches student take exam via webcam and can interact with the student in real-time when exam violations occur)
* Company C – recorded proctoring, with the assistance of artificial intelligence (artificial intelligence flags suspicious behavior, exam session is recorded, and a live proctor or faculty member can go in and watch the video to determine if the behavior is worthy of addressing)

Company A

Company A was chosen initially as an affordable option that would allow the institution to pay for all exam proctoring at no cost to the student. The proctoring software was integrated directly within our learning management system (LMS) so students simply clicked an exam link from within the LMS and Company A began the process of capturing the student’s photo ID and room scan. Although the company did not verify the identity of the student, the instructor was able to go in and watch each video if s/he wished to verify the identity of the students taking the exam. Upon completion of the identity capture process, the student was immediately launched into the exam. Faculty did not receive summary reports from Company A; however, videos that were flagged for suspicious behavior by the artificial intelligence program could be watched by the faculty immediately via the Company A Dashboard. It was the responsibility of each faculty member to go in and watch each individual video to confirm the identity of the students completing exams based on the photo ID presented. The University paid for all exam proctoring with Company A.

Company B

Company B provided multiple types of proctoring solutions, including automated proctoring, recorded proctoring, and live proctoring options. This study used only the live proctoring option. Company B was integrated directly within the LMS. Students began by scheduling an exam time with Company B. Then, the student had to come back and enter the exam during their scheduled exam time. They entered the exam by clicking the Company B hyperlink from the LMS and going through the identity verification process, which included a photo of the student, a photo of the student’s ID, and a 360-degree room scan. Upon completion of the identity verification, the student was re-directed back to the LMS to complete the exam. The live proctor watched the student complete the exam in real time and had the ability to talk to the student throughout the exam if needed (i.e., when the student had a question about how to proceed). The student, live proctor, and computer monitor were also recorded during the exam as documentation. At the completion of the exam, Company B sent the faculty member an email detailing exam violations. These email notifications were sent to faculty within a week. The faculty member could then enter the Company B dashboard at any time to watch the recorded videos. The University’s College of Business paid for all exam proctoring with Company B. However, if a student procrastinated and did not schedule an exam during the week-long timeframe, Company B charged the student an On-Demand Fee for last-minute proctoring. Students failing to schedule an exam within the prescribed time window and, thereby, having to resort to the On-Demand option, occasionally reported an inability to begin an exam due to a lack of available live proctors. Put simply, students who did not make an appointment for an exam or failed to keep an appointment once made or were willing to pay the On-Demand Fee as a last minute convenience were not guaranteed that a proctor would be available to facilitate their examination requiring that an exam either be rescheduled or the student would get a zero, a distinct drawback to live proctoring.

Company C

Company C offered both automated proctoring and recorded proctoring options, including an option that combined the two. The University’s College of Business chose the combined recorded/automated proctoring option. The artificial intelligence built into the automated proctoring included enhanced algorithms to detect web activity, detect multiple device usage, and search for and destroy test banks found online. The recorded proctoring recorded both the webcam and computer screen for each exam session and then had a live proctor watch the recordings and update the automated flags, as needed, based on the live proctor review. During an exam, if multiple exam violations or multiple technical difficulties were logged by the system, an automated notification would be sent to the proctoring tech support team, which would trigger the live pop-in feature. With the live pop-in feature, a live proctor would appear in a chat window on the student’s exam page and could walk the student through technical issues or remind the student about the exam rules, whichever issue was detected. The live proctor would then remain live for about 5 minutes to ensure there were no further difficulties. When satisfied that everything was okay, the live proctor would then disappear unless a new notification was triggered.

When setting up the exam initially, faculty were able to customize the parameters automated proctoring (artificial intelligence) software would require and capture. For example, faculty could choose to require a photo of the student, a photo of the student’s ID, and/or a 360-degree room scan. Faculty could also choose to record web activity, prevent the browser from opening additional tabs, prevent the connection of multiple computer monitors, disable the right-click option on a mouse, search for and destroy test banks containing questions and answers from the selected exam, and/or detect if a secondary device was being used during the exam.

