INDERSCIENCE PUBLISHERS
Linking academia, business and industry through research

International Journal of Technology Enhanced Learning

ISSN online: 1753-5263 - ISSN print: 1753-5255
https://www.inderscience.com/ijtel

Students perspectives on proctoring mobile applications for assessments: the case of South Africa

Frank Makoza

DOI: 10.1504/IJTEL.2024.10061370

Article History:

Received:	26 August 2023
Last revised:	30 August 2023
Accepted:	24 September 2023
Published online:	30 December 2024

Students perspectives on proctoring mobile applications for assessments: the case of South Africa

Frank Makoza

Cape Peninsula University of Technology,
District Six Campus,
Cape Town 8000, South Africa
Email: makozaf@cput.ac.za

Abstract: This paper analysed student's perceptions on use of a mobile proctoring application (app). The study used case of South Africa where few universities were using a proctoring mobile application called The Invigilator. Using constructs from mobile app rating scale (MARS), users' views from app stores, reports and online news articles were thematically analysed. The findings showed that the mobile proctoring app had strengths in app classification, aesthetic and information. However, there were problems with functionality and subjectivity quality. Users reported technical problems during online assessments when using the app, e.g., limited technical support and delays in feedback. The problems were hindering users to complete online assessments and could affect their academic performance. The findings are useful for academics and administrators who are considering mobile proctoring to improve academic integrity of online and remote assessments. The study contributes towards literature on proctoring mobile apps and academic integrity of assessments.

Keywords: academic integrity; mobile apps; mobile app rating scale; MARS; online assessment; proctoring; South Africa.

Reference to this paper should be made as follows: Makoza, F. (2025) 'Students perspectives on proctoring mobile applications for assessments: the case of South Africa', *Int. J. Technology Enhanced Learning*, Vol. 17, No. 1, pp.1–20.

Biographical notes: Frank Makoza is a Lecturer in the Department of Entrepreneurship and Business Management at Cape Peninsula University of Technology, Cape Town, South Africa. He holds a PhD in Information Systems and Master's in Information Systems from the University of Cape Town. His research interests are assessing the societal impact of digital technologies in the context of developing countries and ICT use in small businesses.

1 Introduction

The COVID-19 pandemic intensified adoption and use of teaching and learning technologies in education settings (Duncan and Joyner, 2022; Raman et al., 2021; Shange, 2023). Higher education institutions (e.g., universities and colleges) adopted teaching and learning technologies to support online and remote learning. Examples of teaching and learning were virtual collaboration applications, learning management

system (LMS), mobile learning technologies, research management systems, etc. (Bolton et al., 2020; Dube, 2020). The aim was to prevent the spread of the COVID-19 virus, limit loss of life, and continue with academic programs during the economic lockdown (Agha et al., 2022). Hence, teaching and learning technologies gained prominence in the education discourse during the COVID-19 pandemic.

The sudden transition from face to face to online or remote learning compelled universities to change the way academic programs were offered (Andreou et al., 2021; Dube, 2020). Online teaching and learning was introduced, including online assessments. In some cases, students participated in summative and formative assessments from remote locations and without physical proctors (de Plessis and der Westhuizen, 2022; Holden et al., 2021; Shange, 2023; Verhoef and Coetser, 2021). One of the issues that emerged during the online or remote assessments was the student's dishonest behaviour or online cheating. Several scholars have reported increase of cheating in online or remote assessments during the COVID-19 pandemic (Agha et al., 2022; Alessio and Messinger, 2021; Bucciol et al., 2020; Noorbehbahani et al., 2022; Selwyn et al., 2023). This requires further attention of researchers to understand the situation and find solutions because universities have maintained blended learning in post-COVID pandemic era (Landa et al., 2021).

Universities are focussing on technologies to minimise cheating and student dishonest behaviour during online assessments and promote academic integrity (Alessio and Messinger, 2021; Baijnath and Singh, 2019; Topuz et al., 2022). For instance, universities are using proctoring systems such as IRIS Invigilator, Respondus lockdown browser, Zoom Invigilator, ProctorU, AIProctor, Examity, BVirtual, etc. to minimise online cheating (Andreou et al., 2021; Hussein et al., 2020). Although there are growing studies that have looked at use of proctoring systems to deter cheating during online assessments (Verhoef and Coetser, 2021), to the knowledge of the author, there are few studies that have concentrated on proctoring mobile applications (apps) (e.g., de Plessis and der Westhuizen, 2022; Shange, 2023) in the context of South Africa. This study will attempt to address this knowledge gap.

The study focused on the feedback from users who used a mobile proctoring app called The Invigilator. To the knowledge of the author, few universities in South Africa were using the app (about 4 of the 26 public universities) (The Invigilator, 2022). It was important to understand the quality of the mobile app as more universities may explore mobile technologies to improve remote/online learning and online assessments (Mpungose, 2020). Against this backdrop, the study was guided by the research question:

- What are the views of students on quality of mobile proctoring app used in online assessments?

To answer this question, the study used constructs from mobile app rating scale (MARS) (Stoyanov et al., 2016) to assess the feedback on the quality of The Invigilator. The insights from the study may be useful to the academic administrators, lecturers and developers in understanding the adoption and challenges users face when using proctoring mobile app in online or remote assessments.

The rest of the paper is summarised as follows. The next section presents a review of the literature. The section on methodology summarises the methods used in the study. Section for research findings presents summary of outcomes of data analysis. This is followed by a discussion of the findings and conclusions drawn from the study.

2 Literature review

2.1 South African higher education

South Africa has about 26 public universities that are crucial in the development of the country (Bolton et al., 2020). Universities provide programs that support the development of skills required in the various economic sectors of the country (Mzangwa, 2019). Universities are participation in transformation of the South African society to redress the injustices of the apartheid past. In this effort, universities are changing the way knowledge and skills are produced and acquired, respectively (Waghid, 2002). There is an emphasis on creating critical and reflection skills in teaching and learning processes for both lecturers and students. The transformation agenda also covers access to education, student's success rate, employment opportunities, staffing resources and relevance of academic programs to address needs of society. Further, universities are supporting empowerment of students coming from previously marginalised communities (Mzangwa, 2019; Waghid, 2002).

The majority of public universities in South Africa offer contact or in person programs where students participate in face-to-face classes (Dube, 2020). Other modes of learning include open distance learning, part-time, evening, weekend and block release are offered in few universities (Bolton et al., 2020). However, the COVID-19 pandemic led to adoption of alternative modes of learning in predominantly face to face universities, e.g., remote and online learning, beyond contact learning. Teaching and learning technologies have been crucial in the transition from in person learning to remote or online learning (Dube, 2020; Mpungose, 2020).

