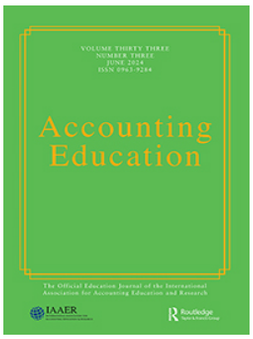

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Accounting students' performance in proctored online exams: early evidence from COVID-19 disrupted tertiary education learning

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ABSTRACT

Given the debate in tertiary institutions on the use of technology for assessments due to the coronavirus (COVID-19) pandemic, we compare the performance of accounting students in proctored paper-based and online exams. We examine exam scores across different demographic variables to provide early insights into the impact of these demographics on student performance. Our exploratory analyses indicate that students perform better in proctored online assessments than invigilated paper-based ones. The differences in student performance between these two assessment methods are associated with distinct factors, such as in-person and distance study modes, and student nationality. In summary, the findings of this study provide support for the adoption of online technology in managing exams.

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Proctored online assessment; paper-based exam; COVID-19; exam performance

Introduction

Along with advancements in education technology, the coronavirus (COVID-19) pandemic has accelerated the adoption of online exams in tertiary institutions. However, there is limited understanding of the specific differences between student performance in proctored online exams and traditional invigilated paper-based exams focussing on the accounting discipline. Here, we investigate whether the adoption of proctored online exams influences accounting student performance, when compared to invigilated paper-based exams. Specifically, we provide early evidence on the effects of online exams on student performance in tertiary accounting education.

In 2020, the COVID-19 pandemic did not spare the tertiary education sector (Mardini & Mah'd, 2022; Yang et al., 2020). Providers of tertiary accounting education were forced to adopt innovative systems to address the challenges the pandemic posed. Proctored online exams became a solution to the practical challenges of physical methods of examination (Saidi et al., 2021). Further, when the pandemic was controlled many educational institutions continued to provide online exams, given the continuous improvements in the online accounting education systems in which they had invested, as well as the

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anticipated benefits from proctored online exams. However, within the same institution some students will likely prefer paper-based exams over the online exam method.

This study should thus be of interest to accounting educators worldwide because it addresses a critical issue in the assessment of accounting students. COVID-19 left accounting educators with no choice than to adopt online assessments to minimise the risk of exposure to COVID-19 posed by in-person, invigilated, paper-based assessments (Sangster et al., 2020). Because of the speed of the transition to online assessment, concerns have been raised about the effect of this transition on student performance (Hancock et al., 2022; Saidi et al., 2021). Consequently, the accounting education literature is yet to address this specific area because the surge in adoption of online assessment is a very recent event. Significantly, this topic merits research attention because online assessment is likely to continue in the post-pandemic period. The adoption of online exams cannot entirely satisfy all student preferences or benefits; students who prefer paper-based exams may perceive the adoption of online exams as inhibiting their exam performance.

This study provides insights into student performance in online exams. We compare the performance of accounting students in proctored online exams and invigilated paper-based exams by using their actual exam scores and the sociodemographic variables associated with changes in their performance. Using univariate and regression analyses, we find some differences in performance between invigilated paper-based and proctored online exams. These differences are associated with sociodemographic variables such as gender, education delivery system (distance versus face-to-face learning), nationality, studying part-time or full-time, grade point average (GPA) and the level of tertiary accounting education (undergraduate versus postgraduate).

Our findings indicate that there is no difference in student performance when proctored online exams substitute invigilated paper-based exams. However, the results vary when grouping students by their sociodemographic characteristics.

Contribution

This study provides empirical evidence on the effects of proctored online exams on student performance in accounting education. Specifically, the study examines whether accounting student performance differs between proctored online exams and invigilated paper-based exams. Some students may have pre-existing preferences regarding paper-based exams or online exams, which could lead to student opinions advocating for one exam format over the other. Such a preference could be associated with student sociodemographic factors, such as gender, nationality and student cohort (Nardi & Ranieri, 2019). To understand this variation among the student population, we examine the association between: (1) student nationality and their performance; (2) the education delivery mode and student performance; and (3) student gender and their performance.

Our study thus contributes to the evolving literature on student evaluation (Edeigba, 2022; Hollister & Berenson, 2009; Marriott & Lau, 2008; Raman et al., 2021) and, importantly, to the literature on the challenges posed by unprecedented events, such as COVID-19, to accounting education (Sangster et al., 2020). Moreover, our findings contribute to improving the effectiveness of assessment in accounting education by

providing evidence-based recommendations on assessment modes based on the actual exam performance of accounting students, as opposed to survey or interview methods that could be influenced by some form of bias, or arguably, perceptions.

Further, this study highlights the importance of considering student characteristics when designing and implementing assessments. This addresses some of the concerns that Sangster et al. (2020) raised following the academic disruption during COVID-19. Apart from the limited research on the effects of the COVID-19 pandemic in this regard, there is a dearth of research comparing student performance in proctored online exams versus traditional invigilated paper-based exams, especially in discipline-specific fields such as accounting. This gap leaves most accounting educators with limited knowledge of the effects of online exams on student performance, notwithstanding the various studies on student evaluation in accounting education (Hancock et al., 2022; Hartnett et al., 2004; Mardini & Mah'd, 2022; Raman et al., 2021). There has also been little exploration of the relative impacts of paper-based exams compared to online exams on student performance. Hence, we address this literature gap by relating accounting student exam scores to the mode of exam in order to provide insights into the effects of exam methods on their performance. Consequently, our findings have implications for accounting educators and researchers, policymakers and professional accounting bodies, as discussed in later sections.

The remainder of this paper is structured as follows. In the next section, we discuss the background of the study. We then present a literature review on invigilated paper-based and proctored online exams, followed by our hypotheses. Next, we discuss the methodology and interpret and discuss our findings. In the last section, we conclude the study and highlight its implications for accounting education.

Background of the study

The attempted containment of COVID-19 began a new era of education delivery and assessments for many tertiary institutions worldwide. The classroom setting for learning and assessment has been the norm for several decades (Kuriakose & Luwes, 2016). Nevertheless, several studies have revealed that students prefer proctored online exams as opposed to invigilated paper-based exams (e.g. Khan & Khan, 2019; Kuriakose & Luwes, 2016; Nardi & Ranieri, 2019; Noyes et al., 2004). This preference can be attributed to the provision of instant or automated feedback on student performance when the exam is designed with automated grading. Other factors may be influential, such as 'coloured diagrams, being able to edit answers, spell check functionality, zooming in to see exam material more carefully, and a checklist to ensure questions have not been missed out' (Kuriakose & Luwes, 2016, p. 673; Nandini & Uma Maheswari, 2020). However, student acceptance of, or preference for, proctored online exams does not indicate that their performance is enhanced or supported by technology.

