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Utilizing webcam-based proctoring to deter misconduct in online exams



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ABSTRACT

Deception and dishonesty in online exams are believed to link to their unmonitored nature where users appear to have the opportunity to collaborate or utilize unauthorized resources during these assessments. The primary goal of this study was to investigate the deterrent effect of Webcam-based proctoring on misconduct during online exams. This study involved an experimental design in comparing an experimental group and a control group. Both groups attended the same course, used the same e-learning system, with the same instructor, and took the same set of online exams. One group was monitored by a Web-based proctor while the other was not monitored. The results indicated no statistically significant difference between the scores of the two groups, although the non-proctored group had slightly higher scores. There was a statistically significant difference found on the time taken to complete the online exams where the proctored group used significantly less time to complete their exams. The results of a post-experiment survey indicated that those who were not proctored perceived to have experienced greater levels of opportunity to engage in misconduct than those who were monitored by a Web-based proctor.

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1. Introduction

Although misconduct in academia has been around for some time (McCabe, Trevino, & Butterfield, 2001), advances in technology intensify the problem (Harmon & Lambrinos, 2008). The intensification of misconduct is particularly on the rise concerning online exams that are administered and taken in an unmonitored setting (Hollister & Berenson, 2009). The critical issue of securing the integrity of online exams has proven challenging (Burke, 2009), particularly as it relates to addressing the mounting challenges of dishonesty in online exams (Ramim & Levy, 2007).

A few technology-based solutions have been proposed and employed to address the problem of learner authentication in online exams. Penteado and Marana (2009) examined the use of a Web-based camera (Webcam) for facial recognition to authenticate users in exams in online learning systems. Levy and Ramim (2009) proposed that multiple distinct biometric devices including fingerprint scanners or face geometry be utilized to authenticate users prior to taking an online exam, and that learners are willing to use such technology. Milliron and Sandoe (2008) noted that most of the technology-based countermeasures have focused on the verification of the user's identity. Although somewhat feasible, these identity

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verification approaches do not address a more complex problem, which is “to verify that the test-taker is unassisted by others or unsupported by resources that are disallowed by the instructor” (Milliron & Sandoe, 2008, p. 4).

Adkins, Kenkel, and Lo Lim (2005) highlighted another method to help deter the misuse of online exams using a proctored environment, such as a human proctor. A proctor is “one appointed to oversee students during an examination” (Rosser, Young, & Klonsky, 2007, p. 1459). Research has demonstrated possible misconduct via the significant inflation of grades in exams carried out in an unproctored setting (Carstairs & Myers, 2009; Prince, Fulton, & Garsombke, 2009). This concurs with Faucher and Caves (2009) who noted that misconduct in exams often occurs when “opportunities are provided and surveillance is minimized” (p. 39). Due to the significant deterrent effect of proctoring on misconduct, some scholars have suggested that online exams need to be taken on campus in a proctored setting (Landon & Robby, 1999; Shuey, 2002). However, Shuey (2002) noted that this might counter one of the primary objectives of distance education, which is remote access. Although it can also be argued that students may visit nearby libraries or sites to be physically proctored, but this may not always be possible depending on where the individual is located.

The goal of our study was to examine the utilization of Web-based proctoring through a Webcam to determine the influence this technology may have on deterring misconduct in online exams. In the context of this work, a Web-based proctor is defined as one who utilizes a Webcam for video surveillance to observe the users and their environment during the online exam session. We sought to ascertain the relationship between the application of video surveillance based technologies and the results of online exams.

This experimental study involved a control as well as a treatment group where both groups were exposed to the same settings and pool of questions with the exception that the treatment group was knowingly monitored by a Web-based proctor. The results of the online exams were analyzed for each group, and a post-experiment survey was administered to collect relevant feedback on whether or not participants felt they had the opportunity to collaborate or use unauthorized resources during the online exam.

The relevance of this research is in the examination of the deterrent effect of Webcam-based surveillance on misconduct in online exams. Our study is unique in that, although there have been numerous suggested technologies on countering the problem (Adkins et al., 2005; Levy & Ramim, 2009), most have been focused on authentication and identity verification. The current research goes beyond this point to address the problem that occurs after authentication, which is of unsanctioned collaboration and the utilization of unauthorized resources during an online exam. This study involved empirically testing the application of Webcams as a video surveillance device to counter the misconduct challenge.

Our study is of significance to the computer education as well as information systems domains, particularly within areas regarding online exams and e-learning systems. This is also important because the United States (US) Department of Education requires that appropriate procedures or technology are implemented to verify the identity of students who participate in distance education courses (U.S. Department of Education Office of Postsecondary Education Accreditation and State Liason, 2010). Additionally, the implication of results should be of significance to a number of other research areas across a number of domains, such as criminology and social sciences in relating to the deterrent effect of surveillance. Our study further examined concepts of deterrence along with surveillance in the context of securing and protecting the integrity of specific academic information systems. The research is also applicable to multiple industries, including those offering online professional certification exams and prospective employee exams (Makransky & Glas, 2011), as well as employee training and testing.