2.2 Teaching and learning with technology

The last decade has seen South African public universities adopt teaching and learning technologies to support the attainment of the higher education transformation objectives (Ng'ambi et al., 2016). Some of the teaching and learning technologies include mobile learning technologies, research management systems, massive open online courses, LMSs, social media and virtual collaborative systems (Dube, 2020; Makoza and Bagui, 2022). Teaching and learning technologies are supporting universities to accommodate more students, collaboration between lecturers and students, improved communication among students, better delivery of learning content, enhanced students support, improving student's retention and throughput (Ng'ambi et al., 2016). The technologies are supporting on-line assessments where learners can do exams from remote locations without the need to be present on campuses to write the exams (Selwyn et al., 2023; Topuz et al., 2022).

Problems persist for online and remote learning including lack of devices among students, prohibitive cost of data, large volumes of content, lack ICT skills, difficulties in integrating technologies in teaching and learning (Dube, 2020; Mpungose, 2020). Additionally, online assessments have raised concerns about academic integrity when students engage in online cheating, especially during the COVID-19 pandemic (Noorbehbahani et al., 2022; Verhoef and Coetser, 2021).

2.3 Academic integrity and online assessments

Academic integrity is "commitment to the fundamental values of honesty, trust, fairness, respect, responsibility, and courage" [Holden et al., (2021), p.1]. Academic integrity involves academics, administrators, and students in promoting ethical behaviour that creates reputation on academic institutions, maintains quality of teaching and learning, dedications to learning, and exchange of ideas. Further, academic integrity promotes creation of knowledge, development of skills and abilities (Baijnath and Singh, 2019; Verhoef and Coetser, 2021).

Universities have adopted fundamental values of academic integrity. The aim is to promote development of a community that has six core values of academic integrity and always act in ethical way (Holden et al., 2021; Verhoef and Coetser, 2021). Such a community addresses the academically dishonest behaviour of students that takes many forms. For example, cheating during exams, copying other students' work, using other academic materials without acknowledgement, receiving support from other people during exams, copying text or programming answers on electronic devices, another person writing exams on behalf of students, and buying exam papers from internet websites (Alessio et al., 2018; Noorbehbahani et al., 2022).

Several factors are suggested to contribute to cheating behaviour among students. The factors are low level of competency, previous experiences, personal beliefs, learning conditions, and structure of classes (Boehm et al., 2009; Holden et al., 2021). Other factors are the opportunity to cheat, justifying the need for cheating, and perceptions that cheating has advantages (Alessio et al., 2018; D'Souza and Siegfeldt, 2017). Lecturers can also influence cheating behaviour of students by not being concerned and dismissive about cheating. Inadequate institutional policies and practices can influence cheating among students (Baijnath and Singh, 2019; Boehm et al., 2009).

Students who have cheating behaviour are likely to continue with dishonesty behaviour in their future life circumstances (Boehm et al., 2009). This can affect society at large because graduates with dishonest behaviour are likely to participate in moral hazards in their professional life and careers (Baijnath and Singh, 2019). Hence, it is important to understand and address the cheating behaviour of students in online education setting (Bucciol et al., 2020; Coghlan et al., 2020).

To overcome dishonesty behaviour among students, scholars have suggested improvement in student's engagement. It is recommended to improve participation, collaboration, working in groups and independent learning (Boehm et al., 2009; D'Souza and Siegfeldt, 2017). Furthermore, it is highlighted that students should be encouraged to do adequate preparations, lecturers require appropriate methods of evaluation selection, having policies and procedures for exam administration, being vigilant, raising awareness of students, and signing the statement of honesty with students (Reddy et al., 2022). While it is acknowledged that cheating is a complex issue, proctoring technologies have become popular to minimise cheating during assessments (Alessio et al., 2018; Raman et al., 2021). The next subsection summarises proctoring systems in education setting.

2.4 Proctoring systems

Proctoring systems can be used to detect any suspicious identity of students and monitor the behaviour of students during assessments that can compromise quality, rules, and integrity of the assessments (Khalil et al., 2022). Proctoring systems use audio, visual,

facial recognition, and location detection features. These features are used to detect suspicious behaviour during exams including switching web browser, close a web page, connection to internet, sound, noise, movement of eyes and facial expressions. Proctoring systems record, analyse the behaviour of students and report suspicious behaviour immediately (Andreou et al., 2021; Coghlan et al., 2020; Khalil et al., 2022). Lecturers or invigilators can monitor online assessments on-site or remotely.

The proctoring software can be categorised into live proctoring, recorded proctoring and automated proctoring (Hussein et al., 2020). Live proctoring systems are used to monitor students while they are writing online exams. They involve a human proctor or invigilator to monitor the students virtually. Recorded proctoring have audio, video recording capabilities, and authenticate students during the online assessment. Activities are recorded during the assessment and can be watched later to validate the integrity of the assessment. Automated proctoring systems do not require a human to invigilate during the assessment and they have advanced features, e.g., visual, audio, biometric data and to detect and report any suspicious activity during online assessments while students are at remote locations (Hussein et al., 2020; Selwyn et al., 2023). The use of a particular category of proctoring system may depend on the goals of the institutions, cost and context.

Table 1 Examples of proctoring systems

Category	*Examples*	*Websites*
Web-based	Talents.ai	https://ntalents.ai
	ProctoredU	https://proctoredu.com
	OnVUE Online	https://home.pearsonvue.com
Remote-based	LeewayHertz	https://www.leewayhertz.com/remote-proctoring-using-ai/
	Honorlock	https://honorlock.com/exclusive/
	Examroom.ai	https://examroom.ai/
	IRIS Invigilator	https://www.irisinvigilation.com/
Platform-based	Optimum Assessment	https://www.optimumassessment.com/en/
	Surpass, Powering Assessment	https://surpass.com/
	Digiexam	https://www.digiexam.com/
	Pearson VUE	https://home.pearsonvue.com/
	Proctor Free	https://www.proctorfree.com/
Mobile phone-based	The Invigilator	https://invigilator.app/
	Proctortrack App	https://verificient.com/
	ProctorExam	https://proctorexam.com/

Mobile applications running on a mobile device, e.g., smartphones or tablets connected to a platform over the internet, are used to monitor students during online assessments. However, few studies have been conducted on the adoption and use of mobile proctoring apps in the context of developing countries (e.g., de Plessis and der Westhuizen, 2022). Mobile apps use in education setting appears to be an area of further research because of high adoption of mobile technologies in developing countries (Chuchu and Ndoro, 2019). Mobile proctoring apps can be used in remote and online assessments during

post-COVID pandemic (Landa et al., 2021). Table 1 summarises examples of categories of proctoring systems.