Company C was integrated with the LMS so to access an exam students simply had to click the exam link from the LMS to begin the identity verification process. Upon completing the identity verification process, the student was automatically launched into the exam. The automated proctoring algorithms flagged suspicious behavior throughout the exam. Upon completion of the exam, a live proctor watched all videos and modified the exam violation flags, as needed, based on the proctor’s manual review. A full exam report was then emailed to the faculty member within 48 hours of exam completion. The report showed both automated flags and live proctor review flags. The faculty member had the ability to go into the Company C dashboard and watch the recorded videos to confirm suspicious behavior. The University’s College of Business paid for all exam proctoring with Company C.

Research Method

Exam scores were collected from students in nine sections of two business courses, both undergraduate- and graduate-level, for a total of 422 student scores. The scores were collected from fall 2017 thru fall 2018. Data collection included mean exam scores between Company A, Company B, and Company C. Homework scores were also collected as a control. Demographic data was not readily available.

Research Questions

The three research questions included in this study were as follows:

1. Is there a significant difference in mean exam scores between students proctored by Company A and students proctored by Company B?
2. Is there a significant difference in mean exam scores between students proctored by Company A and students proctored by Company C?
3. Is there a significant difference in mean exam scores between students proctored by Company B and students proctored by Company C?

Course 1

Serendipitously, all course sections in this study were designed and taught by the same professor and used the same edition of the textbook and, for objective assessment, used the same test bank. Student learning was assessed using four objective exams representing the four units of the course of study. Each unit exam consisted of 25 questions selected from the common test bank of author/publisher provided objective questions for the respective units and randomly drawn from a pool of 225-270 questions for each unit. Exams were timed with students allowed 40 minutes per exam and exams could only be attempted once. Each exam was worth 25 points toward a student’s final grade.

Non-proctored homework assignments were written by the same professor and were identical for each section during the respective semesters. Homework consisted of 2-4 discussion topics per week worth 2 points per discussion topic and one written assignment case study per unit worth 25 points. The four case studies (one per unit) followed a common thread reflecting the material in each respective unit and a unified theme throughout the semester. For each written assignment, students were to identify the issues (legal or ethical) that must be addressed and state the controlling law or ethical principal that would guide them in addressing each issue. As a hedge against plagiarism, minor facts were changed in the factsets for each semester. Changes from a prior semester might include a different highway number, location of a processing facility, quantity or price of goods, or the name of one or more characters in the case study; however, the overriding issues remained the same and any change was consistent for each section for any given semester. Written assignments were graded by the course professor, the same professor who wrote the assignment, and included the use of a common grading rubric.

Students self-selected into the internet or hybrid sections during registration. All LMS material was identical for each section and consistent from semester to semester. No differences existed between the internet and hybrid sections save for the fact that the hybrid sections met as a class for one hour twice a week. As may happen, the hybrid sections were scheduled for the same time in the same classroom each semester. Except for the exam proctoring software used and as stated above, the pedagogy and instructional methodology for each section was identical from semester to semester. For the fall 2017 semester, each section (74 students) used the exam proctoring software and services provided by Company A. For the spring 2018 semester, each section (70 students) used the exam proctoring software and services provided by Company B. For the fall 2018 semester, each section (78 students) used the exam proctoring software and services provided by Company C.

Course 2

All course sections in this study were designed and taught by the same professor and used the same edition of the textbook and, for objective assessment, used the same test bank. Student learning was assessed using two objective exams representing the two units of the course of study:

* The first unit exam consisted of 39 questions chosen by the instructor from the common test bank of author/publisher provided objective questions for the respective units. The exam was timed with students allowed 75 minutes. The exam could only be attempted once. The exam was worth approximately 28% toward a student’s final grade.
* The second unit exam consisted of 64 questions chosen by the instructor from the common test bank of author/publisher provided objective questions for the respective units. The exam was timed with students allowed 130 minutes. The exam could only be attempted once. The exam was worth approximately 46% toward a student’s final grade.