Despite student preference for online exams (Saidi et al., 2021) and a tertiary education system that is highly student-centred (Kuriakose & Luwes, 2016), there is limited understanding of the specific differences between student performance in proctored online exams compared to invigilated paper-based exams in accounting education, particularly at the university level. However, some issues cast doubt on the relationship between the adoption of proctored online exams and student performance in a

summative evaluation. Issues associated with proctored online exams include a lack of technological skills (Khan & Khan, 2019), cognitive workload[1] (Noyes et al., 2004), the student's preparedness for the mode or method by which the exam is conducted (Khan & Khan, 2019), the reliability of the information technology (IT) system by which the test is assessed, including the loading of the assessment and the login process (Khan & Khan, 2019), and examination anxiety (Kuriakose & Luwes, 2016; Saidi et al., 2021). Significantly, alongside COVID-19 forcing a greater reliance on technology, advancements in education technology have accelerated the adoption of online exams. Hence, here we examine the potential consequences of proctored online exams, in contrast to traditional invigilated paper-based exams, on the academic performance of accounting students, with the aim of providing insights into the impact of online exams on learning outcomes. Paper-based exams have been used for generations and have been found effective for evaluation, but preferences for both paper-based and online examination methods continue to be a subject of debate (Clariana & Wallace, 2002; Nardi & Ranieri, 2019; Nikou & Economides, 2016).

Significant developments in IT since the early 1970s (Legris et al., 2003) have led to the increased adoption of IT infrastructure for various tasks, such as accounting practice, organisational systems, and tertiary education, including proctored online exams (Basol & Balgalmis, 2016; Legris et al., 2003; Raman et al., 2021).

A proctored online exam is a computer-based examination that is 'infused with algorithmically driven procedures and artificial intelligence' and is 'designed to seamlessly authenticate students' identity and recognise their in-test (mis)behaviour' in a remotely conducted assessment' (Selwyn et al., 2021, p. 2). Proctored online exams replace the invigilated paper-based exam, which is traditionally conducted in a physical classroom where students are present along with an invigilator who administers the exam and monitors any breaches of academic integrity during the exam.

Most accounting qualifications in New Zealand, such as the Bachelor of Accounting degree or Bachelor of Commerce Degree with an accounting major, involve both proctored and non-proctored assessments, and this approach is prescribed by tertiary institutions and professional accounting associations in New Zealand and Australia (Edeigba, 2022; Hancock et al., 2022). At the time of the study, the Certified Practising Accountant (CPA Australia) and Chartered Accountants Australia and New Zealand (CA ANZ) require that at least 50% of overall assessments for accredited accounting programs in universities and other tertiary institutions be invigilated or proctored. The responsibility for invigilation has now been passed to the individual institutions' accredited programs. This involves verifying and confirming student identities and supervising the exam throughout the scheduled time (Hancock et al., 2022). Non-proctored assessments are completed independently by students. Depending on the assessment, they may have the option to work at their own pace, refer to educational resources and engage in peer-to-peer discussions to gain a better understanding of the assessment tasks and related topics. These assessments are usually timed, but the time limit allows students to work at their preferred pace within the given time limit. In contrast, proctored assessments have a set time limit, but students can still work at their own pace within the allotted time for the assigned tasks in the same way as for invigilated exams.

Proctored assessments are designed to assess student achievement of the course learning outcomes (Kuriakose & Luwes, 2016; Nandini & Uma Maheswari, 2020), either with

or without an opportunity to refer to any resources or engage in peer-to-peer discussion. In the case of the education provider considered in this study, this type of assessment has a greater weighting, as much as 70% or 50% of the overall grade, than a non-proctored assessment (30%). In addition, a student is expected to achieve a minimum pass mark of 50% of the overall marks for the 70% proctored assessment weighting.

The nervousness and anxiety that students experience when completing proctored assessments highlights the importance of such exams for achieving academic success (Nardi & Ranieri, 2019). Hence, combining the stress of a proctored assessment with an online exam format that may be unfamiliar to some students suggests there may be unintended consequences to this delivery method (Kuriakose & Luwes, 2016; Nardi & Ranieri, 2019). Nevertheless, there is currently insufficient empirical evidence to support the assumption that proctored online exams have a significant effect on student performance in a supervised summative assessment. Therefore, the objective of this study is to provide early evidence, if any, on how proctored online exams influence the performance of accounting students compared with invigilated paper-based exams.

We adopt descriptive analysis to examine: (1) whether there is any difference in student performance based on proctored online and invigilated paper-based exams; and (2) whether the effects of proctored online or invigilated paper-based exams vary across students by gender, education delivery system,[2] status,[3] and GPA. The data includes actual examination scores. Our findings imply that there is no significant difference in student performance when proctored online exams are adopted, as opposed to invigilated paper-based exams. Nonetheless, differences in performance are observable when the students are analysed by sociodemographic factors, such as gender and nationality.

Literature review

An examination is any process that evaluates an individual's knowledge, understanding, ability and skills on the basis of set learning outcomes or objectives (Marriott & Lau, 2008), and is a component of assessment that is conducted to ascertain student performance (Raman et al., 2021). Hollister and Berenson (2009) described assessments as an important component of an education institution because they are processes for providing credible evidence of the outcomes of educational learning activities.

Accounting education has undergone significant changes in recent years owing to advancements in technology and changes in the business environment (Edeigba, 2022). COVID-19 further accelerated the adoption of technology in accounting education, particularly in the delivery of courses and assessments (Bryson & Andres, 2020; Lloyd & Robertson, 2011; Rof et al., 2022). While the adoption of technology in education delivery, including assessment and teaching, is generally viewed as a positive development (Bryson & Andres, 2020; Rof et al., 2022), in some disciplines such as accounting, technology adoption is perceived as a threat to effective teaching, learning, and evaluation, creating a 'tension between technology and pedagogy' (Sangster et al., 2020, p. 492; also see Mardini & Mah'd, 2022). The long tradition of completing paper-based learning and exams is perceived by many as ineffective or detrimental to student performance (see Nikou & Economides, 2016).

There is a growing body of accounting education studies on the effectiveness of online versus paper-based assessments in accounting courses. For example, Mardini and Mah'd (2022) found that students who took online accounting courses were less satisfied with their performance than those who took paper-based courses. This difference is attributed to the interactive nature of online courses, which only allows students to engage with the supplied materials (such as learning resources) rather than with an instructor, and the absence of body language that exists in a physical classroom setting is considered detrimental (Bryson & Andres, 2020; Mardini & Mah'd, 2022).

Mardini and Mah'd's (2022) finding is consistent with that of Sangster et al. (2020), who showed that the majority of the accounting students surveyed preferred face-to-face learning over online learning and assessments. Nevertheless, students who studied online also perceived that their assessment performance had been affected by the use of the online method as opposed to the paper-based method (Mardini & Mah'd, 2022).

Nonetheless, Mardini and Mah'd's (2022) study's findings are based on the perceptions of accounting students rather than insights into the actual assessment scores from both paper-based and online accounting exams. Therefore, the specific effects on accounting students of proctored online accounting exams compared to invigilated paper-based exams remain a perception of accounting students and accounting education scholars. In this regard, Sangster et al. (2020) noted that 'there is a need for future research to explore a wide range of issues pertaining to examinations and other forms of assessment in accounting' (pp. 445–446). In line with their view, this study examines student performance in proctored online exams and compares this to invigilated paper-based exams and addresses the impact of the delivery mode and student characteristics on their actual performance.

Whether assessments influence student academic performance or not depends on the assessment type. There are two types of assessments: formative and summative. Formative assessments provide a platform for students to self-evaluate their abilities to improve their learning, test their level of understanding, identify their strengths and weaknesses within a topic and, in some cases, prepare for a summative assessment (Black & Wiliam, 1998; Hounsell, 2003; Rowntree, 1987; Yorke, 2001). A formative assessment is particularly important in accounting courses given the practical nature of the discipline and the specific accounting rules with which businesses must comply.