As can be seen in Table 1, there is diversity of proctoring software. Proctoring systems can also be categorised on the basis of how they are accessed and used. These include web-based, remote-based, and platform-based (Foster and Layman, 2013). Web-based can be integrated with LMSs, and remote-based do not require an invigilator to be on the assessment site. Platform-based are proctoring systems that are run as a service and can be accessed via the internet (Andreou et al., 2021). Mobile phone-based proctoring systems allow remote monitoring of students during assessments. The use of mobile phone-based proctoring systems is emerging as there are few applications available compared to other forms of proctoring systems (de Plessis and der Westhuizen, 2022; Shange, 2023). From these examples, adoption and use of proctoring systems may depend on the context and preferences of the users.

There are advantages and disadvantages of using proctoring applications in assessments (Hussein et al., 2020). The advantages are support for maintaining academic integrity of assessment supporting students to develop trustworthy behaviour. Proctoring systems support detecting inappropriate behaviour during assessment and promote fairness. Proctoring systems also help students develop skills and meet learning outcomes for their courses (de Plessis and der Westhuizen, 2022; Reddy et al., 2022). Proctoring systems are also helping lecturers conduct assessments where students are located in remote areas. Lecturers have more time to prepare course content (Andreou et al., 2021; Hussein et al., 2020; Verhoef and Coetser, 2021).

Studies have showed proctoring systems can cause students to be nervous during exam (Duncan and Joyner, 2022). There are also concerns about privacy where students can not feel comfortable being watched during assessments (Coghlan et al., 2020; Khalil et al., 2022). Security issues have also raised concerns when using proctoring systems during assessments. There are many proctoring systems which can also be challenging to select systems that are appropriate for particular assessment of courses (Foster and Layman, 2013). The management of user information, including biometrics, may need to be secure and have legal compliance issues. Some studies that are using artificial intelligence have reported algorithmic biases there by affecting the fairness of the assessments (Hussein et al., 2020). Therefore, the selection of proctoring systems must consider the highlighted advantages and disadvantages of proctoring systems.

3 Theoretical perspective to the study

The study used the MARS (Stoyanov et al., 2015, 2016) that was developed to assess the quality of mobile applications (apps). MARS integrates application quality assessment measures drawn from human-computer interaction, user experience design approach, and mobile health application standards. MARS suggest six dimensions of measuring quality of mobile apps and they include engagement, aesthetics, functionality, information and subjective quality. Engagement is the capability of the app to provide interactive features that provide interest to the target group of users. Aesthetic relates to the design, consistency and feel of the app that can provide visual appeal to users. Functionality is the ease of use through navigation and logical steps of the app in supporting users to achieve specific goals. Information related to the relevance, accuracy, and quality of information that the app provides to the users to achieve their goals when using the app.

Classification are the features of the app that facility privacy, security, and confidentiality when using the mobile app. Subjective quality related to personal interests and perceived impact of the app on attitudes and intentions of users (Werner et al., 2022; Stoyanov et al., 2015, 2016). Table 2 summarises the MARS dimension that can be analysed when assessing the quality of an app.

Table 2 Summary of MARS dimensions

Dimensions	*Categories*
Engagement	Entertainment, interest, customisation, interactivity, and target group
Functionality	Performance, ease of use, navigation, and gestural design
Aesthetic	Layout, graphics, and visual appeal
Information	Accuracy, goals, quality information, quality of information, visual information, credibility, and evidence base
Subjective quality	Recommendation, frequency of use, willing to pay, and star rating
Classification	Confidentiality, security, registration, community, and affiliation

Source: Stoyanov et al. (2015)

The study considered MARS to assess the quality of the mobile proctoring app used in online and remote evaluation. MARS is widely used in assessing mobile health apps, but few studies have used for teaching and learning technologies. MARS was selected because it is simple and can be adapted to the quality of non-health mobile apps (Stoyanov et al., 2016). MARS dimensions can be applied to obtain both objective and subjective views of quality from the users, developers, designers and professionals from multidisciplinary teams (Stoyanov et al., 2015).

4 Research methodology

The study used qualitative research approach to understand the views of students on use of mobile proctoring app during online and remote assessment (Patton, 2014; Ridder, 2017). The study was exploratory in nature because few universities were using mobile app for proctoring online assessment in the context of South Africa. An exploratory case study approach fit well with the objective of the study (Ridder, 2017).

4.1 Case description: The Invigilator

The Invigilator is an example of a mobile proctoring application (app) that is used to minimise risks in online and remote assessments. The app was launched in 2020 and provides capabilities for control and monitoring assessments in a remote context. It uses artificial intelligence in a non-invasive way. Key features of the app include photo authentication, speech detection, proximity checking using GPS, LMSs integration capabilities, and plagiarism detection of assessment scripts (The Invigilator, 2022).

The Invigilator app has the ability to secure user profiles, verify students, verify a particular exam, an option to capture student's selfie, a timer for the assessment, monitor the exam environment by collecting audio and upload information on a platform. Lecturers can view the information stored on the platform. The app can be linked to a

LMS where users can use their identification information to log into the app (The Invigilator, 2022).

Users are required to install the app on their mobile device and ensure that the app is running properly. The app can be installed from three app stores: Apple Store (for iPhone) and AppGallery (for Huawei devices) and Google Play (for other mobile devices). Users register on the app using their organisations details, e.g., e-mail, and capture their selfie that is used for identification. The app simulate the roles of a physical proctor and request students at random to take selfies, photo of student card or ID document, a photo of a script and record audio during the assessment. The app can be linked to a LMS and request verification of the assessment using a code (The Invigilator, 2022).

Students can access the LMS via the app, download question papers on their devices, and work of the assessment, and at the end upload the paper for the assessment. Students can download the app on their mobile device and register on the app using their university e-mail address (The Invigilator, 2022). The advantage of the mobile proctoring app is that it does not need a constant internet connection and only requires the Internet at the beginning of an assessment to authenticate students and at the end of the process to upload the scripts of the assessment. Hence, the app does not require large amount of data bundles. The app does not require a lot of power from the battery. However, students have to keep the application running during the assessment and the mobile app detects speech, proximity to other students, and identity of the students (The Invigilator, 2022).

4.2 Data collection and analysis

Data of the study emerged from multiple sources. The data that was relevant for the study was purposefully selected (Patton, 2014). Data on The Invigilator app (proctoring mobile application) including media reports, user manuals, and user reviews from Google Play Store, Apple Store, and AppGallery. Covered the period between March 2020 and September 2022. The multiple data sources were useful in verifying some of the information presented by the students and user support team of the application (Patton, 2014).

