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Factors Influencing the Use of E-Assessment in Engineering Education During Emergency Remote Teaching: A Qualitative Approach

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Abstract: - The study aims to investigate engineering education instructors' observations and experiences with e-assessment challenges during the COVID-19 pandemic's Emergency Remote Teaching (ERT) period. The study employed a focus group discussion method with a criterion sample of seven instructors from engineering education in a higher education institution. The data gathered was transcribed and analyzed using thematic analysis, which revealed four major themes: benefits, challenges, different types of remote assessment, and recommendations and guidelines for future better practice. The study's findings offer insights into the challenges faced by engineering education instructors during the ERT period, as well as recommendations for future better e-assessment practices.

Keywords: Challenges, COVID-19, E-assessment, ERT, Factors, Online Engineering Education.

I. INTRODUCTION

As an outcome of social distancing during the COVID-19 outbreak, many higher education institutions worldwide ceased abruptly and shifted from face-to-face classes to unintended Emergency Remote Teaching (ERT) [1], [2] through different online platforms. A compulsory transformation of the way education was delivered to ERT without adequate preparation caused problems in different aspects of remote teaching and learning [3] since the sudden shift to ERT entailed the utilisation of available resources and a rapid redesign of physical face-to-face classes into remote online courses [1]

ERT was implemented in the form of online learning in many countries around the world during the COVID-19 pandemic [4], [5], [6] to ensure that education continues. Oman was not an exception from the world; therefore, the Supreme Committee announced the shift to remote online teaching and learning [7] as an attempt to stop the spread of the coronavirus pandemic. Online learning is featured by its accessibility, flexibility, self-pacing interactivity and cost-saving [8], [9], [10], [11]. However, some issues related to remote online learning and teaching have been made apparent during ERT due to the COVID-19 pandemic. [1], for instance, questioned the quality of education due to the unplanned shift to emergency remote teaching and learning. [12] questioned the unsuitability of certain courses to be delivered in remote learning and teaching mode. Instructors of courses like sports sciences, engineering and medical sciences that require in-person practical experiences and hands-on instructional activities found it difficult to deliver and assess such courses through online remote teaching [13].

ERT urged instructors to try different assessment methods [14]to evaluate the students learning throughout the online courses [15], [16]. However, content delivery, engagement of students through online platforms, and then e-assessing their acquisition and retention of knowledge using traditional methods pose some challenges [17]. Consequently, e-assessment (EA) requires necessary changes affecting the revision of traditional assessment activities together with involving learners and instructors in assessment management [18], [19].

Although some studies have investigated the practicality of e-assessment during the COVID-19 pandemic, research output remains insufficient for a deep understanding of practical guidelines for pursuing e-assessment of engineering education in ERT. Therefore, it is worthy to investigate how the instructors in engineering education assessed students in the ERT during COVID-19 and to outline e-assessment guidelines for the online delivery of engineering education during ERT. The following research question guides this study:

1. What are the factors influencing the use of e-assessment in Engineering Education during Emergency Remote teaching?

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II. LITERATURE

A. Emergency Remote Teaching

ERT is a temporary change in the delivery mode of teaching and learning due to crises [1]. This means utilising full distance learning solutions for teaching or learning that would ordinarily be provided face-to-face or as blended or hybrid sessions and will revert to this format once the crisis or emergency has passed [20]. As a result of the COVID-19 crisis, digital and online technology has been developed and adopted at a faster pace, allowing students to be assessed from a distance.

B. E-Assessment in Engineering Education

E-assessment (EA) is the process of creating, distributing, assessing, and providing feedback for formative, summative, diagnostic, or self-assessment using digital technology [21]. It entails the use of digital technology to evaluate and provide feedback to students. The role of EA in education is extremely beneficial, as it provides several benefits to students, instructors, and educational institutions. [21] believe that EA provides for the evaluation of essential life skills, the improvement of scoring reliability and, as a result, the quality of the test itself, and it helps to avoid the limitations of the conventional paper-based assessment method, such as grading time. Additionally, [22] stated that EA is a useful stage in the learning process for students and instructors. They claimed that EA is a useful tool for arranging student learning in an online setting where appropriate study resources and assignments are available for evaluation, by giving students more independence. It is also a useful online tool that aids instructors in course design by assisting them in tracking learners' progress and errors as well as the achievement of learning objectives.

Following the abrupt switch of classes to ERT in Spring 2020, instructors in engineering education used various e-assessment methods to help engineering students finish their assignments and training [23]. Researchers used different modes of e-assessment such as project-based assignments, training workshops, webinars, short courses, discussion panels, online quiz tools within the LMS, open-book, take-home exams, student presentations, peer-reviewed activities, cooperative quizzes, oral assessments, course summary papers and online portfolios [16], [20], [24], [25].