Non-proctored homework assignments were provided by the same publisher software and were identical for each section during the respective semesters. Homework consisted of 10-20 objective questions. Assignments were graded by the publisher software.

Students self-selected into the internet sections during registration. All LMS material was identical for each section and consistent from semester to semester. Except for exam proctoring software used and as stated above, the pedagogy and instructional methodology for each section was identical from semester to semester. For the spring 2018 and summer 2018 semesters, each section used the exam proctoring software and services provided by Company B. For the fall 2018 semester, each section used the exam proctoring software and services provided by Company C.

Results

Research Question 1

A one-way ANOVA was conducted with the Bonferroni post hoc option to compare the effects of using Company A versus Company B for online exam proctoring. Significance was measured at *p < .05*. Proctor ID was used as the independent variable. Dependent variables included proctored Exam 1, Exam 2, Exam 3, and Exam 4. Unproctored homework included discussions and written assignments. Sample sizes varied across courses and sections. A significance in mean exam scores, with no significance in mean homework scores, would indicate that the change in proctor made the difference.

Descriptives and Homogeneity of Variances are shown in Tables 2 and 3. Results of the ANOVA are shown in Table 4. The Bonferroni Multiple Comparisons data, presented in Table 5, shows that proctored Exams 1, 2, 3, and 4 have a mean difference of 20.00% (p=.000), 27.44% (p=.000), 20.63% (p=.000), and 20.27% (p=.000) respectively. Meanwhile, unproctored Discussions and Written Assignments have a mean difference of 0.77% (p=1.000) and -3.81% (p=.874).

The un-proctored homework scores did not change significantly, whereas the proctored exam scores did. Since the content of homework and exams did not change over the courses/course sections, the results suggest that the change in proctoring services was the factor that affected exam scores. Specifically, Company B is more effective than Company A at reducing cheating; or, live proctoring is more effective than computer-automated proctoring at reducing cheating.

Research Question 2

A one-way ANOVA was conducted with the Bonferroni post hoc option to compare the effects of using Company A versus Company C for online exam proctoring. Significance was measured at *p < .05*. Proctor ID was used as the independent variable. Dependent variables included proctored Exam 1, Exam 2, Exam 3, and Exam 4. Unproctored homework included discussions and written assignments. Sample sizes varied across courses and sections. A significance in mean exam scores, with no significance in mean homework scores, would indicate that the change in proctor made the difference.

Descriptives and Homogeneity of Variances are shown in Tables 2 and 3. Results of the ANOVA are shown in Table 4. The Bonferroni Multiple Comparisons data, presented in Table 5, shows that proctored Exams 1, 2, 3, and 4 have a mean difference of 18.76% (p=.000), 28.00% (p=.000), 20.31% (p=.000), and 17.24% (p=.000) respectively. Meanwhile, unproctored Discussions and Written Assignments have a mean difference of -3.76% (p=.330) and -2.71% (p=1.000).

The un-proctored homework scores did not change significantly, whereas the proctored exam scores did. Since the content of homework and exams did not change over the courses/course sections, the results suggest that the change in proctoring services was the factor that affected exam scores. Specifically, Company C is more effective than Company A at reducing cheating; or, recorded proctoring with the assistance of artificial intelligence is more effective than computer-automated proctoring at reducing cheating.

Research Question 3

A one-way ANOVA was conducted with the Bonferroni post hoc option to compare the effects of using Company B versus Company C for online exam proctoring. Significance was measured at *p < .05*. Proctor ID was used as the independent variable. Dependent variables included proctored Exam 1, Exam 2, Exam 3, and Exam 4. Unproctored homework included discussions and written assignments. Sample sizes varied across courses and sections. A significance in mean exam scores, with no significance in mean homework scores, would indicate that the change in proctor made the difference.