The collected data was analysed using content analysis (Bengtsson, 2015). The four steps of data analysis were followed and summarised as follows:

- *Decontextualisation:* Reading and rereading data to become familiar with the text.
- *Recontextuality:* Noting an interesting text that is related to the study and assigning codes to the text.
- *Categorisation:* Grouping codes together into categories and subcategories.
- *Compilation:* Writing up a report to address the research objectives and research questions guiding the study.

The study used concepts from MARS dimensions as a theoretical sensitising device (Bengtsson, 2015; Patton, 2014) meaning that we explored data using core concepts with an open mind to potential diverse views beyond the prescribed dimensions of MARS framework. The process was iterative where the steps were repeated to improve the quality of the outcome of data analysis. A NVivo qualitative data analysis application was used to store the data in a repository and manage the coding process.

5 Research findings

5.1 Engaging with the mobile app

One of the important features of any mobile app is to have the capabilities that users find useful so that there is engagement when using the app. The findings showed diverse views related to engagement with The Invigilator. Some of the users reported that the app was easy to use during online assessment from remote locations. One user noted that: "Very good, service is excellent, and the app works very well." Other users perceived that the app improved their exam process: "I have no disagreement with the idea behind this app. In fact, it was a fantastic idea to come up with an app to simulate the exam environment" (#usrcmg). On overall, users had interest in the app and perceived that it was easy to follow the instructions during the exams: "Easy to use, it is a great app up to so far" (#usrcmg). Users also perceived the mobile proctoring app to be more engaging and able to recover from minor errors: "I used the app last year for my exams … worked very well, had no issues. All my papers were two hours, had network error this one time but luckily, I managed to log in" (#usrcmg). Another user also confirmed that: "My experience with this app is great, not complaining" (#usrcmg).

It was interesting to note that mobile app was assisting students with special needs during assessments. For example, a user reported about the app supports her with anxiety: "The online exams could be brilliant. Especially for people with social anxiety and other mental/physical disorders" (#usrcmf). The positive statements from the users confirmed that the app was developed in consideration of the targeted users, e.g., students use for proctoring. Another important feature of engaging was the process of taking a selfie for identification during the exam. The users did not indicate any comments related to customisation. This may mean that users were unable to change the features of the mobile app to suit their needs. The mobile app was used as part of the assessment process.

While there were positive statements on engagement with the mobile app, there were also reports of limited interactivity when using the mobile app. Some of the challenges were related to lack of feedback to the users when there was a problem. For example, one user reported that: "The app is unable to handle the large number of students during exams. It gives an error message that saver problem. I ended up not writing my exam" (#usrcmg). This statement may mean that users were not able to recover from errors despite having errors displayed on their devices, and users were not able to use the information to continue with the examination activities.

Another issue was the time it takes complete activities when using the mobile app during examinations. Some procedures took a while when using the mobile proctoring app. The lengthy process affected the students during exams: "I understand that this is a new app, and you will, in some cases have issues, but students really do not have the time for this just before an exam" (#usrcmg). Another user also highlighted the importance of time when using the app:

> "When I was finally able to log in, the QR scanner could not scan my paper, which was so frustrating and time consuming. I ended up losing about 20 minutes of my exam time trying to log in. This app is terrible, please fix it. There is nothing worse than trying to use this useless app during an already stressful exam." (#usrcmg)

The users perceived that engaging with the mobile app had to be with minimal effort to achieve their goals and focus on the examinations. This may mean that the trial session for users to learn and be familiar with the exam processes was important: “There should be a feature to test the app sound before you start assessment, not when you start doing the assessment” (#usrcmg). Some students lost time during the assessments and affected their performance.

5.2 Aesthetic of the mobile app

The aesthetic of a mobile app can help users to achieve their goals easily. In content of assessments, performing activities in a more appealing environment of the mobile app was crucial. One user noted that mobile app was user friendly: “It is user friendly, however the app had more time allocated than the actual exam itself” (#usrcmg). Similarly, another user commented that: “Very easy to use and less expensive” (#usrcmg). Another user reported that “Love the app. So far, I have no problem with it” (#usrcmg). Another user who had used the app for the first time indicated that it was easy to use and had no problems: “It was my first time using it & I did not experience any problems at all. I like that you can get you to the university website without leaving the app. It is easy to understand and use. Keep it up” (#usrcma). Some users attributed the way the mobile app was designed, it was easy to use: “I have never experienced any error with this app. It is user friendly” (#usrcma). This may mean that the proctoring mobile app had visual appeal to users and required limited effort to accomplish tasks.

Beyond layout and visual appeal, some users perceived that the design of the mobile app was not good. Users indicated problems with brightness, battery drain and constant crushing when processing user input: “This app is terribly designed, you cannot manually focus the camera and it drains your phone’s battery by forcing full brightness. On top of that, full brightness makes my phone overheat! This is an atrocious design! There is no reason why the app cannot still function with the screen turned off during the exam” (#usrcmg). Similarly, another user reported the problem of brightness and battery draining: “Locks the screen on full brightness. Wastes battery and causes my phone to heat up, damaging the battery and risking that it may shut off” (#usrcmg).

Issues related to quality of the graphics were noted where some users felt that the mobile proctoring app had limitations when processing images: “Quality of the images taken on the app is horrible. I have no issue with the app itself, my only concern is the quality” (#usrcmg). Similarly, another user commented that the mobile app did not have good capabilities to process images and affected the quality of images: “The software processing the pictures taken within the app is horrible, it does not allow flashes or a tap to focus which means photos are always dark and blurry no matter the distance from the page” (#usrcmg). This feature was important because the images collected were used in the identification of the students. In addition, students were required to take photos of their exam papers and upload the papers at the end of the exam: “When I was finally able to log in, the QR scanner could not scan my paper, which was so frustrating and time consuming. Ended up losing about 20 minutes of my exam time … There is nothing worse than trying to use this useless app during an already stressful exam” (#usrcmg). If the images were of inferior quality, it could also affect their performance, e.g., examiners failing to read the information in the papers.