C. E-assessment Challenges

The current technology revolution, as well as ubiquitous accessibility and continuous connectivity, has opened numerous doors for distance education and chances for learning and information sharing throughout the world. However, EA poses some challenges.

To start with, the unprecedented COVID-19 incident has caused different challenges for higher education institutions in terms of teaching and learning. In this case, a transition from traditional to online education would seem to be the right alternative. However, access to digital technology equipment as well as Internet coverage and speed are critical challenges to EA [23]. Also, EA has become unavoidable as a result of social distance restrictions and remote learning, necessitating a compelling requirement to ensure achieving the learning outcomes in engineering education. EA is conducted online without the physical presence of students and the invigilators; thus it poses some other particular issues in terms of avoiding cheating and academic dishonesty and maintaining integrity [26], [27]. [28] suggested that a well-designed valid EA should follow before-during-after strategies as major preventative measures for academic misconduct. Dental students were asked to sign a Test Ethics Pledge before the tests as part of the pre-testing process. A tablet PC with a face tracking capability, a Zoom videoconferencing program, and a random question sequencing tool in a Computer-Based Test were all used during-test process. Penalties for cheating were made explicit and offered specific lists of "cheating behaviours" for after-test process [28].

Some of the pedagogical challenges of EA are the lack of practice and lack of feedback and an evaluation system [29], [30]. Engineering education is incomplete without practical experience. Hands-on practice is an integral pillar in engineering education [15]. EA may not offer students real practice in the field.

Engagement and motivation toward the subject is another pedagogical matter in EA. Teachers should engage with students frequently and regularly so that they do not feel alone, confused or demotivated. They should keep in touch with students regularly by forming a community group, sending them e-mails, and establishing a Frequently Asked Questions (FAQ) part where all students may benefit from the answers to other students' queries [31].

[31] identified some technical challenges that affect EA related to the instability of Internet connections when hundreds of students and faculty are online at the same time, as well as many students' lack of technical gadgets. Teachers' and learners' lack of digital skills, the lack of structured content versus the abundance of online resources, learners' lack of interactivity and motivation, and the social and cognitive issues that teachers and schools must address in this situation are all pedagogical challenges that teachers and institutes must address [31].

III. METHOD

A. Data collection

The research followed a focus group discussion for data collection. Focus group discussion is an interview with a group of four to twelve participants to answer questions on a specific topic face-to-face or via mail; people who participate interact with each other through a guided discussion on a specific topic [14], [32], [33]. The Focus group method is more appropriate for the generation of new ideas formed within a social context [34]. [33] defined five qualities related to the components of a focus group: (1) a small group of people with certain characteristics who (3) give qualitative data (4) in a concentrated conversation (5) assist in comprehending the issue of interest. The researchers used the focus group discussion to find out the understanding and experiences of engineering education instructors about the challenges of e-assessment and their proposed solutions to overcome these challenges during ERT. The researchers created a discussion guide based on the reviewed literature [14], [33], [34], [35], [36]. The guide was reviewed by five referees specialized in qualitative research to ensure its trustworthiness and its convenience in answering the research questions. The researchers discussed the feedback in a virtual meeting and the guide was modified according to the comments received from the referees. An information/consent sheet was also developed by the research team and sent via email to the participants two weeks before the focus group discussion. The information/consent sheet included background about the nature of the research, an invitation to participate willingly in the study, benefits and risks of participation, the confidentiality of the participants' information and data collected and the guidelines for the virtual focus group discussion. The participants read the information sheet and responded by email with the agreement to participate in the focus group discussion. A week before the focus group discussion, the principal researcher sent a polite reminder to the seven participants including the date, day and time of the interview as well as the information/consent sheet. The focus group discussion was conducted virtually via Microsoft Teams® software and it was a videotaped discussion. The principal investigator of this research moderated the discussion. The second researcher and an IT specialist from the virtual and learning environment department in the college provided technical support while both the third and fourth team members took some notes and observed the saturation of data during the focus group discussion. A day after the focus group discussion, the first and second researchers used Otter® software to transcribe the video while the third and fourth researchers reviewed that transcribed data for analysis.

B. Sample

The sample is selected deliberately not at random in qualitative research. A Criterion sampling that is based on the selection of participants who meet pre-determined criteria of importance [37] is followed to select the sample of this study. Seven instructors teaching engineering pathways (3 Marine Engineering, 2 aeronautical engineering, 2 systems Engineering) at the Military Technological College in Oman were approached by their heads of departments and invited to participate willingly in the research after reading the information/consent sheet. As regards the criteria of the participants' selection, generally they shared some common characteristics. They are homogeneous in terms of working in the same institution, having experience of more than 3 years in engineering education, teaching engineering pathways since ERT started in March 2020, and experienced e-assessment in engineering education during ERT. The saturation theory was applied to the participants. The researchers gathered data until they got considerable new information from the focus group.