Summative assessments include graded assignments, tests, and final exams, and evaluate evidence supporting the student's achievement of the learning outcomes (Hancock et al., 2022; Marriott & Lau, 2008). Assignments and tests provide some intrinsic value to students when they use the 'feed-forward' to improve their performance in subsequent assessments, such as final exams. However, a final exam summative assessment does not provide students with intrinsic value because the assessment may not provide specific feed-forward, such as what students could do differently in the future to improve their performance in the course (Hendry et al., 2016; Marriott & Lau, 2008; Price et al., 2010). Hence, a summative assessment is designed to evaluate student performance with a significant proportion of the weighting at the last stage of the course. Therefore, the focus of this study is the final summative assessment methods that examine student performance.

Educational institutions change what is taught (curriculum) or the way educators teach (pedagogy) for several reasons. Tertiary education funding and employers'

expectations have changed following technological advancements (Edeigba, 2022). However, some approaches of tertiary institutions, such as the development of educational content (printed textbooks), the delivery of lectures and tutorials, and assessment methods, have not changed significantly (Kuriakose & Luwes, 2016; Marriott & Lau, 2008; Pincus et al., 2017; Raman et al., 2021). Nevertheless, COVID-19 forced tertiary institutions into a new process of education delivery with the widespread adoption of technology (Mardini & Mah'd, 2022; Yang et al., 2020). Because of the challenges posed by COVID-19, the use of technology is now popular for student summative assessments (Raman et al., 2021). The adoption of technology for assessments is not new to tertiary institutions. The use of technology for proctored online exams is, however, a recent innovation in the tertiary sector.

Hypotheses

Assessment methods and student performance

Despite research on accounting assessments, such as student feedback from a computer-aided assessment (Marriott & Lau, 2008), instructor feedback on formative assessments (Black & Wiliam, 1998), and assessment feedback on student learning (Hounsell, 2003), the impact of proctored online and invigilated paper-based exams on student performance is not supported by empirical evidence. This gap may be due to a lack of data on the actual performance scores of students from both paper-based and online exams. In addition, the current level of online adoption for assessment in accounting education in most tertiary education sectors worldwide was triggered by COVID-19 and increased access to technology (Saidi et al., 2021, p. 956). Hence, the effect of proctored online exams on student performance is unknown because the widespread adoption of technology and proctored online exams in the education sector is recent.

Nevertheless, most students prefer paper-based exams owing to the perceived impact of online exams on student performance (Mardini & Mah'd, 2022). Therefore, it is important to examine the effects of paper-based versus online summative assessments on the performance of accounting students to understand how these two assessment methods affect performance. Our focus is whether the choice of invigilated paper-based or proctored online exams plays a significant role in student performance. Accordingly, our first hypothesis evaluates the relationship between student performance using the two exam methods:

> H_1: The method of completing summative assessments affects student performance outcomes.

Association between student nationality and performance in paper-based and online exams

Tertiary education institutions in developed countries (such as United States, United Kingdom, Australia, New Zealand, and other OECD countries), where education contributes significantly to the host country's economy, have attracted international accounting students (Beine et al., 2014; Rienties et al., 2012). These students are largely from countries such as China, India, Nigeria, and other countries in Asia and

Africa. They study along with local students in their host countries (Beine et al., 2014; Li et al., 2010). The academic performance of students from diverse countries differs and can be influenced by factors such as the characteristics of the host institution, the student's native language, and the adjustments required of them by the social and economic environment of the host country (Li et al., 2010; Rienties et al., 2012).

Among the factors inhibiting some groups of international students, the language barrier is identified as a significant challenge. This is a common issue among students studying in a country where the language of instruction differs from their native language (Li et al., 2010). Even if students demonstrate proficiency in the language of the host country, exams, learning and completing assessment tasks can still be challenging (Li et al., 2010). This is especially problematic when international students are required to write exams in a language that is not their native language – for example, Chinese and Indian students typically write in Indo-Aryan (Hindi) and Sino-Tibetan (Chinese) languages, rather than English (Li et al., 2010). These language differences can adversely affect exam performance, and notably large differences are apparent when comparing international students with predominantly native English speakers (Rienties et al., 2012).

The inability to write clearly and correctly in the language of instruction and assessments in the host country can affect the exam performance of international students from diverse linguistic backgrounds. Online exams have the potential to reduce communication barriers through features such as spell check, zoom capability, editing answers, and language-specific word suggestions. These features can aid students during an online assessment (Crawford & Wang, 2015; Khawaja & Dempsey, 2008; McDowall & Jackling, 2006; Perera & Richardson, 2010; Zafar et al., 2014). However, there is limited research on whether online exams improve the performance of students from diverse nationalities compared with paper-based exams, or other in-person assessment (Szopiński & Bachnik, 2022).

Furthermore, academic performance differs significantly depending on the student's native language and the language of instruction (Crawford & Wang, 2015; McDowall & Jackling, 2006; Perera & Richardson, 2010; Zafar et al., 2014). These differences may be attributed to the national language being central to the medium of instruction in earlier education for some students, unlike for students who are primarily native speakers in the host tertiary institution. The problems associated with language barriers are not limited to writing skills but also include the potential for students to misunderstand exam instructions, which are sometimes provided orally by the exam invigilator in the case of paper-based exams.

Thus, the adoption of proctored online exams is expected to reduce or eliminate communication barriers between accounting education providers and students from different nationalities during exams (Arkoudis et al., 2019). Automated instructions on permissible materials, time management, compulsory questions and exam procedures can ensure students are fully informed and not disadvantaged by overlooking important instructions. In contrast, some paper-based exams lack mechanisms to ensure that students read and follow instructions. For example, it is possible for students to skip instruction pages in a paper-based exam, while the online exam instructions may be mandatory for students to read before they can progress to the exam questions.

The effects of language barriers on the performance of international students in assessments are well documented in the literature (e.g. Hellstén & Prescott, 2004; Khawaja &

Dempsey, 2008; Lee & Rice, 2007; Neri & Ville, 2008). However, the influence of online versus paper-based exams in eliminating communication barriers and improving the performance of students from different nationalities is not fully understood.

It is of note that the adoption of proctored online exams, rather than invigilated paper-based exams, may improve some students' communication. In the online exam format, answers could become more readable as they would have access to suggested words for correct spelling, as well as suggestions for improved sentence structure, based on their answers. This would also benefit the online examiner, as the time taken to mark a typed and more easily readable answer is significantly less than may be expected in a paper-based exam. Therefore, our second hypothesis examines the influence of accounting student nationality on their performance outcomes when a proctored online or invigilated paper-based exam is adopted for summative assessments:

> H_2: Student nationality is associated with their performance in invigilated paper-based and proctored online exams.

Association of method of education delivery with student performance

In recent years, several institutions have implemented distance learning, whereby lectures are delivered using information and communication technology (ICT). The use of ICT helps students to learn from resources supplied through the education provider's learning management system. These resources include formative assessments that students complete online (Saidi et al., 2021).