5.3 Functionality of the mobile app

Functionality was the ability of the mobile app to support the tasks of users during exams. In the study, functions of the mobile proctoring app supported the users in the exam activities, e.g., registration and identification, login to access a particular exam, monitor the conduct of the students, provide feedback on any issues related to exam process, support capturing of the exam papers and upload the exams papers. Some students perceived that the app functions supported the integrity of the exams: "Great tool to ensure academic integrity of assessments. Should be used by all educational institutions. Does not use a lot of data and is easy to use" (#usrcmg). This may mean that there was confidence that the app would support fairness in the exam process where all users would adhere to the exam protocols. Another user reported that: "The app is working absolutely perfect without any discrepancies or errors." This means that the users was able to write the exams using the mobile app without difficulties and that the functions of the app supported the student to achieve their tasks. Interestingly, another user comments on trust in the app as follows: "Really not a bad app. Not as distrustful as I thought it would be. Easy to use" (#usrcmg). This may mean that users had preconceived ideas that the app might be difficult to use. This may be attributed to the fact that often students get pressure to perform well when writing exams. Having a mobile app in the exam process could also add stress to students if the mobile proctoring app did not function as expected.

Users noted a feature that was missing for assessing the mobile proctoring app before actual assessments: "There should be a feature to test the app sound before you 'start assessment' not when you start doing the assessment" (#usrcmg). Users perceived that evaluation would support learning about how the mobile app functions. Some users indicated on the challenges of using the mobile proctoring app related to time. Although users were expected to be able to complete their exams at different times and submit their work, this function did not work as expected in the mobile proctoring app. Users reported that they had to wait until the end of exam:

> "The app is not timed to the online exam. If I finish early, I must sit until the app timer runs out. … It should have a finished exam button or stop timer. I have finished 40 minutes ago. I wait while it winds down and I cannot even move." (#usrcmg)

Similarly, another user commented: "There should be a button that allows you to notify the app that you are done writing the exam, so you do not have to sit in silence without a phone for an hour… That one hour of silence is stressful!!!" (#usrcmg). This may mean that students had to stay in exam setting even though they had completed their assessment. Other students perceived the waiting until end of exam as being held against their wish to do other personal activities: "App is so inconvenience where you finish your exams before time given now have to wait for time to elapse, we have responsibilities we cannot be stuck on your app screen …" (#usrcmg). Thus, the time function of the mobile app required to consider the differences of abilities of users in completing the assessments.

Users raised concerns over the efficiency in the functions for scanning and uploading photos when using the mobile proctoring app: "When I updated the app, I could not upload my scripts so now I might fail two modules because this scanning document function is not uploading as quick as taking photos like previously" (#usrcmg). Another

user also indicated the problem of uploading scripts: “The uploading of scripts (which is the whole point of an exam) just does not happen on this app. The app does a lot here from uploading scripts from the previous exam instead of scanning the current one to just freezing on you” (#usrcmg). During exams, it was crucial for students to upload their work. The students were required to scan all their papers and upload their papers so that they could be marked later. Failure of this process meant that the students could not pass their assessment. Hence, some students were worried when they failed to scan and upload their work when using the mobile proctoring app.

Another problem was related to updating the mobile proctoring app. It was necessary to frequently update the app so that users could get most recent and bug free version of the mobile proctoring app. Users encountered issues with updating including failure to update, contact request for updating, long time for the update process that was costly for the students due to prohibitive cost of data. User also experienced challenges related to updating the mobile proctoring app each time they wanted to use the app during online assessments. While updating was significant in the functions of the mobile proctoring app to support new and updated features, it was important to provide information when updates could be done and minimise disruption in assessment activities.

There were also issues related to identification and access of the mobile proctoring app. Users wearing glasses were not identified properly and could not access to the mobile proctoring: “This app if you take a picture wearing glasses it will not allow you to login. Also there is no option to change your password if forget like all other apps out there” (#usrcmg). This means that students who wore spectacles required further instructions on removing glasses when being identified by the mobile proctoring app. Another problem was loss of internet data because the update process in some devices required multiple attempts to complete the task. For example, one user reported about losing data: “Every time I must update it before using, or I have to uninstall then install again, it is terrible, and I am losing data” (#usrcmg).

5.4 Information about the mobile app

Information about the app and the processes for using the app before, during, and after exams was important for the users. Information was also important when there were errors when using the app to ensure that users were able to recover from the errors and complete their tasks. Additionally, information about the app could also be available from multiple sources so that users can use an alternative when one source was not available. Users reported challenges with accessing information that was useful to recover from errors. One user reported that:

> “I have tried logging in today and it required for an update, now I am being informed that my phone is not compatible. Mind you I am using Huawei P40. I have been reading the reviews and there are no replies or any promises to fix the errors.” (#usrcmg)

This statement may mean that additional sources of information were not effective in addressing all the information requirements of users. Hence, it was important to have a dedicated form means of communication that would provide instant or regular response to the users. This was important especially during the exams because the activities were assigned specific times.

The users also raised issues related to the accuracy of information about activities, e.g., information about the assessments. One user reported the issue of incorrect information: "This app is just nonsense; we will be using it when we are writing but when it is time for getting results, they will say you didn't use it" (#usrcmg). Incorrect information could cause anxiety for the student due to the pressure of the experience of the students to perform in their studies.

While students used the diverse sources to obtain information for assessments and the app (e.g., WhatsApp chat, websites, user manual, YouTube videos, Chatbot and information on their LMSs), some of the comments about the app from the users were also not accurate. The issues raised by the users were not always uniform. For example, a user reported that the reviews' information created the impression that the application was not functional. The user did not experience any problems, as indicated in the following statement: "The reviews gave me anxiety before using the app. Only to find out the app is so user friendly and has no challenges" (#usrcmg).

The quality of information when seeking support was important for the users during the assessments. The user was required to be assisted promptly. Some users explained challenges related delays in feedback when seeking assistance during assessment. For example, one user claimed that the app was not giving accurate information and experienced delays on feedback from the support team:

> "The app gives false reports, I received a report that I was out of the app for more than five minutes that time I did not even touch my phone during the entire time I was writing my exam, then your support team keeps referring me to the university. Absolutely unfair." (#usrcmg)

Similarly, another user reported that the quality of information was not good as expressed dissatisfaction with the support services when using the mobile app: "Extremely poor user support. Assistance was requested from user support via WhatsApp and the personnel who handled the request was condescending, unprofessional and had no intention of offering useful assistance" (#usrcmg). This may mean that when information was a crucial component when using the mobile proctoring app during assessments, especially when errors occurred.

5.5 Subjective quality of the mobile app

Subjective quality was the overall perception of users on the app to achieve their goals in online and remote assessments. Users were able to achieve their objectives during assessments. For example, the Google Play reviews showed that The Invigilator had over ten thousand downloads and 1.52 thousand reviews. The mobile app had a 3.5 star rating. On Apple Store, The Invigilator was star rated at 1.9. On AppGallery, the app was rated as 3.5. Figure 1 show an example of The Invigilator rating.