C. Data analysis

The interpretation of qualitative data is generally required. This implies that the evidence needs many interpretations. This is because a large amount of qualitative data is frequently gathered [38]. Thematic analysis was used to analyse the transcribed data. It is used to look at categories and show data-related themes, depict facts in great detail and use interpretations to deal with a variety of topics [39]. The data analysis process followed [40] six steps: data familiarisation, coding data, searching for themes, reviewing themes, defining and naming themes and writing up. Before conducting data analysis, the second research team member will check the transcription of the focus group discussion that will be retrieved through MS Streams®. To facilitate the data analysis, the transcript will be imported to ATLAS. ti 9® -data analysis software- and shared with the four researchers. The four researchers will read the transcript to get familiarised with the data. Next, the four researchers coded the data and searched for themes independently. The authors conducted two virtual meetings to discuss and review the themes, based on the coding report generated from ATLAS.ti 9®. After two rounds of revisions, the authors collaboratively defined and named the themes. Finally, the themes were divided among the authors for the write-up of the results.

IV. ANALYSIS AND DISCUSSION

COVID-19 endangered people's lives across the world, and it has effects across society. Education is one of these that strives to meet the difficulties of the times. It presented challenges to both the students as well as the instructors, who are essential to the new normal of education. Engineering education instructors encountered various challenges in assessing engineering students practically during the ERT. The qualitative data analysis revealed patterns influencing the e-assessment of engineering education. Four primary topics emerged from the thematic analysis: benefits, challenges, types of remote assessment, and recommendations and guidelines for future better practice. The outcomes of all participants' focus group conversations are presented in this section, with discrepancies highlighted. Participants are identified as instructor 1, instructor 2, instructor 3, etc.

A. Benefits of EA

The analysis of the focus group data revealed that e-assessment offers a variety of benefits for both students and instructors. For students, instructor 2 emphasized e-assessment is a very valuable tool for independent learners, and it can provide positive attitudes towards learning. Additionally, instructor1 noted that students can receive feedback online, leading to a better understanding of the assessment process and increased motivation and independence. Instructor 7 confirmed students can view their assessment results as the marking criteria are made accessible online. The e-assessment had also been made better through the hybrid delivery of coursework during ERT as instructor 2 believed. The hybrid delivery of coursework is an increasingly popular method in engineering education during ERT. This approach allows engineering students to attend traditional in-person classes where they can learn and practice hands-on skills and receive face-to-face instruction from their instructors while also participating in online learning activities and assessments. The online component can include interactive simulations, virtual lab experiments, and remote access to specialized software and equipment. Instructor 2 stated that this approach allowed engineering students to learn at their own pace, have access to a wide range of resources and have flexibility in terms of time and location. While staying safe, this approach also enabled students to take more advantage of the latest technologies, digital tools and software in the field. Four instructors (2, 4, 5 and 7) believed e-assessment allowed for digital literacy and effective communication skills to be instilled among students. Instructors, on the other hand, benefited from e-assessment. Instructor 3 said it allowed teachers to improve their teaching styles and pedagogy, as well as to use technology support to deliver content as they can use the Moodle platform, MTC-Tube channel, and other free open resources to create ready courses and give mock online exams for students. They also were able to try out some new models for the best utilisation of technology in ERT. For instance, instructor 3 was careful about using new technologies during ERT so they followed the SAMR method. They explained that the SAMR model is a way to choose, apply, and evaluate technology education. It's a four-step, category-based method that helps instructors in selecting the right technology for the task at hand. Furthermore, instructor 2 indicated e-assessment allowed teachers to take risks and make new coursework. Finally, participant instructors expressed that the process of giving online feedback is much easier than meeting with students individually.

B. Challenges of EA

The focus groups highlighted several barriers and problems for EA implementation in HEIs. They were classified according to the four themes: preparation and feedback, academic misconduct, communication, and training of engineering pathways.