2. Literature review

2.1. Misconduct

Misconduct was generally defined by Camp, Gaes, Langan, and Saylor (2003) as “the failure to follow explicit rules” (p. 504). Misconduct as it relates to information systems is the unauthorized, deliberate misuse of an organization's information systems. These include but are not limited to such acts as unauthorized use of the information system and accessing unauthorized information (Cronan, Foltz, & Jones, 2006). Misconduct in the context of our study focused on dishonest and delinquent behavior in online exams. Dishonesty in online exams is noted as being related to identity verification and ensuring that students operate within the established boundaries (Gikandi, Morrow, & Davis, 2011). Academic misconduct is further considered to be any act that provides an unearned advantage over another including impersonating someone else for an exam as well as utilizing unauthorized notes or collaborating with others during an exam (Hughes & McCabe, 2006).

McCabe and Trevino (1993) conducted a study with 6096 students from 31 colleges and universities in the US. Their results indicated that approximately 64% of the respondents had engaged in misconduct on exams. Crittenden, Hanna, and Peterson (2009) cited a survey conducted by the Center for Academic Integrity of approximately 50,000 undergraduate students from colleges and universities across the US that found that an overwhelming 70% of respondents admitted to serious academic misconduct on exams. These findings highlight the pervasiveness of the problem of misconduct within academic institutions.

Furthermore, the results from a more limited survey that focused on technology-assisted misconduct indicated that approximately 90% of respondents engaged in some form of Internet based misconduct (Berry, Thornton, & Baker, 2006) and misuse of academic information systems. These findings are further supported by the results of a survey of 62 participants from four English-speaking countries, which suggested that there is a strong perception that technology, which facilitates ease of access to information, has led to increased misconduct (Dick et al., 2002). These statistics have led to a growing

concern within academia as many are troubled by the negative impact on academic integrity (Hughes & McCabe, 2006). Academic integrity has been defined by the Center for Academic Integrity (CAI) as “a commitment, even in the face of adversity, to five fundamental values: honesty, trust, fairness, respect, and responsibility” (The Fundamental Values of Academic Integrity, 1999).

There are a number of elements that motivate misconduct as expressed by Faucher and Caves (2009) who suggested that competition for better grades, insufficient organizational skills, and the thrill of taking risks, as well as the financial and time setbacks associated with failure, are among the factors that contribute to misconduct. Other significant factors that cited include both the opportunity to engage in misconduct as well as the lack of deterrence among the primary reasons why misconduct occurs (Park, 2003; Whitley, 1998).

2.2. Opportunity to engage in misconduct

Engaging in misconduct in an exam occurs when information is given to or received from others or when forbidden material is used during the exam (Faucher & Caves, 2009). This implies that the opportunity to engage in misconduct would include the *opportunity to collaborate* with others as well as the *opportunity to utilize unauthorized resources*. Theoharidou, Kokolakis, Karyda, and Kiountouzis (2005) noted that the theory of Situational Crime Prevention (SCP) suggested that persons need to have motive as well as opportunity to commit an offence and that eliminating opportunities should reduce misconduct. Landon and Robby (1999) stated, “While there are both individual and situational determinants of academic dishonesty, the historic psychological literature has documented that dishonesty is mostly a function of opportunity” (p. 441). This statement implies that opportunity to engage in misconduct is one of the most significant variables that influence such illicit behavior.

One of the major concerns of faculty members with misconduct is student collaboration and the use of forbidden resources during an online exam (Christe, 2003). Where collaboration is concerned, McCabe and Trevino (1996) reported a substantial increase in collaboration on work explicitly meant to be done independently. The results of their study also showed that 37%–52% of participants reported that they had either copied from or helped another during an exam. Additionally, 27% reported that they had used unauthorized resources such as crib notes during an exam. These results denote that collaboration and use of unauthorized resources during an exam is a major concern.

Studies such as Michaels and Miethe (1989), have also demonstrated the significant impact that opportunity to engage in misconduct can have on actual misconduct in academia. The results of their survey of over 600 undergraduates indicated that opportunity to engage in misconduct is strongly associated with illicit academic behavior. Other studies also supported this notion (Hetherington & Feldman, 1964; Perry, Kane, Bernesser, & Spicker, 1990). Hetherington and Feldman (1964) conducted an experiment on 78 college students where they had opportunities to engage in academic misconduct on course exams. In their study, 59% of the participants engaged in misconduct in some way or form, and of these, an overwhelming majority (87%) were found to have done so multiple times. Furthermore, Perry et al. (1990) conducted an experiment on 80 college students and found that individuals are more likely to engage in misconduct if given the opportunity. Witherspoon, Maldonado, and Lacey (2012) also reported of a sample of 186, that nearly 80% reported to have engaged in misconduct; they further stated that those who did so would elect to engage in misconduct if opportunity is available. The results of these studies highlight the significance of opportunity towards engaging in misconduct in online exams as a significant concern.