A formative assessment conducted online differs from a summative assessment in that time constraints are imposed on a summative assessment, whereas most formative assessments are optional and have no specific deadline, such as quizzes at the end of the teaching session. Some universities have adopted additional technologies (e.g. TopHat[4] and Adobe Connect) to support student learning. However, platforms that support summative assessments, such as cloud-based exam software Remote Proctor (RPNow), Creatrix, eSkill and Test Invite, differ from TopHat and similar software used for formative assessments. Students who study online are perceived to require practical computer skills, which can lead to the development of greater proficiency in using a computer to complete activities compared with students who learn in a physical classroom system and are reliant on physical tools such as print books (Arrosagaray et al., 2019; Bryant et al., 2005, p. 267).

Studies comparing physical classrooms and distance learning have categorised these modes of teaching as either on-campus and off-campus learning or simply on-campus and distance learning. However, these studies are not specifically related to accounting education – rather, they examine disciplines such as social work (Oliaro & Trotter, 2010), journalism (Hollerbach & Mims, 2007), or allied health professionals (Williams, 2006), or they conduct a meta-analysis of studies on distance learning across different disciplines, such as social sciences, engineering, and humanities (Allen et al., 2004). A distance learning mode of delivery in most tertiary institutions requires the technological intermediation of communication (*online delivery*), whereas physical classroom delivery requires an educator and students to be present in a physical classroom setting. Arrosagaray et al. (2019) and Allen et al. (2004, p. 403) have noted that the difference between distance learning and physical or on-campus learning is that 'distance learning represents

a change in the fundamental orientation of the learning environment. Traditional, physically co-present classrooms and pedagogical practices involve face-to-face instructor – learner relationships'. Typically, these physically and socially immediate instructional contexts are transformed in distance learning through the technological intermediation of communication between teacher and students.

Most students attending physical classrooms are campus residents or residents in the same community as the education providers. In contrast, students engaging in distance learning can reside in the country in which the institution is located or even anywhere in the world based on the institution's requirements. On-campus students have greater access to education providers than distance students, who may only meet with educators and peers through online or telephone appointments (Arrosagaray et al., 2019; Dumford & Miller, 2018; Perraton, 2020). This difference in access has been described as the 'dilemma of dialogue' by Perraton (2020, p. 87). Dumford and Miller (2018, p. 458) noted that distance learning has a low score for student – faculty interaction and that such interaction can be challenging to implement.

For instance, in some institutions, students engaged in distance learning may have less contact time (e.g. a fortnightly or monthly meeting) with the educator than on-campus students, and they may be provided with recorded lectures and tutorials via the internet. Conversely, on-campus students, may have more frequent contact time with educators (e.g. once or twice a week). The differences in contact time between the two groups could affect the level of student engagement with the course, particularly for distance learning students and this may result in poorer performance. Thus, we expect some differences in paper-based and online exam performance between distance students who have had prior online learning experience and campus-based students who have had only physical classroom experience before the adoption of proctored online exams. In line with this discussion, our third hypothesis examines the relationship between education delivery methods and student performance in invigilated paper-based and proctored online exams:

H_{3a}: Student performance in a proctored online exam is influenced by the method of education delivery.

H_{3b}: Student performance in an invigilated paper-based exam is influenced by physical class learning activities, such as physical lectures or tutorials.

Gender and student performance in online versus paper-based exams

Gender is another factor that is perceived to influence student performance in exams (e.g. Basol & Balgalmis, 2016; Padilla-Meléndez et al., 2013; Terzis & Economides, 2011). Male and female students' exam performance could differ depending on whether an online or paper-based exam is adopted. Prior studies have shown that male and female students could perform differently when taking a computer-based exam as opposed to a paper-based exam because of their different levels of optimism and conscientiousness (Icekson et al., 2020; McDowall & Jackling, 2006; Terzis & Economides, 2011).

It is perceived that male students tend to have greater motivation to use technology such as online software for assessment, which could influence their exam performance when the online exam method is adopted. This is because they have less computer-

based test anxiety and greater efficacy in using technology than female students (Padilla-Meléndez et al., 2013; Reisman, 1990; Siddiq & Scherer, 2019; Terzis & Economides, 2011). In contrast, female students generally feel more anxious about online exams than their male counterparts, which could affect their performance on computer-based exams (He & Freeman, 2010; Terzis & Economides, 2011). However, the performance of females in terms of overall ICT knowledge is superior to males who tend to excel in applying computer knowledge (He & Freeman, 2010; Nardi & Ranieri, 2019; Siddiq & Scherer, 2019; Terzis & Economides, 2011). Thus, the behavioural reactions of students to online exams based on gender differences is expected to influence their performance in different exam settings.

Nonetheless, there is no clear evidence to support a relationship between gender and the performance outcomes of invigilated paper-based accounting education exams (Basol & Balgalmis, 2016). Therefore, in an exploratory analysis in this study, we consider a hypothesis on gender and student performance in a paper-based exam. Our fourth hypothesis examines the relationship between gender and student performance when either a proctored online or invigilated paper-based exam is adopted for summative accounting assessments:

H_{4a}: Student gender is associated with their exam performance when a proctored online exam is adopted for accounting courses.

H_{4b}: Student gender is associated with their exam performance when an invigilated paper-based exam is adopted for accounting courses.

Method and data

Our sample covers students enrolled in accounting programs during 2018–2021 at a New Zealand university. To analyse their performance on a proctored online exam, data on a paper-based exam period (2018–2019) and a proctored online period (2020–2021) were included. A four-year window was chosen to enable consistent comparison of invigilated paper-based and proctored online exams. Further, the selection of these four years was influenced by the availability of data for the proctored online exam, given that this method was adopted during the COVID-19 restrictions in 2020–2021.

Data screening

The setting is a large multi-campus university in New Zealand that offers in-person and online learning to domestic and international students. The data we used in this study is from the official university records. The data on exam marks and GPA were captured after the final exam results were finalised and the other data was captured when students enrolled in a program. To ensure the validity and reliability of measurements of student performance, data was collected from the university's student monitoring and performance evaluation system. This is the same database that the university relies on to issue academic certificates or qualifications to students at the end of their programs. The university's evaluation system captures student performance after exam marking and makes the marks available to each student, who then can dispute the marks in case of inconsistency in the computation.

Furthermore, the university has implemented several moderation and quality control measures, including ensuring that assessment platforms are correctly mapped to the student's portal. During COVID-19, some universities introduced different technologies for assessment completion, including exams. Some of these technologies did not allow invigilation of the assessment; hence, the students completed the assessment based on the principle of trust that they would maintain academic integrity. Several students breached this principle, committing widespread breaches of academic integrity and thus failing in their obligation to uphold the trust placed in them by their university. Notwithstanding the principle of trust, this university adopted an online proctoring system for accounting exams during the COVID-19 period in response to the professional accounting bodies that require invigilated assessments.

The data used in this study is from an institution that utilises the remote proctoring platform RPNow, which performs similarly to the in-class invigilated exam. The proctored online exam and assessment technology adopted by the institution in 2020 and 2021 is an advanced service application that allows exam invigilators to monitor students remotely during and after an exam. A recording of the student and the exam environment is referenced at any time, even after the exam is completed or the submission is assessed. The RPNow technology includes a camera and sensor that monitors the student's computer screen, room, sound, and movement in the assessment room. RPNow verifies the student's identity, requires them to use the video camera to scan their environment and locks their devices; that is, it does not permit them to access other webpages or share information, links or other resources on the computer during the exam. The student and their screen are recorded. The recordings are digitally reviewed to identify any breaches, which are later reviewed and investigated by university staff.