Instructor 4 indicated initial challenges at the beginning of the pandemic regarding the implementation of EA. Most of the participants (instructors 1,3,4,5,7) in the focus group pointed out that the implementation of EA is very challenging. Instructor 4 stated, “at the beginning of the pandemic, we panic!". Instructor 4 declared that one of the major challenges of e-assessment in engineering education is the time and effort required for preparation, marking, and providing online feedback. Instructor 4 explained that instructors and students were not familiar with e-assessment at the beginning of the pandemic and there was no established system for e-assessment during the pandemic, which added to the challenges. Instructor 6 said converting theory into online coursework and designing online exam questions that effectively assess student knowledge has been difficult. Instructor 2 added shifting from physical to online delivery required the need to change hands-on, practical assessments to online assessments although some instructors kept the previous assessment while others introduced new assessment types. Instructor 6 shared the fact that descriptive e-assessments, in particular, require a significant amount of time to mark and provide feedback, especially when different assessment approaches are used for different undergraduate levels. This can be especially challenging when dealing with a large number of students. Instructors 4 and 5 highlighted another challenge regarding marking. Instructor 4 said marking is a crucial challenge of e-assessment in engineering education, specifically when it comes to reading students' handwriting on uploaded exam papers. Instructor 5 confirmed it can take a significant amount of time to mark online exams, especially if the handwriting is difficult to read. Additionally, Instructor 4 emphasized it can be challenging to check for

plagiarism in handwritten assignments that are uploaded online. This problem is further compounded as students are submitting written work online.

Another major challenge of e-assessment for engineering students is the large number of students which can hinder the quality of e-assessment. Instructor 3 asserted the increase in student numbers can lead to academic misconduct of theoretical knowledge, such as cheating and plagiarism, which can be hard to detect and prevent in online exams. Instructor 4 indicated that the use of AI can help to identify such misconduct, but it may not be able to fully address it. Additionally, instructor 2 highlighted the use of social media to share answers can also be a problem. This problem is worsened when students band together in WhatsApp groups to share answers during exams, even in math courses. Furthermore, online written exams have the added challenge of being unable to check for plagiarism and students often copy from each other. From a grader's point of view, instructor 4 said this can lead to students following similar steps, making it difficult to differentiate their work.

Participant instructors expressed a common concern related to communication, particularly regarding feedback. Instructor 7 asserted that, unlike physical attendance in classrooms, online classes lack positive communication from students. Many students were not willing to cooperate or pay attention during online classes. Many students do not come back to discuss the feedback provided by the teachers, leading to a lack of communication which hinders the implementation of new strategies and plans. Instructor 5 clarified that this lack of communication is further exacerbated by the teaching load and having different modules, which hinders communication between instructors and the module coordinator. As a result, instructors may not be sure if the content is reaching the students as it was offline teaching, and they may not receive any response from students to their e-feedback as instructor 6 indicated.

Another challenge of e-assessment in engineering education regarding testing students online. Instructors pointed out that analytical knowledge, in particular, can be difficult to assess remotely and may require on-campus or hands-on assessments. Instructor 6 explained, “this is particularly true for level 3 content, which includes both descriptive and analytical components”.

Participant instructors also expressed a critical challenge of e-assessment for engineering students which is training. Instructor 7 declared independent learning is essential for students, but it can also place a significant burden on instructors and technicians who must train engineering students beforehand. Instructor 1 pointed out that in most of the modules, the assessments are based on some of the practicals in the aircraft or the trainers. Instructor 6 revealed that “there is some part which you don't do practically on hand, they are not covered in that scene, a depth and breadth”.

E-assessment has brought about some challenges for students in engineering education as expressed by the participant instructors. One of the main challenges has been internet connectivity issues. Instructors agreed that many students have struggled to upload exam papers and send them back to teachers. Instructor 5 said this has been particularly difficult for students who live in areas with poor internet connectivity, as it has made it difficult for them to submit their work on time. Another challenge for students has been the lack of hands-on practice. Instructors 2,4 and 6 agreed that many students have missed the experience of connecting wires and working with physical equipment. This has been particularly difficult for students in engineering programs, where hands-on experience is essential for learning. Another challenge that students have faced is confusion between teaching approaches and online approaches. Instrutor 6 said that with many instructors switching to online teaching, students have found it difficult to keep up with the new teaching methods. This has led to confusion, which has made it difficult for students to learn. Instructor 2 said that communication and feedback have also been a challenge for students during e-assessment. Instructor 6 complained that while some students have been able to discuss online feedback with their teachers, others have not. Instructor 4 added that this has made it difficult for instructors to understand how well students are understanding the material.

C. Types of EA during ERT

The focus group discussion about e-assessment types in engineering education highlighted several key points. The discussion revealed themes under the types of EA during ERT: a mix of EA, EA types, EA authenticity and engineering hybrid program.