Descriptives and Homogeneity of Variances are shown in Tables 2 and 3. Results of the ANOVA are shown in Table 4. The Bonferroni Multiple Comparisons data, presented in Table 5, shows that proctored Exams 1, 2, 3, and 4 have a mean difference of -1.24% (p=1.000), 0.56% (p=1.000), -0.33% (p=1.000), and -3.03% (p=1.000) respectively. Meanwhile, unproctored Discussions and Written Assignments have a mean difference of -4.53% (p=.176) and 1.10% (p=1.000).

Neither the proctored exam scores nor the un-proctored homework scores changed significantly between the Company B group and the Company C group. These results suggest that Company B and Company C are equally effective at reducing cheating; or, live proctoring and recorded proctoring with the assistance of artificial intelligence are equally effective at reducing cheating.

Conclusion

Prudent universities consider many factors when selecting an online proctoring vendor. This study focused on one aspect – the relationship between student exam means and online proctoring solutions as vehicles to protect academic integrity and to better ensure that student test scores more accurately reflect knowledge gains. Although current research suggests that as the level of proctoring increases the level of academic dishonesty decreases (Hylton, Levy, & Dringus, 2016), our study shows that that recorded proctoring, with the assistance of artificial intelligence, can be just as effective as live one-on-one proctoring.

This finding is significant because our experience with proctoring services suggests that recorded proctoring, with the assistance of artificial intelligence, is less expensive than live proctoring while offering a service that is just as effective. Cost is, for most institutions, a critical factor. Live proctoring can be expensive, running as high as $14 per student per assessment for one of the vendors in this study, depending on the level of authentication and proctoring selected. Meanwhile, recorded proctoring can be more cost efficient at around $10 per student per year with unlimited assessments, according to another vendor in this study.

Consideration should also be given to technical support provided and user friendliness of the software for both students and faculty as end-users. Some proctoring services require significant faculty investment of time and attention while others provide summary proctoring data for faculty to then inquire further as desired.

All of these factors should be considered when looking for an online proctor. For the purpose of this study, we were focused on finding an online proctor that was both effective and cost efficient. Results showed that recorded proctoring with the assistance of artificial intelligence met both criteria. Fortunately, this company also checked the boxes for being user-friendly and offering excellent customer service, although those factors were not investigated in this study. Future research should include the factors of technical support and user-friendliness, as those factors are significant in reducing (or increasing) the stress involved with using an online proctor.

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Table 1 The University’s College of Business use of Online Proctoring Services

|  |  |  |  |
| --- | --- | --- | --- |
|  | Company A | Company B | Company C |
| Type of Proctoring | Automated | Live | Recorded, with automated assistance |
| Dates Used by COB | 2016-2018 | 2017-2018 | 2018-Present |
| Identity Verification | No | Yes | Yes |
| Summary Reports | No | Yes | Yes |
| Results Available | Immediate | 2-5 days | 2 days or less |
| Faculty Access to recordings | Yes | Yes | Yes |
| Effective (per the results of this study) | No | Yes | Yes |
| User-friendly to Students | Yes | No | Yes |
| User-friendly to Faculty | No | No | Yes |