Population and sample

The total number of observations for the exams is 12,982, over 20 accounting courses involving 3,319 students. The courses are offered across study levels. The dataset includes all students enrolled in courses each year.

The course delivery was online for a brief period when lockdown restrictions prevented face-to-face delivery of courses. The syllabus and weighting of each exam remain the same across the sample years. However, the final exam weighting differs across the courses, varying from 50% to 70% of the total assessment. Therefore, our analysis focuses on proctored exams because proctoring affects the outcome of the exam relative to non-proctored term assessments. Having consistent weights over time eliminates any impact of assessment weighting on the measurement and enables us to tease out the variations in the performance of either proctored online or invigilated paper-based exams.

Measurement of dependent variable

We use performance (*Performance*) as the dependent variable, in line with McDowall and Jackling (2006) and Li et al. (2010) who used the overall performance of students as a measure of their learning outcomes and academic performance. Our measure of performance is the student's actual exam score, calculated as the numerical score they

achieved in a proctored three-hour examination at the end of the semester. We use this measure for the following reasons. First, the proctored exam weight forms a significant proportion of the weighting of the overall student assessment. Second, the results from the proctored exam are more reliable and potentially free from academic integrity issues. Thus, proctoring reduces breaches of academic integrity, cheating and access to 'cheat sites', given the strict oversight of the exam in this study site. Third, the actual exam mark is an objective indicator of student performance and, therefore, helps to meet the objective of this study.

Measurement of independent variables

Our main variable of interest is exam type (*Exam type*), that is, the method of completing summative assessments. This variable helps to investigate whether the method of completing the exam as a summative assessment affects student performance outcomes. We measure *Exam type* as a dummy variable that takes the value of 1 for invigilated paper-based exams and 0 for proctored online exams.

Following the literature, we also explore other variables related to student background, including nationality (*Nationality*), enrolment type (*Enrolment*), that is, in-class learning versus distance learning, and gender (*Gender*). *Nationality* is measured as a column vector of dummy variables representing the top four and all other nationalities of students (India, Malaysia, China, New Zealand, and Other).[5] We use a dummy coding approach that compares each category to a reference category (Alkharusi, 2012; Suits, 1957). This approach also helps to avoid perfect collinearity (dummy variable trap). The students in the *New Zealand* category are used as the reference category because the setting for this study is a university based in New Zealand. In addition, students with New Zealand nationality form the majority of our sample. *Enrolment* is measured as a dummy variable that takes the value of 1 for internal students (in-class learning) and 0 for distance students. *Gender* is measured as a dummy variable that takes the value of 1 for females and 0 for males.

Measurement of control variables

Following the literature, we include study (*Study*), program (*Program*), and grade point average (*GPA*) as control variables (MacCann et al., 2012; Miguéis et al., 2018; Moro-Egido & Panades, 2010; Tang et al., 2021). These variables help to account for some of the variations in student performance. *Study* is measured as a dummy variable that takes the value of 1 for full-time students and 0 for part-time students. The evidence from the literature on the association between the study mode and student performance is inconclusive. For example, while MacCann et al. (2012) and Moro-Egido and Panades (2010) found an association between study mode and student performance, Darolia (2014) did not find any such evidence. *Program* is measured as a dummy variable that takes the value of 1 for an undergraduate program and 0 for a postgraduate program. Tang et al. (2021) argued that postgraduate students are expected to have prior tertiary learning experience and hence show readiness to learn and achieve higher assessment performance than do undergraduate students.

GPA[6] measures a student's cumulative performance over time; it captures the variation in their academic capability and indicates their ability to achieve high performance in a course. For example,

> … in a situation in which two students have the same average grade, the one that did not have to repeat any course should have a higher performance score than the other that failed some courses and had to repeat them in a subsequent semester or academic year. (Miguéis et al., 2018, p. 42)

Hence, a student's academic capability influences their overall performance.

Research model

Multiple regression is used to test whether there is any difference in academic performance between invigilated paper-based and proctored online exams. Paper-based exams were held prior to the COVID-19 period. Therefore, the paper-based exams represent 7,090 observations for exams conducted during 2018–2019, while proctored online exams represent 5,892 observations for exams conducted in 2020–2021.

To examine student performance and the hypothesised covariates, the following regression model is applied:

$$\begin{aligned} Performance = {} & \beta 0 + \beta 1 Exam\ type + \beta 2\, Nationality + \beta 3 Enrolment \\ & + \beta 4 Gender + \beta 5 Study + \beta 6 Program + \beta 7 GPA + \varepsilon \end{aligned} \tag{1}$$

Findings, interpretation, and discussion

Presentation of findings

In this section, we present the analysis results. Each table (1–3) will be discussed below in reference to the hypotheses proposed. Table 1 reports the sample distribution, descriptive statistics and univariate analysis for final exams during 2018–2021. This table reports the

Table 1. Sample distribution, descriptive statistics and univariate analysis for final exams.

Description	Category	*N*	Percentage	*Mean*	*SD*	Mean diff.	*t*-statistics
Exam type	Paper-based exam	7,090	55	60.17	18.00	−1.83***	−5.75
	Proctored online exam	5,892	45	62.00	18.09		
Nationality	New Zealand	6,937	53	60.92	18.47		
	China	3,855	30	60.33	17.36	0.59*	1.66
	Malaysia	588	5	62.26	15.38	−1.34**	−2.00
	India	238	2	60.89	16.21	0.03	0.03
	Others	1,364	11	62.78	19.18	−1.86***	−3.29
Enrolment	Internal	5,854	45	59.76	17.52	−2.25***	−7.10
	Distance	7,128	55	62.01	18.45		
Gender	Female	8,675	67	61.22	18.06	0.66**	1.96
	Male	4,307	33	60.56	18.06		
Study	Full-time	7,411	57	59.79	18.33	−2.82***	−8.83
	Part-time	5,571	43	62.61	17.74		
Program	Undergraduate	11,595	89	60.08	18.25	−8.64***	−17.02
	Postgraduate	1,387	11	68.72	14.35		
GPA	Paper-based exam	7,090	55	4.30	1.85	−0.33***	−9.74
	Proctored online exam	5,892	45	4.63	1.97		

*** and ** represent significance at the 1% and 5% levels, respectively.

mean for each category and the mean difference test between the categories within the covariates. In general, the number of students decreased for the proctored online exam, which also represents the COVID-19 period, when student enrolment was lower than in the pre-COVID-19 period.

Table 2 reports the distribution for final exams for invigilated paper-based and proctored online exams separately for all covariates. In this table, we present the results of the mean difference test on student performance between these two exam methods for each category of the covariates. The results show that, in general, the students performed significantly better in the proctored online exam than the paper-based exam for each category of the covariates, except for students from Malaysia, students from other nationalities, and postgraduate students. Performance of students from Malaysia, other nationalities, and postgraduate students' performance under the paper-based and proctored online exams are not different based on the univariate results in Table 2.