Instructors adopted a mix of existing and new technology to adapt to the new teaching environment in engineering education during emergency remote teaching. Some instructors continued to use traditional assessment methods (instructors1,4,5 and 7), while others introduced new types of assessment (instructors 2, 3 and 6). Technology support was used to deliver content and different platforms were explored to find the most effective for teaching. Instructor 4 disclosed that the Moodle platform was utilized as a helpful resource, as pre-prepared course materials were available. Instructor 1 said that students were given opportunities to interact with each other and their instructions through forum discussions on the Moodle platform. Also, the Google Classroom platform was used to facilitate cooperation among students. Instructor 7 confirmed that Students were able to see how they were assessed, as marking criteria were made available online via the Moodle platform.

Instructor 6 conveyed that mock online exams were given to prepare students for the real exams, and challenging exam questions were used to test their understanding without the use of internet resources. Instructors 3 and 4 added that open-ended, descriptive questions were also included in the assessments. In terms of e-assessment types, instructor 2 discussed the use of different software, such as Autodesk products as an alternative to SolidWorks while instructor 4 insisted that to make learning and assessment more interactive, gamified learning and open-source tools were utilized.

At the start of the pandemic, traditional assessments were used, but as time progressed the shift was made to online assessments. Overall, the group discussed a variety of e-assessment types such as case studies, quizzes, simulations, coursework assignments, descriptive assessments, scenario-based questions, online exam questions, open-book type examinations, and open-ended questions. Some instructors were careful while employing e-assessment. The group revealed that a new e-assessment approach was implemented to support independent learning. Instructor 6 indicated that new e-assessments were designed based on the specific requirements of each module, taking into account the different types of modules and levels. Instructor 4 introduced simulation software to deliver Training and Needs Analysis (TNA) online. Instructor 3 emphasised that online quizzes were introduced for the first time, and OneNote was used to help students manage their research more effectively. Instructor 6 disclosed that as there were no prior plans, multiple-choice tests were created and mock online exams were given to students. Coursework was introduced as an assessment method to replace traditional online exams. Instructor 2 used coursework assignments instead of online exams to test the theoretical part of the module.

Ensuring authenticity was a key focus in e-assessment during emergency remote teaching (ERT). To achieve this, instructors 5,6, and 7 ensured that a set of authentic questions was developed by a team of cooperative instructors within each engineering department. These questions were unseen and locally designed, to prevent them from being accessed through search engines such as Google. Various sets of questions were prepared for quizzes to ensure authenticity. The group emphasized that feedback was provided to students online through the use of online plagiarism detection software such as Turnitin.

A hybrid program was introduced to assess the practical skills related to specific outcomes. This program, called "hybrid weeks," involved a combination of online and on-site learning, allowing for the assessment of practical skills. Instructor 5 explained that the program utilized a hybrid delivery method, where students attended a hybrid week, during which they performed practical exercises and answered questions related to the equipment they were using. Instructor 6 said “So for that hybrid, we did change one thing we also included the on-site or on equipment, student’s answers, so that the students are doing the practical exercise, and they are being asked the questions at the same time about the equipment”. Instructors agreed that this approach was implemented because it was recognized that students may not have had sufficient time to gain hands-on experience with the equipment and machinery. Instructor 6 confirmed that the hybrid weeks were designed internally by the academic staff in each department to provide both descriptive and analytical content, with a focus on level 3 content. The analytical knowledge was acquired both on campus and off campus. The hybrid delivery approach has allowed for the successful implementation of coursework assessments. Instructors 2 and 1 asserted that the incorporation of on-site and online learning in the hybrid delivery has improved the coursework experience for students. As a result, coursework is now viewed as a positive alternative to traditional exams.

D. Recommendations and Guidelines

The focus group discussion on e-assessment in engineering education made several recommendations and guidelines for teachers, students, and institutions. For instructors, the group suggested instilling digital literacy as it is essential for e-assessment (instructor2), matching pedagogy and exam approaches together (instructor 4), having a quick response to teachers and students to avoid miscommunication and doing some research to cope with the new online delivery and e-assessment (instructors 2,3, & 5). Additionally, it is important to consider that e-assessment depends on the module type and not using a one-size-fits-all approach (instructor 5). The group also recommended implementing exams in a certain setting, following an independent learning approach, enriching students' e-assessment experience by giving mock online exams and maintaining communication with students and colleagues as a module coordinator (instructors 1 & 4). Improving teaching styles and pedagogy as well as e-assessment strategies, being up-to-date with new tools and software, and using AI to solve issues with handwritten assignments were also considered (instructor4). The group suggested different platforms to find the best for teaching, using simulation and technology support to deliver content and using coursework instead of online exams. Providing feedback online via online plagiarism detection software such as Turnitin was also recommended.