Table 2 Descriptives

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptives** | | | | | | | | | |
|  | | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
| Lower Bound | Upper Bound |
| Proctored  Exam 1 | 1 | 75 | 89.0667% | 19.01730% | 2.19593% | 84.6912% | 93.4421% | 0.00% | 100.00% |
| 2 | 188 | 69.0709% | 20.74861% | 1.51325% | 66.0857% | 72.0562% | 0.00% | 104.00% |
| 3 | 159 | 70.3061% | 15.94624% | 1.26462% | 67.8083% | 72.8038% | 24.00% | 104.00% |
| Total | 422 | 73.0900% | 20.14536% | 0.98066% | 71.1624% | 75.0176% | 0.00% | 104.00% |
| Proctored  Exam 2 | 1 | 75 | 90.2400% | 12.23623% | 1.41292% | 87.4247% | 93.0553% | 56.00% | 100.00% |
| 2 | 188 | 62.8000% | 19.85556% | 1.44812% | 59.9433% | 65.6567% | 0.00% | 100.00% |
| 3 | 159 | 62.2440% | 20.68860% | 1.64071% | 59.0035% | 65.4846% | 0.00% | 100.00% |
| Total | 422 | 67.4673% | 21.78267% | 1.06036% | 65.3830% | 69.5516% | 0.00% | 100.00% |
| Proctored  Exam 3 | 1 | 75 | 87.9467% | 21.35409% | 2.46576% | 83.0335% | 92.8598% | 0.00% | 100.00% |
| 2 | 70 | 67.3143% | 22.64761% | 2.70691% | 61.9142% | 72.7144% | 0.00% | 100.00% |
| 3 | 78 | 67.6410% | 23.86269% | 2.70192% | 62.2608% | 73.0212% | 0.00% | 100.00% |
| Total | 223 | 74.3677% | 24.55201% | 1.64412% | 71.1276% | 77.6078% | 0.00% | 100.00% |
| Proctored  Exam 4 | 1 | 75 | 88.2133% | 20.29931% | 2.34396% | 83.5429% | 92.8838% | 0.00% | 100.00% |
| 2 | 70 | 67.9429% | 24.84029% | 2.96898% | 62.0199% | 73.8658% | 0.00% | 100.00% |
| 3 | 78 | 70.9744% | 22.22376% | 2.51635% | 65.9637% | 75.9850% | 0.00% | 100.00% |
| Total | 223 | 75.8206% | 24.08626% | 1.61294% | 72.6420% | 78.9993% | 0.00% | 100.00% |
| Unproctored  Overall  Discussion  Percentage | 1 | 75 | 88.1667% | 15.05807% | 1.73876% | 84.7021% | 91.6312% | 25.00% | 100.00% |
| 2 | 70 | 87.3929% | 16.27679% | 1.94545% | 83.5118% | 91.2739% | 2.50% | 100.00% |
| 3 | 78 | 91.9231% | 11.97890% | 1.35634% | 89.2223% | 94.6239% | 40.00% | 100.00% |
| Total | 223 | 89.2377% | 14.54961% | 0.97431% | 87.3176% | 91.1578% | 2.50% | 100.00% |
| Unproctored  Overall  Written  Assignment  Percentage | 1 | 75 | 68.1867% | 20.02748% | 2.31257% | 63.5788% | 72.7946% | 15.00% | 100.00% |
| 2 | 70 | 72.0000% | 20.68256% | 2.47204% | 67.0684% | 76.9316% | 0.00% | 100.00% |
| 3 | 78 | 70.8974% | 23.99274% | 2.71664% | 65.4879% | 76.3070% | 0.00% | 100.00% |
| Total | 223 | 70.3318% | 21.65323% | 1.45001% | 67.4743% | 73.1894% | 0.00% | 100.00% |
| Unproctored  CNow  Assignment  Percentage | 1 | 0 | . | . | . | . | . | . | . |
| 2 | 118 | 93.3033% | 14.27402% | 1.31403% | 90.7009% | 95.9056% | 0.00% | 100.00% |
| 3 | 81 | 95.5190% | 6.50215% | 0.72246% | 94.0813% | 96.9568% | 75.20% | 100.00% |
| Total | 199 | 94.2052% | 11.77580% | 0.83476% | 92.5590% | 95.8513% | 0.00% | 100.00% |