2.3. Assessment scores

Carstairs and Myers (2009) conducted a study with 302 individuals that compared unproctored online exams to traditional proctored exams. Their results revealed that, in situations where the exam is administered online in an unproctored setting, the scores attained are significantly inflated when compared to exams done in proctored settings and essentially implied that related misconduct may have occurred. These results contrast findings by Schultz, Schultz, and Round (2008) who found no significant difference in the scores between proctored exams and unproctored online exams. Despite the findings of Schultz et al. (2008), their results were limited as they mentioned that different exams, which could have also varied in difficulty, might have been administered in each case. Moreover, other studies (Harmon & Lambrinos, 2008; Prince et al., 2009) have used exam scores as a variable to measure misconduct. Examining scores should provide important measures in determining if misconduct occurred during an exam.

2.4. Average time taken to complete an online exam

There is a conflict in literature as it relates to the issue of using time as a factor to measure potential misconduct in online exams. Some scholars, such as Burlak, Hernández, Ochoa, and Muñoz (2006), purported that longer response times on an online exam may reflect possible misconduct. Whereas others, such as Burke (2009) contradict this point by contending that short response times imply potential acts of misconduct. Burlak et al. (2006) conducted a study to explore the use of data mining techniques to detect if misconduct took place in online exams; they utilized time taken to answer exam questions as one of the variables to aid identifying potential misconduct. They theorized that individuals who might utilize unauthorized resources during an online exam would take significantly more time to respond to questions. This assertion is further

supported by other scholars, advocating that strict time limits be imposed on answering questions or completing entire exams in order to suppress misconduct during unproctored online exams (Christe, 2003; Eplion & Keefe, 2007; Schultz et al., 2008).

On the other hand, Burke (2009) suggested that rapid response times along with correct answers could mean that the users had access to the questions prior to taking the test and, therefore, may have engaged in academic misconduct on the online exam. This view was also asserted by Milliron and Sandoe (2008). They noted that those who already have the answers tend to rush through the online exam by completing the questions and exam quickly. Because of this discrepancy in literature, it is evident that more research is needed on the factor of time as it relates to misconduct in online exams. Thus, our study further investigated this matter and sought to provide clarity where this is concerned.

2.5. Proctoring assessments

One method noted to be effective at deterring academic dishonesty, particularly concerning online exams, is to conduct them within proctored settings (Adkins et al., 2005). Despite a study by Schultz et al. (2008), which found that there was no significant difference between the final grades of courses with proctored exams and those that were not proctored, other research (Carstairs & Myors, 2009; Prince et al., 2009) found evidence of the potential occurrence of misconduct as well as significant inflation of grades in unproctored exams. Harmon and Lambrinos (2008) conducted an experiment on two online courses in which the final exam for one course was proctored and the other was not proctored. Their findings suggested that misconduct occurred when the exam was not proctored. Consequently, Harmon and Lambrinos declared that online exams “administered in a proctored environment might equalize the incidence of academic dishonesty between online courses and face-to-face courses” (p. 123). Furthering this point, Carstairs and Myors (2009) conducted an experiment involving 302 undergraduates; their results indicated that proctoring does have a significant impact on performance on exams in high stakes situations.

Based on the inherent challenges and difficulties with the validity of unproctored online exams, Carstairs and Myors (2009) concluded that such exams should be avoided in high stakes situations and should rather be limited to evaluations that carry little weight in determining someone's final grade. Likewise, Makransky and Glas (2011) noted that unproctored Internet testing is widely used in the administration of exams for employment; however, due to the potential for misconduct, decisions should not be based on these alone but rather with a follow-up test that is proctored. Because of the known effectiveness of proctoring exams at inhibiting misconduct, some scholars, such as Landon and Robby (1999) and Shuey (2002), suggested that institutions should insist that persons taking distance education or online courses need to take exams on campus in a proctored setting. However, Shuey (2002) also noted that this method is inconvenient and sometimes infeasible, as well as contradictory to the primary rationale for taking online courses. A number of these studies, however, were limited to traditional proctoring in a physical setting, while more research appears to be warranted in addressing the gap by focusing on technology assisted proctoring in online exams.

2.6. Online proctored assessment

Several technologies have recently developed to facilitate proctoring online exams remotely; these include applications and Web services such as Remote Proctor™, Kryterion™ Live Video Monitoring, and ProctorU. Remote Proctor is a technology that combines biometric authentication with surveillance that records sessions of users and their environment during an exam (Bedford, Gregg, & Clinton, 2009). Bedford et al.'s (2009) assessed the acceptance, perceived usefulness, and ease of use of Remote Proctor™ with 31 students and 20 faculty members, while concluding that the technology is not only easy to use and acceptable to potential users, but it is useful in deterring misconduct in online exams. However, Kitahara, Westfall, and Mankelwicz (2010) noted that statistical data had yet to be collected on the effectiveness of Remote Proctor™. In addition to being an experiment instead of a case study, our research differs from Bedford et al. (2009) in that, rather than acceptance and usability, the primary focus was on investigating the differences between two groups concerning specific factors attributed to misconduct behavior as well as the opportunity to engage in misconduct.