The group also recommended that students should improve their effective communication skills, this is important as e-assessment often involves online communication and collaboration. Furthermore, students should consider their study environments and make adjustments to optimize their learning experience (instructors 6 and 7). Additionally, students should compare online outcomes to hybrid week outcomes, this would help them

understand the importance of both online and on-site learning (instructor 6). The group also emphasized that students' experiences should be taken into account when designing e-assessments and providing feedback. This would ensure that e-assessments are tailored to meet the needs of individual students and that they can receive the support they need to succeed.

Instructors expressed that institutions should take certain considerations into account when implementing e-assessment for engineering education. Since instructional design is frequently related to specific requirements, it can be challenging to expand the use of electronic assessment methods without the necessary institutional support (instructors 3,4, 1). The institution should also play a role in incorporating the same plan in the pedagogical approach as well as in the teaching approach. The group also mentioned that professional development in digital literacy is essential for both teachers and students, as it allows them to effectively navigate the use of technology in e-assessment. Teachers also need to invest time and effort to learn new software (instructor 1) and to train on the use of technology and e-assessment (instructor 5). To prevent academic misconduct, institutions should consider using AI tools (instructor 4). Institutions should also consider students' study environments and take students' experiences into account when designing e-assessments. Exams should be implemented in a certain setting that is appropriate for the assessment and proper communication should be kept with both instructors and students to avoid miscommunication when introducing coursework (instructor 2). The institution should also provide interactive assessment tools, whether paid or free, to support instructors and students in their e-assessment efforts (instructor 4). Lastly, institutions should reframe the assessment to make sure that it is aligned with the new teaching and learning environment (instructors 1, 5, 6, 7).

V. CONCLUSION

Since the pandemic impacted all routines, eLearning developed from theoretical concepts into practice. While earlier eLearning reached a limited number of participants, now it resonates with everyone. After the pandemic, educators use online tools to teach distance courses, communicate and interact, assign, and collect assignments, and perform assessments. In this research, researchers aim to examine the use of e-assessment and instructors' perspectives on their unique experience of e-assessment of engineering education during the COVID-19 pandemic.

The focus group discussion emphasized the importance of digital literacy, independent learning, and considering students' experiences and environments. They also recommended using different platforms, simulations, and technology support to deliver content. The group also suggested using coursework instead of online exams and providing feedback online. They also suggested that institutions should provide necessary support and use AI to address academic misconduct.

In summary, as educational scholars, we recommend engineering educators shift to well-designed e-assessment and hybrid assessment, which would assess engineering education as an important part of the learning process.

A. Practical implications

The practical implications of the research about factors influencing the use of e-assessment in engineering education during emergency remote teaching is that it provides insight into the challenges and opportunities of using e-assessment in remote teaching situations. The findings of the study can be used to inform the development of e-assessment tools and strategies that are better suited to the needs of engineering students and educators during emergency remote teaching. Additionally, the study highlights the importance of providing training and support for both students and educators to ensure the effective use of e-assessment tools. Additionally, it may aid in identifying the factors that are hindering the adoption of e-assessment in the field of Engineering education.

B. Future research and limitations

Future research could include a larger and more diverse sample of participants and compare them across institutions, to present a more comprehensive picture of the EA during ERT and provide more thorough results. Future research could also include a quantitative study to supplement the findings of the current qualitative study. Additionally, future research could explore the long-term effects of e-assessment on student learning, attitude and engagement in engineering education.

Limitations of the current study include the fact that the study only focused on engineering education. Therefore, it is important to replicate the study with a larger sample size, including participants from different specializations, and institutions to generalize the findings. Additionally, the study was conducted during a specific moment in time ERT which could limit the generalizability of the findings. Therefore, future research should consider the possible changes in the scenario and assess the factors again.

REFERENCES

[1] C. Hodges, S. Moore, B. Lockee, T. Trust, and A. Bond, 'The difference between emergency remote teaching and online learning', Educause review, p. 7, 2020.

[2] M. K. Barbour, R. LaBonte, C. Hodges, and S. Moore, 'Understanding pandemic pedagogy: differences between emergency remote, remote, and online teaching', State of the Nation: K-12 e-Learning in Canada, no. December, pp. 1–24, 2020.

[3] S. Şenel and H. C. Şenel, 'Remote Assessment in Higher Education during COVID-19 Pandemic', International Journal of Assessment Tools in Education, no. January, pp. 181–199, 2021, doi: 10.21449/ijate.820140.

[4] F. Castroverde and M. Acala, 'Modular distance learning modality: Challenges of teachers in teaching amid the Covid-19 pandemic', International Journal of Research Studies in Education, vol. 10, no. 8, 2021, doi: 10.5861/ijrse.2021.602.

[5] R. Mahajan, W. M. Lim, S. Kumar, and M. Sareen, 'COVID-19 and management education: From pandemic to endemic', International Journal of Management Education, vol. 21, no. 2, 2023, doi: 10.1016/j.ijme.2023.100801.