As can be seen in Figure 1, on overall the users rate the app at 3.5 meaning that they were able to achieve their objectives when doing assessment. There were also some users that experienced challenges when using the mobile app. For example, some users did perceive that the app was not meeting their expectations: "Distracting. It deserves no star" (#usrcmg). This can be viewed as opportunity for the developers to obtain feedback on areas that required attention to improve the app. For instance, one user commented the need for fixing errors that users had identified: "Why don't you fix the problem about this app. A lot of people are complaining about it" (#usrcmg).

Figure 1 The Invigilator app rating on Google Play (see online version for colours)

There was no information related to payment for using the mobile app. Students were required to use their university e-mail to register on the app. This meant that only universities that acquired the app could use the app. Frequency of use evident in the use of the app during. Overall, the mobile app had a good rating, meaning that the users were confident in using the app despite some challenges:

> "Previously gave the app a 2-star review. However, I noticed the developers provided an update which fixed the issues relating to sign-up/login I was referring to. Credit where it is due, it would be unfair to keep that rating. I used the app today and thought it worked much better. Keep up the great work!" (#usrag).

This statement may mean that some users developed confidence when using the mobile app after some time. The users recovered from errors because they developed knowledge about how to deal with errors when using the mobile app.

5.6 Classification of the mobile app

Classification was the ability of the mobile app to maintain records of correct users, provide access and verification, and ensure that the collected information was safe and only authorised users can access the stored information. Therefore, the mobile application required registration on the Internet and log-in each time users wanted to access the mobile proctoring app. All app users were registered with universities that had purchased the mobile app. Hence, the registration process required e-mail address from the university and a master selfie (e.g., a picture of a user without glasses, mask or face covering) for identification. Users were also required to confirm their student number and e-mail address.

Regular updates were requested to ensure that all changes made to the app were active in the versions running on the devices of the users. The update process also tested the microphone and camera to ensure support for audio and selfie capturing. The process required an internet connection, but other users had no internet access as one user pointed out that: "It says please connect your device to the internet (on start-up but I do have internet" (#usrcmg). In addition, a quick response (QR) code was used at the beginning of assessment classification.

The mobile proctoring app capabilities covered security to ensure that only registered and authorised users used the app during the assessment. However, some users reported challenges with registration and login when using the app. For instance, one user reported issues of signup: "I am struggling to sign up. The system says my email address is not verified by my university. I also sent a WhatsApp message to the technical support team for assistance, and there is answer to my request. I am slowly losing my mind. Is there

anyone out there who can help in this matter?" (#usrcmg). The users interacted with support teams to obtain feedback. In cases of delays, users relied on feedback from their peers.

Another interesting point was that failure to register on the app could mean that users could not participate in the assessment. For instance users who had problems with login explained: "Nearly missed an exam because I could not login" (#usrcmg). Similarly another user failed to access the app noted that: "I cannot register my details on the app it keep on saying my email is not confirmed by my university" (#usrcmg). Beyond login, users also experienced challenges with uploading of the master selfie that was used for identification of users of the app. For example, one user reported that: "I am not happy with this app. I am using Huawei Y5 Lite. Now when I take a selfie it kicks me out. It is so disappointing" (#usrcmg). On overall, this meant that the mobile app was accessible to users with correct login details and sometimes there were problems with login details. The ability to access the mobile app was crucial for users to participate in assessments and ensure progress in their academic achievement.

The privacy policy statement of the mobile proctoring app stated that the collected data would be only used for the intended purposes and maintain privacy of the users. However, some users felt that the app did not maintain privacy. For example, one user commented on the app related to privacy:

> "It is a privacy violation and filled with bugs. I had no choice but to install it due to my school, but this app is bad. Schools please do not use it. It will cause more errors and will not prevent students from cheating." (#usrcmg)

While there were concerns about privacy, there was no further evidence to prove that the app violated privacy of users. This may mean that some users were making claims that were not true as a way of justifying their unwillingness to use the mobile proctoring app in assessments.

6 Discussion of research findings

The study aimed to analyse the opinions of users of a mobile proctoring app. The study was guided by the research question: What are the student's views of students on quality of mobile proctoring app used in online assessments? The findings showed that there were both positive and negative views about the mobile proctoring app. Positive views were related to engagement, aesthetic, functionality, information, and subjective quality of the app. Users also reported challenges they experienced when using the mobile proctoring app during assessments. The challenges include limited feedback for support and delays in responses from the technical team during exams. These findings were consistent with earlier studies on use of proctoring systems in online systems, e.g., web-based and platform-based proctoring systems (Alessio et al., 2018; Andreou et al., 2021; Hussein et al., 2020; Verhoef and Coetser, 2021). However, there new insights that emerged from the study that can contribute towards better understanding of use of mobile phone-based proctoring systems in education setting. These are discussed in the subsequent paragraphs.

The findings showed that users engaged with the app during the exams and were able to recover from minor errors. This finding was consistent with other studies that have highlighted engaging features of proctoring systems, e.g., web-based platforms (Werner

et al., 2022). The contribution of the study was that mobile proctoring app can also be engaging and interactive. Users can enhance their exam experience through following exam steps using the app. The app supported students with special needs (e.g., anxiety or those who are not comfortable to write exams in a group). The study highlighted that the proctoring mobile app had limited customisation. This had implications on the users because the users used different types of mobile devices to access the app. This may mean that the proctoring apps should be designed in consideration of portability where it can be used on different types of mobile devices (Coons et al., 2019). This was one of the areas that was missing in the MARS dimension.

The mobile proctoring app ability to support users to achieve their goals was crucial during the online/remote assessments. The findings showed that most of the users achieved their goals during the online or remote assessments. This may mean that the app was well-designed for proctoring of remote or online assessments. The users achieved their goals during the exams. However, some users experienced challenges related to information and feedback when using the app during exams. Other authors have highlighted the challenges of information and feedback (Alessio et al., 2018; Eler et al., 2019). The study contributes to the understanding of this problem, more specific to the context of exams where there was limited feedback when there was an error with the mobile proctoring app. The findings showed that some users failed to recover from errors. Thus, the study demonstrated the significance of timely and meaning feedback from the mobile proctoring app and the technical support team.

Subjective quality of the mobile proctoring app was viewed in light of the use of the app in supporting users during assessments. On overall, users managed to achieve their goals and expressed satisfaction and confidence when using the app. This was consistent with the overall star rating of the app of 3.5. This finding was consistent with other studies that have highlighted higher star rating of an app (e.g., Eler et al., 2019; Frei et al., 2017; Hassan et al., 2018). Table 3 summarises the dimensions and their status in the mobile proctoring app.