Table 3 Test of Homogeneity of Variances

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test of Homogeneity of Variances** | | | | | |
|  | | Levene Statistic | df1 | df2 | Sig. |
| Proctored  Exam 1 | Based on Mean | 3.813 | 2 | 419 | .023 |
| Based on Median | 5.682 | 2 | 419 | .004 |
| Based on Median and with adjusted df | 5.682 | 2 | 347.346 | .004 |
| Based on trimmed mean | 5.270 | 2 | 419 | .005 |
| Proctored  Exam 2 | Based on Mean | 9.755 | 2 | 419 | .000 |
| Based on Median | 13.059 | 2 | 419 | .000 |
| Based on Median and with adjusted df | 13.059 | 2 | 414.595 | .000 |
| Based on trimmed mean | 11.440 | 2 | 419 | .000 |
| Proctored  Exam 3 | Based on Mean | 1.766 | 2 | 220 | .173 |
| Based on Median | 4.156 | 2 | 220 | .017 |
| Based on Median and with adjusted df | 4.156 | 2 | 204.557 | .017 |
| Based on trimmed mean | 3.208 | 2 | 220 | .042 |
| Proctored  Exam 4 | Based on Mean | 3.469 | 2 | 220 | .033 |
| Based on Median | 5.773 | 2 | 220 | .004 |
| Based on Median and with adjusted df | 5.773 | 2 | 207.057 | .004 |
| Based on trimmed mean | 4.859 | 2 | 220 | .009 |
| Unproctored  Overall  Discussion  Percentage | Based on Mean | 2.646 | 2 | 220 | .073 |
| Based on Median | 2.129 | 2 | 220 | .121 |
| Based on Median and with adjusted df | 2.129 | 2 | 209.863 | .122 |
| Based on trimmed mean | 2.371 | 2 | 220 | .096 |
| Unproctored  Overall  Written  Assignment  Percentage | Based on Mean | 1.192 | 2 | 220 | .306 |
| Based on Median | .905 | 2 | 220 | .406 |
| Based on Median and with adjusted df | .905 | 2 | 204.718 | .406 |
| Based on trimmed mean | 1.121 | 2 | 220 | .328 |
| Unproctored  CNow  Assignment  Percentage | Based on Mean | 3.517 | 1 | 197 | .062 |
| Based on Median | 1.361 | 1 | 197 | .245 |
| Based on Median and with adjusted df | 1.361 | 1 | 151.082 | .245 |
| Based on trimmed mean | 1.747 | 1 | 197 | .188 |

Table 4 ANOVA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ANOVA** | | | | | | |
|  | | Sum of Squares | df | Mean Square | F | Sig. |
| Proctored  Exam 1 | Between Groups | 23413.086 | 2 | 11706.543 | 33.267 | .000 |
| Within Groups | 147443.714 | 419 | 351.894 |  |  |
| Total | 170856.800 | 421 |  |  |  |
| Proctored  Exam 2 | Between Groups | 47327.957 | 2 | 23663.978 | 65.048 | .000 |
| Within Groups | 152430.052 | 419 | 363.795 |  |  |
| Total | 199758.009 | 421 |  |  |  |
| Proctored  Exam 3 | Between Groups | 20841.026 | 2 | 10420.513 | 20.291 | .000 |
| Within Groups | 112980.821 | 220 | 513.549 |  |  |
| Total | 133821.848 | 222 |  |  |  |
| Proctored  Exam 4 | Between Groups | 17694.518 | 2 | 8847.259 | 17.520 | .000 |
| Within Groups | 111098.307 | 220 | 504.992 |  |  |
| Total | 128792.825 | 222 |  |  |  |
| Unproctored  Overall  Discussion  Percentage | Between Groups | 886.752 | 2 | 443.376 | 2.115 | .123 |
| Within Groups | 46108.652 | 220 | 209.585 |  |  |
| Total | 46995.404 | 222 |  |  |  |
| Unproctored  Overall  Written  Assignment  Percentage | Between Groups | 564.878 | 2 | 282.439 | .600 | .550 |
| Within Groups | 103522.566 | 220 | 470.557 |  |  |
| Total | 104087.444 | 222 |  |  |  |
| Unproctored  CNow  Assignment  Percentage | Between Groups | 235.813 | 1 | 235.813 | 1.707 | .193 |
| Within Groups | 27220.728 | 197 | 138.176 |  |  |
| Total | 27456.541 | 198 |  |  |  |