[6] Y. Zhao and J. Watterston, 'The changes we need: Education post COVID-19', Journal of Educational Change, vol. 22, no. 1. 2021. doi: 10.1007/s10833-021-09417-3.

[7] M. E. T. Osman, 'Global impact of COVID-19 on education systems: the emergency remote teaching at Sultan Qaboos University', Journal of Education for Teaching, vol. 46, no. 4, pp. 463–471, 2020, doi: 10.1080/02607476.2020.1802583.

[8] S. C. Yen, Y. Lo, A. Lee, and J. M. Enriquez, 'Learning online, offline, and in-between: comparing student academic outcomes and course satisfaction in face-to-face, online, and blended teaching modalities', Educ Inf Technol (Dordr), vol. 23, no. 5, pp. 2141–2153, 2018, doi: 10.1007/s10639-018-9707-5.

[9] P. Leszczyński et al., 'Multimedia and interactivity in distance learning of resuscitation guidelines: a randomised controlled trial', Interactive Learning Environments, vol. 26, no. 2, pp. 151–162, 2018, doi: 10.1080/10494820.2017.1337035.

[10] J. Smedley, 'Modelling the impact of knowledge management using technology', OR Insight, vol. 23, no. 4, pp. 233–250, 2010, doi: 10.1057/ori.2010.11.

[11] J. O'Donoghue, G. Singh, and C. Green, 'A comparison of the advantages and disadvantages of IT based education and the implication upon students', Interactive educational multimedia: IEM, vol. 9, no. 9, pp. 63–76, 2004.

[12] R. A. Machado, P. R. F. Bonan, D. E. Da Cruz Perez, and H. Martelli Júnior, 'COVID-19 pandemic and the impact on dental education: Discussing current and future perspectives', Braz Oral Res, vol. 34, pp. 1–6, 2020, doi: 10.1590/1807-3107BOR-2020.VOL34.0083.

[13] P. Wenceslao and G. Felisa, 'Challenges to Online Engineering Education during the Covid-19 Pandemic in Eastern Visayas, Philippines', International Journal of Learning, Teaching and Educational Researchfile:///C:/Users/amal1/Downloads/A comparison of the advantages and disadvantages of IT based education and the implications upon students..pdf, vol. 20, no. 3, pp. 84–96, 2021, doi: 10.26803/ijlter.20.3.6.

[14] F. Rabiee, 'Focus-group interview and data analysis', Proceedings of the Nutrition Society, vol. 63, no. 4, pp. 655–660, 2004, doi: 10.1079/pns2004399.

[15] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, and A. Sciortino, 'An observational study of engineering online education during the COVID-19 pandemic', PLoS One, vol. 16, no. 4 April, pp. 1–17, 2021, doi: 10.1371/journal.pone.0250041.

[16] P. Tilak, S. Salim, and K. Hakim, 'A survey on online examination during COVID 19 pandemic : Perception of Management Students .', vol. IX, no. Viii, pp. 285–290, 2020.

[17] R. Kumar, 'Assessing Higher Education in COVID-19 Era', Brock Education Journal, vol. 29, no. 2, p. 37, 2020, doi: 10.26522/brocked.v29i2.841.

[18] S. Y. Almossa, 'University students' perspectives toward learning and assessment during COVID-19', Educ Inf Technol (Dordr), no. 0123456789, 2021, doi: 10.1007/s10639-021-10554-8.

[19] K. K. Naji, X. Du, F. Tarlochan, U. Ebead, M. A. Hasan, and A. K. Al-Ali, 'Engineering students' readiness to transition to emergency online learning in response to COVID-19: Case of Qatar', Eurasia Journal of Mathematics, Science and Technology Education, vol. 16, no. 10, 2020, doi: 10.29333/EJMSTE/8474.

[20] S. El Firdoussi, M. Lachgar, H. Kabaili, A. Rochdi, D. Goujdami, and L. El Firdoussi, 'Assessing Distance Learning in Higher Education during the COVID-19 Pandemic', Educ Res Int, vol. 2020, 2020, doi: 10.1155/2020/8890633.

[21] Astalini, Darmaji, W. Kurniawan, K. Anwar, and D. A. Kurniawan, 'Effectiveness of using e-module and e-assessment', International Journal of Interactive Mobile Technologies, vol. 13, no. 9, pp. 21–39, 2019, doi: 10.3991/ijim.v13i09.11016.