Kryterion™ Live Video Monitoring and ProctorU are two Web services that operate in essentially the same manner. These web services provide persons who serve as online proctors to monitor online exams in real-time. ProctorU allows users to be monitored by a live proctor via Webcam while taking online exams. The use of ProctorU was tested at a university in the United States, the results of which indicated that aside from a few easily resolved issues, there were no significant technical problems and all participants were able to complete their online exams while being proctored by a ProctorU staff member (Kitahara et al., 2010). Levy and Ramim (2009) noted, that these technology solutions are dependent on third party providers, an issue that raises concerns about privacy if not properly contracted with the home institution. Moreover, privacy concerns have been highlighted by the lawsuit filed against the Pennsylvania School District for activating Webcams of school laptops while at the homes of students and capturing video and images (“F.B.I. queries Webcam use by schools,” 2010). The problem with this case is that the Webcams were activated and the video captured without the knowledge and consent of the students or their parents. Conversely, the system used for Webcam based proctoring of online exams in our study had explicitly declared the intent for using Webcams, and participants were fully consented and aware that they were being monitored only during the online exam period.

This literature review provided the theoretical foundation for our study. Our review demonstrates the importance of the primary variables and constructs such as surveillance and deterrence as they relate to addressing the prevalent problem of the misconduct in online exams. This review also established the link between the presented variables in the context of academic dishonesty, particularly as it relates to misconduct on online exams. The review of empirical research regarding misconduct within academia by [Crown and Spiller \(1998\)](#) demonstrated the connection between the constructs presented. Despite the fact that a number of potential technology solutions have been applied to the problem, much attention has been focused on authentication and verification of the user's identity. It is necessary to address the problem of misconduct that may occur after authentication to determine if unauthorized collaboration and utilizing restricted resources can be prevented. As such, additional research is needed to address the questions of whether or not Webcam-based proctoring can significantly deter users from misconduct during online exams.

3. Research goals and hypotheses

The essence of our study was to investigate if misconduct during online exams can be deterred using a Webcam for remote proctoring and if the use of a Webcam can improve the integrity of such online exams. The need for this work has been demonstrated by previous studies that emphasized the importance of utilizing technology to foster academic integrity by creating more secure Web-based systems ([Levy & Ramim, 2009](#); [Milliron & Sandoe, 2008](#)).

This research had one primary overarching goal and five related specific goals. The main goal of our study was to assess the deterrent effect of using Webcams to counter misuse and dishonesty in online exams. This study involved comparing the results of two groups taking the same set of online exams – one administered using a Web-based proctor and one without. The first of the four specific goals was to assess the differences between scores from two sets of online exams: a) one set where participants are monitored by a Web-based proctor (MbWP); and b) another set of online exams in which participants were not monitored (NM). The second goal was to examine the differences in the average time taken to complete each of these two sets of online exams (MbWP & NM). The third goal was to evaluate the differences in the level of perceived opportunity to collaborate experienced between participants who were MbWP and those who were NM. The fourth goal was to examine the differences in the level of perceived opportunity to utilize unauthorized resources experienced between participants in each group. The fifth goal was to investigate the differences in the levels of perceived deterrence to engage in misconduct experienced between each group.

The main research question that our study addressed was:

Main RQ: *Are there statistically significant differences between the set of online exam results that were taken by participants being monitored by a Web-based proctor and the results of online exams that were not monitored?*

Prior research suggested that misconduct occurs most often when surveillance is minimized ([Faucher & Caves, 2009](#)) and that test scores are usually inflated in assessments without a proctor or formal surveillance ([Carstairs & Myors, 2009](#)). Furthermore, [Milliron and Sandoe \(2008\)](#) noted that elapsed time is useful in indicating misconduct in online exams. The following hypotheses are presented based on the research goals (noted in null layout):

- H1.** *There will be no statistically significant difference between the **Web-based assessment scores** of participants that are monitored (MbWP) and those that are not (NM).*
- H2.** *There will be no statistically significant difference between the **average time taken to complete the Web-based assessments** of participants that are monitored (MbWP) and those that are not (NM).*
- H3.** *There will be no statistically significant difference in the **perceived opportunity to collaborate** during Web-based assessments of participants that are monitored (MbWP) and those that are not (NM).*
- H4.** *There will be no statistically significant difference in the **perceived opportunity to utilize unauthorized resources** during Web-based assessments of participants that are monitored (MbWP) and those that are not (NM).*
- H5.** *There will be no statistically significant difference in the **level of perceived deterrence to engage in misconduct** during Web-based assessments of participants that are monitored (MbWP) and those that are not (NM).*

4. Methodology

We utilized a mixed method approach where a true experimental design was employed in addition to utilizing an appropriate survey. The experiment was conducted in a field setting and participants were randomly assigned to a treatment group (TG) or a control group (CG). Both groups were enrolled in the same undergraduate course at a private university in Jamaica and took online exams derived from the same pool of questions. The distinction was that the treatment group consisted of results of online exams that had been monitored by a Web-based proctor (MbWP), whereas participants in the control group were not be monitored (NM) during the online exam.