The analysis shows a significant difference in the performance of student enrolments for the paper-based and proctored online exams for on-campus students. This is not surprising, given that during the proctored online period was the Covid-19 outbreak when there was a decline in the number of enrolments, particularly among international students who mostly study on-campus, as well as the continuing low enrolment among domestic students (Brownie et al., 2024). The distance students' performance during the paper-based period is not significantly different from the proctored online period. Our analysis also shows significant differences in the performance of female and male students, full-time and part-time, and undergraduate students during paper-based and proctored online exam periods. These differences are mostly decreases in the number of students during the proctored online exam period compared to the paper-based exam period.

Table 3 shows the results of the regression analysis. The standardised regression coefficients and *t*-statistics (in parentheses) are reported for all samples in Panel A (Model 1), for the invigilated paper-based exam in Panel B (Model 2) and for the proctored online exam in Panel C (Model 3). We report the coefficient to show the relative strength of each of the independent variables to the dependent variable. The adjusted R^2 from the Panel A regression model indicates that the independent variables explain 45.6% of the variance in student performance in the final exam. A similar level of variance is explained in Panel B (47.2%) and Panel C (43.8%). Panels A, B, and C show an *F*-value of 834.615, 528.010 and 382.044, respectively. Overall, the *F*-values of all three models are significant at $p \leq 0.001$. Although many factors could potentially affect student performance in the final exams, the results show an overall goodness of fit for the models.

It is likely that the characteristics of the students in our study do not remain the same across the sample period. This may impact the conclusions drawn and the validity and reliability of our results, particularly if those changes are not captured in our regression model. We therefore test the validity and reliability of our results by including year fixed effects in Equation (1) to control for unobservable factors that change over time and are common to all students. We expect that if our main results are spurious and unreliable, the inclusion of the year fixed effect will affect the conclusions to be drawn (Imai & Kim, 2019; Phillips, 1986).

The results reported in the Appendix reveal that all the variables are similar in terms of the direction (positive or negative) of the coefficient signs and the level of

Table 2. Sample distribution for final exam (paper-based and proctored online).

Description	Category	Paper-based exam			Proctored online exam			Mean Diff.	*t*-statistics
		N	Percentage	*Mean*	*N*	Percentage	*Mean*		
Nationality	New Zealand	3,590	51	60.15	3,347	57	61.74	−1.59***	−3.59
	China	2,203	31	58.80	1,652	28	62.36	−3.56***	−6.41
	Malaysia	518	7	62.23	70	1	62.49	−0.25	−0.13
	India	100	1	58.20	138	2	62.83	−4.63**	−2.15
	Others	679	10	63.42	685	12	62.14	1.28	1.24
Enrolment	Internal	3,629	51	58.77	2,225	38	61.38	−2.61***	−5.61
	Distance	3,461	49	61.63	3,667	62	62.37	−0.74*	−1.69
Gender	Female	4,705	66	60.26	3,970	67	62.36	−2.10***	−5.40
	Male	2,385	34	59.99	1,922	33	61.26	−1.26**	−2.27
Study	Full-time	4,272	60	59.12	3,139	53	60.70	−1.58***	−3.69
	Part-time	2,818	40	61.76	2,753	47	63.47	−1.71***	−3.60
Program	Undergraduate	6,257	88	59.09	5,338	91	61.23	−2.14***	−6.29
	Postgraduate	833	12	68.26	554	9	69.41	−1.16	−1.43

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

Table 3. Regression results for final exam (paper-based and online exams).

Model	Panel A (Model 1)	Panel B (Model 2)	Panel C (Model 3)
Exam type	−0.003		
	(−0.451)		
Nationality			
China	0.030***	0.010	0.052***
	(3.313)	(0.816)	(3.801)
Malaysia	0.054***	0.072***	0.014
	(7.668)	(7.406)	(1.413)
India	0.013**	0.002	0.026***
	(2.045)	(0.213)	(2.611)
Others	0.0132	0.012	0.011
	(1.865)	(1.291)	(1.179)
Enrolment	−0.026***	−0.050***	−0.001
	(−2.755)	(−4.010)	(−0.003)
Gender	−0.022***	−0.028***	−0.014
	(−3.318)	(−3.186)	(−1.392)
Study	−0.043***	−0.021**	−0.063***
	(−5.990)	(−2.178)	(−6.053)
Program	−0.035***	−0.052***	−0.015
	(−4.960)	(−5.479)	(−1.417)
GPA	0.664***	0.669***	0.656***
	(99.671)	(75.156)	(65.715)
R^2	0.455	0.472	0.437
F-value	1085.025***	703.740***	509.357***

Note: The table reports the regression results for students' performance in an invigilated paper-based exam and a proctored online exam. ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. *t*-statistics are reported in parentheses. *New Zealand* is excluded to avoid perfect collinearity (dummy variable trap). Panel A reports the results for all exam data for the sample period (i.e. proctored online and invigilated paper-based exams), Panel B reports the results for the invigilated paper-based exam, and Panel C reports the results for the proctored online exam.

significance, except the *Nationality* variables *China* and *Other*. *China* is positive and significant at the 1% level (coefficient = 0.030, $p < .01$) in Table 3 Panel A (Model 1) but significant at the 5% level (coefficient = 0.029, $p < .05$) in the Appendix. *Other* is positive but not significant in Table 3 Panel A (Model 1) but positive and marginally significant at the 10% level (coefficient = 0.012, $p < .10$). Finally, the R^2 is similar in both tables. The results reported in the Appendix are qualitatively similar to the regression results in Panel A (Model 1) of Table 3, suggesting that our results are not affected by changes in the sample years, thus confirming the internal and external validity, as well as the reliability, of our results.

H1 – invigilated paper-based versus proctored online exam

The study aims to examine the differences between accounting students' academic performance related to invigilated paper-based and proctored online exams. H_1 predicts that the method of completing summative assessments affects student performance outcomes. In the univariate analysis in Table 1, the sample distribution shows that 55% represents invigilated paper-based exams and 45% represents proctored online exams. The results show that students performed better in the proctored online exam than in the invigilated paper-based exam and the difference in performance between the two exam types is significant at the 1% level (mean difference = −1.83, $p < .01$). This result is consistent with that of Nardi and Ranieri (2019), who find that students preferred and performed better in computer-based testing than paper-based.

However, our univariate analysis results do not hold in the multiple regression, in which the coefficient on *Exam type* is not significant. This result suggests that the method of assessment does not affect student performance. This finding contrasts with that of Marriott and Lau (2008), who find that the use of computer-based tests is beneficial for phased summative assessments – that is, a series of assessments that test students' understanding of small areas of the syllabus rather than one test that covers many topics. Given that final exams cover many topics and carry significant weight in the overall assessment, it is unlikely that an online exam will offer any incremental benefit to students. Thus, it is likely that any change in student performance could be attributed to their characteristics, rather than to the assessment method. Therefore, this finding addresses the mixed perceptions associated with paper-based and online exams by suggesting that the method used in conducting the exam has no significant impact on performance.