[22] Z. Raud and V. Vodovozov, 'Advancements and Restrictions of E-Assessment in View of Remote Learning in Engineering', 2019 IEEE 60th Annual International Scientific Conference on Power and Electrical Engineering of Riga Technical University, RTUCON 2019 - Proceedings, 2019, doi: 10.1109/RTUCON48111.2019.8982349.
[23] S. El Firdoussi, M. Lachgar, H. Kabaili, A. Rochdi, D. Goujdami, and L. El Firdoussi, 'Assessing Distance Learning in Higher Education during the COVID-19 Pandemic', Educ Res Int, vol. 2020, 2020, doi: 10.1155/2020/8890633.
[24] J. Chen, A. Kolmos, and X. Du, 'Forms of implementation and challenges of PBL in engineering education: a review of literature', European Journal of Engineering Education, vol. 46, no. 1, pp. 90–115, 2021, doi: 10.1080/03043797.2020.1718615.
[25] L. Elsalem, N. Al-Azzam, A. A. Jum'ah, N. Obeidat, A. M. Sindiani, and K. A. Kheirallah, 'Stress and behavioral changes with remote E-exams during the Covid-19 pandemic: A cross-sectional study among undergraduates of medical sciences', Annals of Medicine and Surgery, vol. 60, no. November, pp. 271–279, 2020, doi: 10.1016/j.amsu.2020.10.058.
[26] F. M. Guangul, A. H. Suhail, M. I. Khalit, and B. A. Khidhir, 'Challenges of remote assessment in higher education in the context of COVID-19: a case study of Middle East College', Educ Assess Eval Account, vol. 32, no. 4, pp. 519–535, 2020, doi: 10.1007/s11092-020-09340-w.
[27] M. García-Alberti, F. Suárez, I. Chiyón, and J. C. M. Feijoo, 'Challenges and experiences of online evaluation in courses of civil engineering during the lockdown learning due to the covid-19 pandemic', Educ Sci (Basel), vol. 11, no. 2, pp. 1–19, 2021, doi: 10.3390/educsci11020059.
[28] J. Lee, R. J. Kim, S. Y. Park, and M. A. Henning, 'Using technologies to prevent cheating in remote assessments during the COVID-19 pandemic', J Dent Educ, no. July, pp. 1–3, 2020, doi: 10.1002/jdd.12350.
[29] K. Mukhtar, K. Javed, M. Arooj, and A. Sethi, 'Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era', Pak J Med Sci, vol. 36, no. COVID19-S4, p. S27, 2020, doi: 10.12669/PJMS.36.COVID19-S4.2785.
[30] M. S. C. Thomas and C. Rogers, 'Education, the science of learning, and the COVID-19 crisis', 2020, doi: 10.1007/s11125-020-09468-z.
[31] F. Ferri, P. Grifoni, and T. Guzzo, 'Online Learning and Emergency Remote Teaching: Opportunities and Challenges in Emergency Situations', 2020, doi: 10.3390/soc10040086.
[32] A. Moser and I. Korstjens, 'European Journal of General Practice Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis', 2018, doi: 10.1080/13814788.2017.1375091.
[33] R. A. Krueger and M. A. Casey, Focus groups: A practical guide for applied research., 5th ed. Sage publications, 2014.
[34] R. L. Breen, 'A practical guide to focus-group research', Journal of Geography in Higher Education, vol. 30, no. 3, pp. 463–475, 2006, doi: 10.1080/03098260600927575.
[35] F. M. Amin and H. Sundari, 'Efl students' preferences on digital platforms during emergency remote teaching: Video conference, lms, or messenger application?', Studies in English Language and Education, vol. 7, no. 2, pp. 362–378, 2020, doi: 10.24815/siele.v7i2.16929.
[36] V. Braun and V. Clarke, 'Using thematic analysis in psychology', Qual Res Psychol, vol. 3, no. 2, pp. 77–101, 2006, doi: 10.1191/1478088706qp063oa.
[37] A. Moser and I. Korstjens, 'Series : Practical guidance to qualitative research . Part 3 : Sampling , data collection and analysis', European Journal of General Practice, vol. 0, no. 0, pp. 9–18, 2018, doi: 10.1080/13814788.2017.1375091.
[38] M. Ibrahim, 'THEMATIC ANALYSIS: A CRITICAL REVIEW OF ITS PROCESS AND EVALUATION', West East Journal of Social Sciences-December, vol. 1, no. 1, 2012.
[39] H. Kallio, A.-M. Pietilä, M. Johnson, and M. Kangasniemi, 'Systematic methodological review: developing a framework for a qualitative semi-structured interview guide', J Adv Nurs, vol. 72, no. 12, pp. 2954–2965, Dec. 2016, doi: 10.1111/JAN.13031.
[40] V. Braun and V. Clarke, 'Using thematic analysis in psychology'.