We not only sought to assess the differences between scores from both groups, but also examined the differences in the level of perceived opportunity to collaborate experienced between those participants who took online exams taken while being MbWP, and those that were NM. Furthermore, we assessed the difference in the amount of perceived opportunity to

utilize unauthorized resources between those participants being MbWP and participants that were NM. As such, a survey instrument based on validated measurements in prior studies (Bolin, 2004; Michaels & Miethe, 1989) was utilized to collect relevant data regarding the perceived opportunity to collaborate as well as the perceived opportunity to utilize unauthorized resources.

The approach of using an experimental design is appropriate seeing that the chief goal is to answer the main research question of whether or not there are statistically significant differences between two groups (Ellis & Levy, 2009; Sekaran, 2003) and to evaluate the application of Webcams as a deterrent to misconduct in online exams. We sought to identify the difference of each variable (exam scores, average time taken, perceived opportunity to collaborate, perceived opportunity to utilize unauthorized resources, and perceived deterrence) between the treatment group and the control group. Fig. 1 illustrates the distinct groups involved in this experiment.

The researchers examined the results of online exams administered to undergraduates at a private university. It was conducted with moderate interference in a field setting (non-contrived), where activities were naturally taking place (Sekaran, 2003). The software that was utilized for administering and taking the online exams was Computer Aided Proctored Assessments (CAPA), which is a prototype software that utilized Webcams to facilitate the remote proctoring of online exams, similar to the one used by ProctorU or other vendors. CAPA works by streaming a Webcam based video feed of the users and their environment while the online exam is being taken. The proctor's video was also shown on the participants' screens while they took the exam in order to make them fully aware that their actions were being monitored, addressing privacy concerns. In addition to being able to monitor those taking the online exam, CAPA also disallows all other applications, such as a Web browser, from being active during the online exam. All participants used the same tool; however, the Webcam proctoring module was only enabled for the group taking the exam while being MbWP.

Participants were allowed to install the CAPA application on their own personal computers and were able to take the online exams from home or any other convenient location. Additionally, Webcams were made freely available for the duration of the experiment to participants who did not own such a device. Designated stations with the requisite software and equipment were also available in the generally accessible computer lab for participants who did not own or have access to a personal laptop or computer.

5. Results

Appropriate analysis was conducted on the data collected from the results of online exams taken by participants as well as from the Web-based survey.

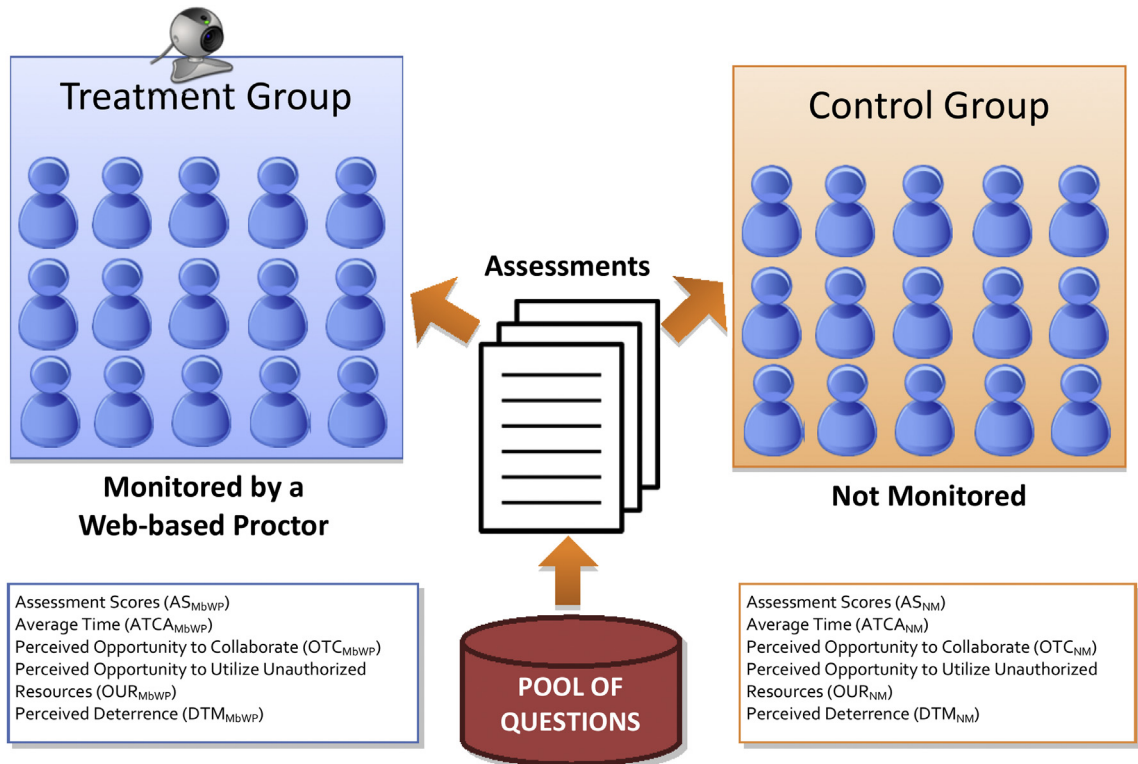


Fig. 1. Illustration of the experimental groups for this research.