H2 – nationality

The results in Table 1 show some variations in the nationality of students: 53% are from New Zealand (mean = 60.92), 30% are from China (mean = 60.33), 5% are from Malaysia (mean = 62.26), 2% are from India (mean = 60.89), and 11% are from other nationalities (mean = 62.78). To determine whether there are significant differences between the categories of nationality, we use New Zealand as the basis for comparison. We find that students from New Zealand performed slightly better than students from China and India but the difference in performance is statistically significant only for China (mean difference = 0.59, $p < .10$). In contrast, students from New Zealand performed worse than those from Malaysia and other nationalities and the difference in performance is statistically significant at the 5% and 1% levels, respectively (mean difference = −1.34, −1.86, $p < .05$, .01). In line with our prediction in H_2 and the results of Li et al. (2010), we find that nationality influences student performance. However, the difference in performance is unlikely to be attributable to language barriers because the results show that students from nationalities other than New Zealand performed better.

In Table 2, we find that the number of students from countries other than New Zealand decreased for proctored online exams, which is consistent with the COVID-19 disruptions affecting international student enrolments across tertiary institutions. Moreover, all categories of nationality performed better in the proctored online exam than in the invigilated paper-based exam. The difference in performance is statistically significant at the 1% level for students from New Zealand and China and at the 5% level for students from India, but not significant for students from Malaysia and other nationalities. This finding suggests that in an online exam, technological features, such as spell check, word suggestions, zoom capabilities, answer editing and automated reading can potentially reduce communication barriers and aid students during the assessment.

The results in Panel A of Table 3 show that the coefficients for China, Malaysia, India, and other nationalities, are positive and significant at the 1%, 5%, and 10% levels, respectively. If English language influences performance during an online exam, then the expectation is that students from New Zealand will perform better than students from any non-English speaking country. However, the results indicate that students from China, Malaysia, India, and other nationalities perform better than students from New

Zealand. The results support H_2 that student nationality affects performance; however, the difference in performance is unlikely to be attributable to language, in contrast to the findings regarding perceived communication barriers reported in related literature (Hellstén & Prescott, 2004; Khawaja & Dempsey, 2008; Lee & Rice, 2007; Neri & Ville, 2008). Hence, language is unlikely to be a barrier to student performance. The results in Panel B further show that only students from Malaysia performed better than students from New Zealand in the invigilated paper-based exam. The Panel C results reveal that students from China and India performed better than students from New Zealand in the proctored online exam. This result suggests that students from China and India are more comfortable with proctored online exams which likely removes communication barriers associated with the exams.

H3 – enrolment

The sample consists of 45% internal and 55% distance students. Internal students scored 59.76 in the exam and distance students scored 62.01, with the mean difference between these two student types being significant at the 1% level (mean difference = −2.25, $p < .01$). This result indicates that distance students performed significantly better than internal students.

In Table 2, the results show that the number of internal students decreased while the number of distance students increased significantly relative to that of internal students. This could be attributed to the COVID-19 restrictions and lockdowns, which affected the movement and delivery of face-to-face lectures. Tertiary institutions moved their course deliveries to an online mode occasionally, which might have influenced student decisions to enrol for either distance or in-class learning, with most students opting for distance learning. While both distance and internal learning students may have attended lectures and tutorials online during a few lockdowns in New Zealand, the former were mainly taught using an asynchronous approach, whereas internal students at the university we studied were taught using a synchronous approach without any pre-recorded lectures and tutorials. Internal students performed significantly better in the proctored online exam than in the invigilated paper-based exam, whereas distance students performed slightly better in the proctored online exam than in the invigilated paper-based exam.

The results in Panel A of Table 3 show that the coefficient on *Enrolment* is negative and significant at the 1% level (coefficient = −0.026, $p < .01$), indicating that the performance of internal students is lower than that of distance students. Therefore, H_3 is supported by our findings. This contrasts with Vamosi et al. (2004), who found students in the distance learning mode had lower levels of satisfaction and decreasing effectiveness in understanding the course materials. Consequently, distance students are likely to have low motivation which may contribute to their lower performance (Snell & Mekies, 1999). The subsample analyses in Panels B and C suggest that the method of education delivery (*Enrolment*) influences student performance when an invigilated paper-based exam method is adopted (Panel B), but not in a proctored online exam (Panel C). This result indicates that internal student performance is lower than that of distance students when a paper-based exam is adopted.

The performance of distance students compared with internal students is surprising, given that internal students have greater access to staff, the campus library and

learning resources, they can attend in-person classes and tutorials, they have peer-to-peer contact, and they are more likely to live in on-campus accommodation (student hostel) with the probability of greater commitment to academic activities. In contrast, distance students live in different countries, including New Zealand, and in the community, and they have commitments beyond academic activities. Distance students must study and complete assessments remotely, mainly use resources provided on the learning management system (e.g. recorded lectures), have access to educators within a specified time, and sometimes attend online tutorials. Further, they have less contact with peers and mostly study in isolation from their peers. The attendance rate for distance students is disproportional to that of internal students. This could be because many distance students work during tutorials or are unable to attend these because of the time difference between New Zealand and other countries, or because of other commitments. Therefore, the performance of internal students was expected to be better than that of distance students. However, our findings and experience in teaching and examining these groups of students suggest otherwise. This requires further investigation. Nevertheless, there is no significant difference in the performance of internal and distance learning students when an online exam method is adopted (Panel C).

H4 – gender

The distribution of students in terms of gender is approximately 67% female and 33% male. Female students scored 61.22 and male students scored 60.56 in the exam. However, the difference between the female and male students' scores is significant at the 5% level (mean difference = 0.66, $p < .05$). In Table 2, the results show that female and male students both performed significantly better in the proctored online exam than in the invigilated paper-based exam.

However, we observed some contradictory results between our univariate and multivariate analyses in relation to gender. In Table 3, the coefficient on *Gender* is negative and significant at the 1% level in both Panel A (coefficient = −0.022, $p < .01$) and Panel B (coefficient = −0.028, $p < .01$), but not significant in Panel C. The Panel A results indicate that student gender is associated with their performance. The Panel B results suggest that the performance of males is better than that of females only when an invigilated paper-based exam is adopted, consistent with our prediction in H_{4b}. While there are no prior research findings on the relationship between gender and performance in the paper-based exam method, the relationship documented in Panel B provides exploratory insights into this relationship.

Based on gender, we find performance is not significantly different when an online exam is adopted. This suggests that the performance gap between female and male students noted in the paper-based exam seems to have been eliminated in a proctored online exam. This requires further investigation.

Control variables

The results from Table 1 show that the sample consists of 57% full-time students and 43% part-time students. Full-time students scored 59.79 in the exam and part-time students

scored 62.61, with the mean difference between them being significant at the 1% level (mean difference = −2.82, $p < .01$). Most of the students in the sample were undergraduate students (89%), and the rest (11%) were postgraduate students. The mean score for undergraduate students is 60.08 and the mean score for postgraduates is 68.72. The mean difference between undergraduate and postgraduate students is significant at the 1% level (mean difference = −8.64, $p < .01$). From the sample, the mean *GPA* is 4.63 for proctored online exams and 4.30 for paper-based exams. The mean difference between the *GPA* for these two exam methods is significant at the 1% level (mean difference = −0.33, $p < .01$).