Table 5 Bonferroni Multiple Comparisons

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Multiple Comparisons** | | | | | | | |
| Bonferroni | | | | | | | |
| Dependent Variable | (I) Proctor  ID | (J) Proctor  ID | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| Proctored  Exam 1 | 1 | 2 | 19.99574%\* | 2.56197% | .000 | 13.8377% | 26.1538% |
| 3 | 18.76059%\* | 2.62775% | .000 | 12.4444% | 25.0767% |
| 2 | 1 | -19.99574%\* | 2.56197% | .000 | -26.1538% | -13.8377% |
| 3 | -1.23516% | 2.02113% | 1.000 | -6.0932% | 3.6229% |
| 3 | 1 | -18.76059%\* | 2.62775% | .000 | -25.0767% | -12.4444% |
| 2 | 1.23516% | 2.02113% | 1.000 | -3.6229% | 6.0932% |
| Proctored  Exam 2 | 1 | 2 | 27.44000%\* | 2.60493% | .000 | 21.1787% | 33.7013% |
| 3 | 27.99597%\* | 2.67182% | .000 | 21.5739% | 34.4180% |
| 2 | 1 | -27.44000%\* | 2.60493% | .000 | -33.7013% | -21.1787% |
| 3 | 0.55597% | 2.05502% | 1.000 | -4.3835% | 5.4955% |
| 3 | 1 | -27.99597%\* | 2.67182% | .000 | -34.4180% | -21.5739% |
| 2 | -0.55597% | 2.05502% | 1.000 | -5.4955% | 4.3835% |
| Proctored  Exam 3 | 1 | 2 | 20.63238%\* | 3.76613% | .000 | 11.5469% | 29.7179% |
| 3 | 20.30564%\* | 3.66487% | .000 | 11.4644% | 29.1469% |
| 2 | 1 | -20.63238%\* | 3.76613% | .000 | -29.7179% | -11.5469% |
| 3 | -0.32674% | 3.73100% | 1.000 | -9.3275% | 8.6740% |
| 3 | 1 | -20.30564%\* | 3.66487% | .000 | -29.1469% | -11.4644% |
| 2 | 0.32674% | 3.73100% | 1.000 | -8.6740% | 9.3275% |
| Proctored  Exam 4 | 1 | 2 | 20.27048%\* | 3.73462% | .000 | 11.2610% | 29.2800% |
| 3 | 17.23897%\* | 3.63421% | .000 | 8.4717% | 26.0062% |
| 2 | 1 | -20.27048%\* | 3.73462% | .000 | -29.2800% | -11.2610% |
| 3 | -3.03150% | 3.69979% | 1.000 | -11.9570% | 5.8940% |
| 3 | 1 | -17.23897%\* | 3.63421% | .000 | -26.0062% | -8.4717% |
| 2 | 3.03150% | 3.69979% | 1.000 | -5.8940% | 11.9570% |
| Unproctored  Overall  Discussion  Percentage | 1 | 2 | 0.77381% | 2.40594% | 1.000 | -5.0303% | 6.5780% |
| 3 | -3.75641% | 2.34125% | .330 | -9.4045% | 1.8917% |
| 2 | 1 | -0.77381% | 2.40594% | 1.000 | -6.5780% | 5.0303% |
| 3 | -4.53022% | 2.38350% | .176 | -10.2802% | 1.2198% |
| 3 | 1 | 3.75641% | 2.34125% | .330 | -1.8917% | 9.4045% |
| 2 | 4.53022% | 2.38350% | .176 | -1.2198% | 10.2802% |
| Unproctored  Overall  Written  Assignment  Percentage | 1 | 2 | -3.81333% | 3.60504% | .874 | -12.5102% | 4.8836% |
| 3 | -2.71077% | 3.50812% | 1.000 | -11.1738% | 5.7523% |
| 2 | 1 | 3.81333% | 3.60504% | .874 | -4.8836% | 12.5102% |
| 3 | 1.10256% | 3.57142% | 1.000 | -7.5132% | 9.7183% |
| 3 | 1 | 2.71077% | 3.50812% | 1.000 | -5.7523% | 11.1738% |
| 2 | -1.10256% | 3.57142% | 1.000 | -9.7183% | 7.5132% |
| \*. The mean difference is significant at the 0.05 level. | | | | | | | |