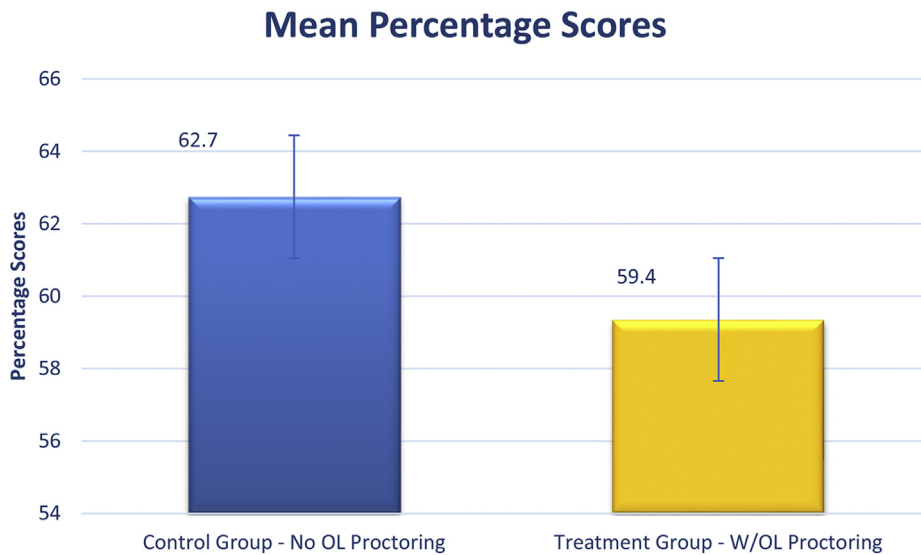


Fig. 2. Percentage score differences between groups.

5.1. Assessment data analysis

The data garnered from the results of online exams administered were analyzed using an independent-samples *t*-test to help determine if there was a significant difference between the treatment group and the control group. This test compared the means scores as well as duration taken to complete the online exams of the treatment and control groups. Regarding the scores received, the *t*-test was calculated comparing the mean score of participants who were monitored by a Web-based proctor (MbWP) and those who were not monitored (NM). The results indicated that participants who were not monitored had higher scores ($M = 62.74$, $SD = 15.29$) than those participants who were monitored by a Web-based proctor ($M = 59.35$, $SD = 16.06$); $t(368) = 2.079$, $p = 0.038$. Figs. 2 and 3 illustrate the differences between each group on scores and duration respectively.

An independent-samples *t*-test was also done to compare the mean duration taken of participants in each group. Participants in the control group who were not being monitored took longer to complete tests ($M = 14.54$, $SD = 7.63$) than those

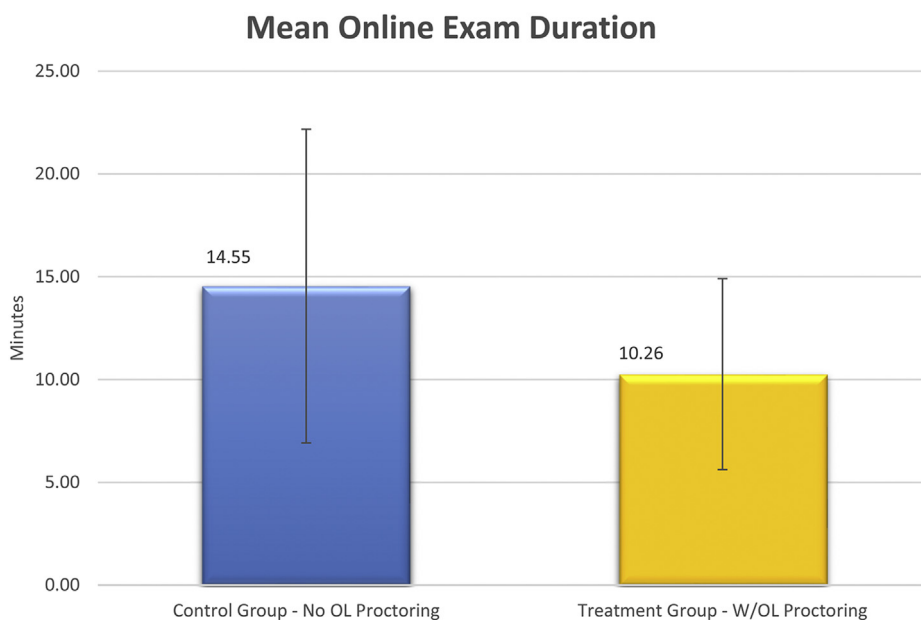


Fig. 3. Duration differences between groups.

Table 1
Group statistics – scores & duration (n = 370).

Group	N	Scores			Duration		
		Mean	Std. Deviation	Std. Error mean	Mean	Std. Deviation	Std. Error mean
Control Group (NM)	184	62.7446	15.29116	1.12728	14.5470	7.62759	.56231
Treatment Group (MbWP)	186	59.3548	16.06113	1.17766	10.2611	4.64104	.34030

Table 2
Mann–Whitney U and ANOVA test results (n = 73).