In Table 2, the results show a decline in both full-time and part-time student numbers, but the magnitude of decrease is larger for full-time students. This difference could be attributed to the COVID-19 disruptions and restrictions, a period in which universities experienced significant decreases in the number of international students, most of whom normally enrol as full-time students. Part-time students performed better than full-time students in both invigilated paper-based and proctored online exams, although full-time and part-time students both performed better in the proctored online exam than in the invigilated paper-based exam. These results are consistent with those of Hartnett et al. (2004) and Jackling and Anderson (1998) who found that part-time students are goal-driven, enter the course with a purpose, give greater thought to the course learning process, and have better time-management skills.

In addition, postgraduate students performed better than undergraduate students in both invigilated paper-based and proctored online exams, but undergraduate and postgraduate students both performed better in online exams than in the invigilated paper-based exam. However, the difference in performance in the invigilated paper-based and proctored online exams is not significant for postgraduate students.

The multiple regression results in Table 3 confirm that full-time students underperformed relative to part-time students in all three models. Moreover, in general the performance of undergraduate students is lower than that of postgraduate students; however, the lower performance is only evident for the invigilated paper-based exam. This is likely due to postgraduate students having prior tertiary learning experience and are therefore better at managing their studies, in turn leading to higher achievement. It appears undergraduate student performance significantly increased in the proctored online exam. The reasons for this need to be investigated further. The coefficient on *Program* in Model 3 is not significant, suggesting that students' performance is not significantly different when an online exam is adopted. As expected, and consistent with prior studies (Hodara & Lewis, 2017; Miguéis et al., 2018), *GPA* is positively and significantly associated with performance. Thus, students with a higher GPA are likely to perform better.

Conclusion

This study addresses whether the transition from the traditional invigilated paper-based exams to proctored online exams impacts student performance in accounting courses. In addressing this question, we examine the association between exam methods (paper-based and online exam) and student performance including the factors associated with student performance. Our analysis shows no significant differences in student

performance between proctored online exams and paper-based exams. Furthermore, our analysis indicates that student performance in both paper-based and online exams are influenced by sociodemographic factors. Notably, we observe that exam outcomes, whether through paper-based or online methods, are shaped by factors such as gender, mode of education delivery, full-time or part-time enrolment, nationality, and academic abilities as reflected in their GPA.

Thus, this study contributes to the evolving accounting education literature on the assessment of student course performance by providing empirical findings on the variations in their performance when paper-based and online assessment methods are adopted. Therefore, the findings of this study provide insights into whether student performance is impacted by the mechanism by which they are examined, addressing possible concerns accounting students, faculty, or other stakeholders may have about assessments conducted online or in invigilated paper-based formats.

The implications of our findings extend to both policy and theory. Educational institutions can consider these insights when designing and implementing assessments, ensuring the authenticity and fairness of assessment processes, accommodating diverse student needs, and optimising student performance. Additionally, our study provides early insights into the effects of adopting proctored online exams, particularly during the challenges posed by the COVID-19 pandemic.

The significance of our study unfolds on three fronts. First, it provides insights into how the choice between online and paper-based exams influences student performance, considering the distinct requirements of diverse student groups, with a special focus on the advantages of online exams for international students. Second, our research addresses perceptions of bias associated with online versus paper exams, revealing that the mode of examination alone generally does not significantly impact overall student performance, except for specific student subsets. Third, the impact of factors such as gender, mode of education delivery, enrolment status, nationality, and academic ability underscores the importance of considering a range of student characteristics when evaluating the effects of online versus paper-based exams, rather than solely focusing on the exam format.

In conclusion, our analyses suggest that online exams have the potential to offer specific advantages to certain student groups over paper-based exams. Consequently, the benefits of online exams should not be generalised, and their adoption to enhance student exam performance should be carefully tailored, such as targeting initiatives towards international students studying in a language different from their native language.

Limitations and future research directions

This study lays the groundwork for future investigations, potentially involving longitudinal studies aimed at probing into the nuanced costs and benefits associated with proctored online exams. These future studies could offer a more comprehensive understanding of student evaluations or assessments as COVID-19 restrictions on educational activities are lifted.

It is pertinent to note that while paper-based assessments have been a longstanding tradition, proctored online assessments represent a more recent development. The

widespread adoption of the proctored online assessment method increased considerably during the period of COVID-19 restrictions. The current study utilised a dataset covering a two-year period for each assessment method. Consequently, caution is advised in interpreting the findings. Notably, proctored online assessments were conducted during an unprecedented time, marked by the educational and personal impact of COVID-19, including the adjustment to new technology-based assessments. In light of these circumstances, our results should be approached with some caution and considered as preliminary insights into the links between proctored online assessments and student performance.

Our findings provide a basis for future studies to examine the relationships between the factors examined in this study and student performance using a large dataset, such as over a five-year period for each assessment method. Studies on the effects of proctored paper-based and online assessments should be conducted after the present pandemic, when all COVID-19 restrictions on educational activities are lifted, to gain more perspective on how proctored online assessments affect student performance. This would necessarily be several years away and conditional upon whether universities continue to utilise proctored online exams. Given the inexhaustible list of factors that may influence the performance of accounting students, future studies addressing the effect of the examination mode on accounting students could consider other factors, such as the student's marital status, geographic location from the educational institution (for on-campus enrolled students), and course load.

In this study, the gender variable was dichotomously classified as male or female. Considering contemporary shifts in societal gender classifications, it is suggested that future studies explore the adequacy of data encompassing other gender classifications. This approach would assist in understanding whether the findings extend to additional gender classifications beyond the traditional male or female categories.

Notes

1. Noyes et al. (2004) described cognitive workload as the mental interaction between the demand of tasks a student is expected to complete and the student's ability to complete the tasks given the resources available. They found cognitive workload to be an enhancing factor in the case of UK students.
2. Campus-based study and distance learning programs.
3. Student nationality, and whether full-time of part-time student.
4. TopHat is a learning service application that allows an educator to create simple and interactive activities for students to complete. Students are allowed to complete most activities on TopHat at their discretion and are not invigilated or assessed.
5. The top five nationalities of the students are selected, namely, the first four – New Zealand, China, Malaysia, and India – and all other nationalities, which are categorised as Other. For ease of interpretation of this categorical variable in our regression, we convert the nationality into dummy variables and use New Zealand as the reference variable.
6. GPA ranges from 1 (lowest student capability) to 9 (highest student capability).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethics statement

The data of this study cannot be made openly available because of confidentiality agreements and ethical concerns. The data samples and detailed coding procedures can be accessed by contacting the authors.

Data availability statement

The data that support the findings of this study are not publicly available because of privacy or ethical restrictions.

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Appendix

Regression results including year dummies.

Model	Panel A (Model 1)
Nationality	
China	0.029**
	(3.172)
Malaysia	0.053***
	(7.534)
India	0.014**
	(2.057)
Others	0.012*
	(1.767)
Enrolment	−0.026***
	(−2.741)
Gender	−0.022***
	(−3.267)
Study	−0.042***
	(−5.969)
Program	−0.035***
	(−4.943)
GPA	0.664***
	(99.636)
Year 2018	0.003
	(0.394)
Year 2019	0.030***
	(3.606)
Year 2020	0.025***
	(3.088)
R^2	0.456
F-value	907.357***

Note: This table reports the regression results for students' performance in an invigilated paper-based exam and a proctored online exam. ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. *t*-statistics are reported in parentheses. *New Zealand* is excluded to avoid perfect collinearity (dummy variable trap).