Further, the findings showed that the mobile proctoring app had all the dimensions of the MARS (Stoyanov et al., 2015, 2016). However, there was no comments from the users for information dimension related to visual information, credibility and evidence-based. This may be attributed to nature of use for the app where assessments did not require such information, e.g., evidence-based for making decisions as in health context.

The findings confirmed the significance of security for proctoring apps. This was demonstrated by users concerns over privacy, e.g., the perception about the mobile proctoring app to maintain confidentiality of personal data and disclosure of the information to third parties. The highlighted security concerns were consistent with similar studies on app quality (Coghlan et al., 2020; Stoyanov et al., 2016; Shange, 2023). Nonetheless, there was no evidence of security affecting users during the assessments. This may mean that users could raise concerns about security to justify their unwillingness to use the app in assessments. If the complaints cannot be addressed during assessments, the situation can create opportunities for moral hazards during remote or online assessments (Boehm et al., 2009; Coghlan et al., 2020). Thus, vigilance is also paramount to support mobile-based proctoring systems in education setting.

Table 3 Summary of MARS dimensions and their status in the mobile proctoring app

Sub-category	*Examples of dimensions*	*Status*	*Comments*
Engagement	Entertainment	✓	Dimensions confirmed
	Interest	✓	Dimensions confirmed
	Interactivity	✓	Dimensions confirmed
	Target group	✓	Dimensions confirmed
	Customisation	×	Dimension was limited
Aesthetic	Layout	✓	Dimension confirmed
	Visual appeal	✓	Dimension confirmed
	Graphics	✓	Dimension confirmed
Functionality	Performance	✓	Dimension confirmed
	Ease of use	✓	Dimension confirmed
	Navigation	✓	Dimension confirmed
	Gestural design	×	Dimension not confirmed
Information	Accuracy	✓	Dimension confirmed
	Goals	✓	Dimension confirmed
	Quality information	✓	Dimension confirmed
	Quality of information	✓	Dimension confirmed
	Visual information	×	Dimension not confirmed
	Credibility	×	Dimension not confirmed
	Evidence-based	×	Dimension not confirmed
Subjective quality	Recommendation	✓	Dimension confirmed
	Frequency of use	✓	Dimension confirmed
	Willing to pay	×	Dimension not confirmed
	Star rating	✓	Dimension confirmed
Classification	Confidentiality	✓	Dimension confirmed
	Security	✓	Dimension confirmed
	Registration	✓	Dimension confirmed
	Community	✓	Dimension confirmed
	Affiliation	✓	Dimension confirmed

The study was without limitations. We focus on comments from the users of the mobile proctoring app. In addition, the study did not explore the views of lecturers and technical team members who were supporting the mobile proctoring app. However, the findings in this study provide insightful details on the strengths of the mobile proctoring app from the user's point of view, highlighting areas that need attention for improvement. Further studies can arise from the study can look at:

a views of the lecturers on functionality and subjective quality of the app

b views of the technical team in addressing the technical challenges of the users.

Our recommendation for practice are related to the need for the lecturers and developers to review the processes of remote/online assessments and note areas that require

attention, e.g., issues of registration process when using the mobile proctoring apps for the first time, conducting pre-test where users can become familiar with the mobile proctoring apps and the assessment processes, providing adequate information to users so that they can recover from errors and allowing submission and closing of the mobile proctoring app when users finish their assessments early. Another important area is providing timely support and feedback during the assessments. This was important to ensure that users do not panic when there are technical problems during the assessments.

In conclusion, the objective of the study was analysing the views of users of a mobile-based proctoring app. The findings demonstrated that The Invigilator had strengths in app classification, aesthetic, information and security to support integrity of online and remote assessments in education setting. Users of the mobile proctoring app also raised issues related to functionality and subjective quality that could affect user performance during online and remote assessments. The study offers areas for further research and recommendations for practice to enhance the users experience of the mobile proctoring app in online or remote assessments.

References

Agha, K., Zhu, X. and Chikwa, G. (2022) 'Towards academic integrity: using Bloom's taxonomy and technology to deter cheating in online courses', in *Technologies, Artificial Intelligence and the Future of Learning Post-COVID-1*, pp.447–466, Springer, Cham.

Alessio, H. and Messinger, J. (2021) 'Faculty and students' perceptions of academic integrity in technology-assisted learning and testing', *Frontiers in Education*, Vol. 6, pp.1–8.

Alessio, H., Malay, N., Maurer, K., Bailer, A. and Rubin, B. (2018) 'Interaction of proctoring and students major on online test performance', *International Review of Research in Open and Distributed Learning*, Vol. 19, No. 5, pp.1–22.

Andreou, V., Peters, S., Eggermont, J., Wens, J. and Schoenmakers, B. (2021) 'Remote versus on-site proctored exam: comparing student results in a cross-sectional study', *BMC Medical Education*, Vol. 21, No. 1, pp.1–9.

Baijnath, N. and Singh, D. (2019) 'Examination cheating: risks to the quality and integrity of higher education', *South African Journal of Science*, Vol. 115, Nos. 11/12, pp.1–6.

Bengtsson, M. (2015) 'How to plan and perform qualitative study using content analysis'. *NursingPlus Open*, Vol. 2, pp.8–14.

Boehm, P., Justice, M. and Weeks, S. (2009) 'Promoting academic integrity in higher education', *The Community College Enterprise*, Vol. 15, No. 1, pp.45–61.

Bolton, H., Matsau, L. and Blom, R. (2020) *Flexible Learning Pathways: The National Qualification Backbone*, South African Qualification Authority, Pretoria, South Africa.

Bucciol, A., Cicognani, S. and Montinari, N. (2020) 'Cheating in university exams: the relevance of social factors', *International Review of Economics*, Vol. 67, pp.319–338.

Chuchu, T. and Ndoro, T. (2019) 'An examination of the determinants of the adoption of mobile applications as learning tools for higher education students', *International Journal of Interactive Mobile Technologies*, Vol. 3, No. 3, pp.53–67.

Coghlan, S., Miller, T. and Paterson, J. (2020) 'Good proctor or 'big brother'? Ethics of online exam supervision', *Philosophy & Technology*, Vol. 34, pp.1581–1606.

Coons, J., Patel, R., Coley, K. and Empey, P. (2019) 'Design and testing of Medivate, a mobile app to achieve medication list portability via fast healthcare interoperability resources', *Journal of the American Pharmacists Association*, Vol. 59, No. 2, pp.S78–S85.