Item	Monitored by web-based proctor (MbWP)			Not Monitored (NM)			ANOVA		Nonparametric (Mann–Whitney test)		
	Mean Rank	Mean	SD	Mean Rank	Mean	SD	F	p	Z	Sig. (Two-tailed)	
OTC	OTC1	30.45	1.29	.636	45.87	2.42	1.501	19.346	.000***	–3.635	.000***
	OTC2	28.29	1.14	.417	48.81	2.35	1.355	29.886	.000***	–4.845	.000***
	OTC3	29.50	1.90	1.185	47.16	3.16	1.416	16.971	.000***	–3.645	.000***
OUR	OUR1	27.92	1.52	.890	49.31	2.84	1.241	27.831	.000***	–4.552	.000***
	OUR2	27.86	1.67	.979	49.39	3.00	1.265	25.778	.000***	–4.475	.000***
	OUR3	28.76	2.38	1.188	48.16	3.52	1.029	18.203	.000***	–3.961	.000***
DTM	DTM1	43.99	3.52	1.194	27.53	2.58	1.057	12.241	.001**	–3.368	.001**
	DTM2	45.08	3.55	1.194	26.05	2.35	1.170	18.107	.000***	–3.878	.000***
	DTM3	43.46	3.83	.961	28.24	3.03	.983	12.165	.001**	–3.163	.002**
	DTM4	39.07	2.90	1.792	34.19	2.45	1.362	1.388	.243	–1.013	.311

***p < 0.001; **p < 0.01.

in the treatment group who were being monitored by a Web-based proctor ($M = 10.26$, $SD = 4.64$); $t(368) = 6.54$, $p < 0.005$. The results of the t -tests on the online exam duration are presented in Table 1.

5.2. Survey data analysis

Both the ANOVA and the non-parametric Mann–Whitney U tests were conducted on the data from the self-reported Web-survey. This test helped to determine if there were any significant differences between the two groups regarding the perceived opportunity to collaborate, the perceived opportunity to utilize unauthorized resources, and the perceived deterrence experienced.

As it relates to the perceived opportunity to collaborate (OTC) the results of both the ANOVA and the Mann–Whitney U tests indicated that there was a significant difference between both groups. The results of the Mann–Whitney U test indicated that OTC1, OTC2, and OTC3 as significant ($p < 0.001$, $n = 73$). Those who were not monitored (NM) felt as though they had a greater opportunity to collaborate with others than those who were monitored by a Web-based proctor while taking the online exams.

Likewise, there was a significant difference between both groups on their perceived opportunity to utilize unauthorized resources (OUR) while taking an online exam. The analysis showed that OUR1, OUR2, and OUR3 as significant ($p < 0.001$, $n = 73$), with the treatment group which was monitored by a Web-based proctor (MbWP) perceiving that they had significantly less opportunity to utilize unauthorized resources during the online exams than those who were not monitored. The ANOVA and Mann–Whitney U test results are shown in Table 2.

The Web-survey also included four questions on deterrence that were used to help assess the level of perceived deterrence to engage in misconduct that participants experienced during the online exams. The results determined that there was a significant difference between both groups on the level of perceived deterrence to engage in misconduct. The analysis showed DTM1 and DTM3 as significant ($p < 0.01$); as well as DTM2 as significant ($p < 0.001$). The results also indicated that the fourth item on deterrence (DTM4) was not found to be significantly different between the groups. This is because DTM4 was worded slightly but significantly different for each group. The distinction between the two as illustrated below is solely on the word “NOT” which essentially reverses the question being posed.

DTM4 - Treatment Group	How influential did knowing that you were being monitored by a Web-based proctor have on your decision to engage in misconduct or not during the Web-based assessments?
DTM4 - Control Group	How influential did knowing that you were NOT being monitored by a Web-based proctor have on your decision to engage in misconduct or not during the Web-based assessments?

Consequently the responses showed that being monitored or not influences participants on whether to engage in misconduct or not during the online exam. All deterrence items considered, the results of the Mann–Whitney U analysis revealed that those who were being monitored by a Web-based proctor felt a greater level of deterrence to engage in

misconduct while taking the online exams than those who were not monitored. The results of the Mann–Whitney U test are outlined in [Table 2](#).

Overall, all five hypotheses were rejected. The results of the study determined whether there were statistically significant differences between the set of online exam results that were taken by participants being monitored by a Web-based proctor and results from those that were not monitored. Statistically significant differences were found between each group on the scores, average time taken to complete the online exam, the perceived opportunity to collaborate, the perceived opportunity to utilize unauthorized resources, and the level of perceived deterrence to engage in misconduct experienced.

6. Discussion

6.1. Implications

Our study not only contributes to the body of knowledge, but also has implications for industry as well as for further investigations. This research involved the examination of particular information technologies to counter misconduct in online exams. We also examined the concepts of deterrence and surveillance systems in the context of securing and protecting the integrity of online exams and related information systems.