D'Souza, K. and Siegfeldt, D. (2017) 'A conceptual framework for detecting cheating in online and take-home exams', *Decision Sciences Journal of Innovative Education*, Vol. 15, No. 4, pp.370–391.

de Plessis, E. and der Westhuizen, G. (2022) 'Building academic integrity through online assessment apps', *Education and New Development*, Vol. 2, pp.49–53.

Dube, B. (2020) 'Rural online learning in the context of COVID-19 in South Africa: evoking an inclusive education approach', *Multidisciplinary Journal of Educational Research*, Vol. 10, No. 2, pp.135–157.

Duncan, A. and Joyner, D. (2022) 'On the necessity (or lack thereof) of digital proctoring: drawback, perceptions, and alternatives', *Journal of Computer Assisted Learning*, Vol. 38, No. 5, pp.1482–1496.

Eler, M., Olandin, L. and Oliveira, A., (2019) 'Do Android app users care about accessibility? An analysis of user reviews on the Google Play Store', *Proceeding of IHC 2019*, Victoria – ES, Brazil, 22–25 October, Vol. 19, pp.1–11.

Foster, D. and Layman, H. (2013) *Online Proctoring Systems Compared* [online] https://caveon.com/wp-content/uploads/2013/03/Online-Proctoring-Systems-Compared-Mar-13-2013.pdf (accessed 26 November 2022).

Frei, K., Hartmann-Boyce, J., Jebb, S., Albury, C., Nourse, R. and Aveyard, P. (2017) 'Insights from Google Play Store user reviews for the development of weight loss apps: mixed-method analysis', *JMIR MHealth*, Vol. 5, No. 12, pp.1–14.

Hassan, S., Tantithamthavorn, C., Bezemer, C. and Hassan, A. (2018) 'Studying the dialogue between users and developers of free apps in the Google Play Store', *Empirical Software Engineering*, Vol. 23, pp.1275–1312.

Holden, O., Norris, M. and Kuhlmeier, V. (2021) 'Academic integrity in online assessment: a research review', *Frontiers in Education*, Vol. 6, No. 639814, pp.1–13.

Hussein, M., Yusuf, J., Deb, A., Fong, L. and Naidu, S. (2020) 'An evaluation of online proctoring tools', *Open Praxis*, Vol. 12, No. 4, pp.509–525.

Khalil, M., Prinsloo, P. and Slade, S. (2022) 'In the nexus of integrity and surveillance: proctoring (re) considered', *Journal of Computer Assisted Learning*, Vol. 38, No. 6, pp.1589–1602.

Landa, N., Zhou, S. and Marongwe, N. (2021) 'Education in emergencies: lessons from COVID-19 in South Africa', *International Review of Education*, Vol. 67, Nos. 1–2, pp.167–183.

Makoza, F. and Bagui, L. (2022) 'Rhizomatic learning and use of mobile instant messaging platforms: case of university of technology in South Africa', *International Journal of Virtual and Personal Learning Environments*, Vol. 12, No. 1, pp.1–17.

Mpungose, C. (2020) 'Emergent transition from face-to-face to online learning in a South African University in the context of the coronavirus pandemic', *Humanities and Social Sciences Communication*, Vol. 7, No. 113, pp.1–9.

Mzangwa, T. (2019) 'The effects of higher education policy on transformation in post-apartheid South Africa', *Cogent Education*, Vol. 6, No. 1, pp.1–16.

Ng'ambi, D., Brown, C., Bozalek, V., Gachago, D. and Wood, D. (2016) 'Technology enhanced teaching and learning in South African higher education – a review of a 20 year journey', *British Journal of Education Technology*, Vol. 47, No. 5, pp.843–858.

Noorbehbahani, F., Mohammadi, A. and Aminazadeh, M. (2022) 'A systematic review research on cheating in online exams from 2010 to 2021', *Education and Information Technologies*, pp.1–48 https://doi.org/10.1007/s10639-022-10927-7.

Patton, M. (2014) *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*, Sage Publications, London.

Raman, R., Veena, G., Vachharajani, H. and Nedungadi, P. (2021) 'Adoption of online proctored examinations by university students during COVID-19: innovation diffusion study', *Education and Information Technologies*, Vol. 26, pp.7339–7358.

Reddy, L., Letswalo, M., Sefage, A., Kheswa, B., Balakrishna, A., Changundega, J. and Nemakhavhani, T. (2022) 'Integrity vs. quality of assessments: are they compromised on the online platform', *Pedagogical Research*, Vol. 7, No. 2, pp.1–9.

Ridder, H. (2017) 'The theory contribution of case study research design', *Business Research*, Vol. 10, pp.281–305.

Selwyn, N., O'Neill, C., Smith, G., Andrejevic, M. and Gu, X. (2023) 'A necessary evil? The rise of online exam proctoring in Australian universities', *Media International Australia*, Vol. 186, No. 1, pp.149–164.

Shange, T. (2023) 'The bad and the ugly: reflections on the use of Invigilator app by first-year students in English proficiency for university studies at an Odel University in South Africa', in Makua, M. et al. (Eds.): *The Focus Conference (TFC 2022)*, pp.214–232, Atlantis Press.

Stoyanov, S., Hides, L., Kavanagh, D. and Wilson, H. (2016) 'Development and validation of the user version of the mobile application rating scale (uMARS)', *JMIR mHealth and uHealth*, Vol. 4, No. 2, pp.1–5.

Stoyanov, S., Hides, L., Kavanagh, D., Zelenko, O., Tjondronegoro, D. and Mani, M. (2015) 'Mobile app rating scale: a new tool for assessing the quality of Health mobile apps', *JMIR mHealth and uHealth*, Vol. 3, No. 1, pp.1–9.

The Invigilator (2022) *The Invigilator. Exam Proctoring from your Smartphone* [online] https://invigilator.app/ (accessed 28 November 2022).

Topuz, A., Saka, E., Fasta, O. and Kursun, E. (2022) 'Emerging trends of online assessment systems in the emergency remote teaching period', *Smart Learning Environments*, Vol. 9, No. 17, pp.1–21.

Verhoef, A. and Coetser, Y. (2021) 'Academic integrity of university students during emergency remote online assessment: an exploration of student voices', *Transformation in Higher Education*, Vol. 6, pp.1–12.

Waghid, Y. (2002) 'Knowledge production and higher education transformation in South Africa: towards reflexivity in university teaching, research and community service', *Higher Education*, Vol. 43, pp.457–488.

Werner, N., Brown, J., Loganathar, P. and Holden, R. (2022) 'Quality of mobile apps for care partners of people with Alzheimer disease and related dementias: mobile app rating scale evaluation', *JMIR mHealth uHealth*, Vol. 10, No. 3, pp.1–14.