Our results, therefore, imply a number of points. With the use of appropriate information technology, it is possible to proctor in a Web-based environment and such proctoring can deter misconduct. This supports [Bedford et al. \(2009\)](#) who purported that technology such as online proctoring can aid in countering misconduct in online assessments. Web-based proctoring can also significantly reduce the perceived level of opportunity to engage in misconduct during online exams. There is less-perceived opportunity to collaborate with others and utilize unauthorized resources where surveillance such as Web-based proctoring is employed. Such perceptions have been linked by others ([D'Arcy, Hovav, & Galletta, 2009](#); [Raser, 1966](#)) to result in actual deterrence. [D'Arcy et al. \(2009\)](#) noted that an individual's perception has a direct effect on their intention to misuse information systems. With these in mind, it may be important to incorporate similar technology where relevant surveillance during online exams can increase in order to deter misconduct.

Other findings of our research further supports previous studies that show the value of opportunity towards misconduct, as well as the impact of surveillance as a deterrent to the misuse of information systems. The results are aligned with [Perry et al. \(1990\)](#) who found that participants are more likely to engage in misconduct if they have the opportunity. Likewise, this also supports [Theoharidou et al. \(2005\)](#) who put forward that the level of misconduct can be reduced by increasing deterrence and reducing opportunity to engage in misconduct. These results also support those of [Carstairs and Myors \(2009\)](#) who found that exam scores were significantly inflated among those who were unproctored. Additionally, our research supports findings of a number of previous studies ([Corcoran & Rotter, 1987](#); [Covey, Saladin, & Killen, 1989](#); [Houston, 1978](#)) on the impact of surveillance on the temptation to engage in misconduct.

Our findings therefore concur with previous studies and adds to the body of knowledge particularly regarding exams administered online. As it relates to existing and future research in the field, it may be important to explore if there is a distinction between online exams that are comprised of mostly recall questions, versus those that consist of mostly analytic and/or critical thinking questions.

6.2. Alternate interpretations

There can be alternate interpretations of the results as well. First and foremost, an argument may be presented that the longer time participants who were not being monitored took to complete tests could be a result of them feeling more relaxed and free to use the time allotted, than actually making attempts to utilize unauthorized resources or collaborate during the test. There may be other reasons for why a participant may have taken a longer time than actually attempting to engage in academic misconduct. Additional study could provide further knowledge regarding other reasons why participants taking unmonitored tests may take longer than those who are not monitored.

Likewise, there may be the view that participants who are monitored by a Web-based proctor may have the inclination to rush through a test due to the additional anxiety resulting from the proctored environment. This anxiety and could also negatively impact their test score, resulting in lower scores than participants who were not monitored. Although these alternate views may be plausible, a number of other studies ([Carstairs & Myors, 2009](#); [Harmon & Lambrinos, 2008](#); [Prince et al., 2009](#)) have used test scores to measure academic misconduct.

6.3. Recommendations

The results of our research study provide recommendations for both the industry and the research community. The case is made that there is a greater level of deterrence to engage in misconduct experienced by those who were MbWP. Consequently, it may be warranted to employ proctoring or similar surveillance technologies when administering online exams to better secure academic integrity. This corresponds with [Bedford et al. \(2009\)](#) who suggested that appropriate technology can be deployed to counter the significant problem of misconduct in online exams. Suitable surveillance techniques will help to reduce deception as well as the level of opportunity to engage in misconduct during online exams.

It is equally important to note that this method is not a panacea for this problem. It may be best utilized along with other techniques that have been proven to help address this challenge. Other such methods include having a large pool of questions (Adkins et al., 2005; Harmon & Lambrinos, 2008; Prince et al., 2009), limiting the time (Christe, 2003; Eplion & Keefe, 2007; Schultz et al., 2008), and establishing an honor code environment (Burrus, McGoldrick, & Schuhmann, 2007; Faucher & Caves, 2009; Granitz & Loewy, 2007). A combination of these techniques may create an environment that reduces the level of misconduct in online exams.

7. Conclusion and future research

Academic misconduct during online exams is a major challenge. It has been deemed essential that misconduct in online exams be guarded against. The findings of our study indicate that the absence of surveillance during online exams can increase the level of opportunity to engage in misconduct. The findings also suggest that relevant technology such as Web-based proctoring as was used in this experimental study can be employed to counter deception and dishonesty in online exams. Doing so could add another layer of deterrence against the misuse of these information systems.

As it relates to the research community, there are a few noteworthy recommendations for future research. Firstly, it may be meaningful to repeat the study at another institution as well as within another type of course. Furthermore, Burlak et al. (2006) suggested that longer response times might reflect possible misconduct. Future studies could also explore whether there is a relationship between the time taken to complete an online exam among those who were NM, and the scores received. Other studies could explore informing a group that they are being monitored even though they are not, to examine if the threat of monitoring will deter academic misconduct. Finally, future research could consider employing a pre-test and post-test methodology, where the group that is initially NM would be MbWP after the first set of data is collected. Likewise, the group that is initially MbWP would be NM midway through the experiment. These challenges may provide further insight into the deterrent effect of surveillance in online exams.

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