The Advantages and Challenges of Electronic Exams: A Qualitative Research based on Shannon Entropy Technique

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Introduction: The electronic exam is one of the foremost imperative instruments for evaluating students' execution. Accordingly, this study aimed to identify the advantages and challenges of electronic exams based on Iranian and international studies.

Methods: The present qualitative study used meta-synthesis in the first phase. Thus, keywords such as electronic exams, online exams, electronic assessment, and online assessment in Iranian and international databases for 2005-2021 were searched. In the second phase, using the Shannon entropy technique, the advantages and challenges of electronic exams were weighted.

Results: Challenges of e-exams were classified into seven sub-categories (poor technical knowledge, security challenges, complexity and challenges in designing examination, complexity and challenges during examination, complexity and challenges after examination, lack of infrastructure, socio-cultural challenges). The advantages of e-exams were also classified into five sub-categories, including improvement of teaching and learning process, effectiveness of student performance assessment, advantages in designing exams, advantages during examinations, and advantages after examinations. In Shannon's entropy findings, challenges (complexity and challenges after examination and poor infrastructure) and advantages (advantage after exams implementation) had the largest weight.

Conclusion: Considering the importance of electronic exams, especially with the outbreak of the COVID-19 epidemic, the inevitable movement of university systems, increasing concerns about student performance assessment, and improving educational performance in the current situation, decision-makers are expected to emphasize the advantages of this kind of exam and address its challenges to help improve the student assessment mechanisms.

Keywords: Exam; Assessment; Education; Evaluation; Qualitative research

Introduction

Today, the rapid advances in artificial intelligence have led to profound implications in the functioning of academic systems. For example, it has had profound consequences on education (1) and research (2) in the higher education system. In reaction to this progress, education systems have also grown rapidly so that electronic learning has been accepted and merged with the education system (3, 4). Therefore, today, e-learning has been accepted as a significant part of the higher education system (5). As to conceptualization of this word, e-learning is defined as a kind of distance learning that is done entirely through electronic channels such as the Internet or using support tools (6-9). Meanwhile, student evaluation is a key factor in electronic exams and learning scenarios (10). The electronic exam is one of the foremost imperative instruments for evaluating students' performance. Hence, under current circumstances and the predominance of COVID-19, planning and arranging for e-exams is fundamental in two ways.

First, along with the development of information and communication technologies, e-exams have increased (11). Unlike traditional pen-and-paper exams, e-exams do not restrain professors from assessing and evaluating students. Thus, e-exams can be used for diagnostic, formative assessments, or both (12). Although there is no commonality and universal point of view among researchers regarding the advantages and challenges of e-exams, the trends of education systems, and whether or not they direct the higher education systems to this kind of exam, from the first point of view, according to many researchers, e-exams have many positive effects and advantages in measuring and evaluating the learners' performance (13-16). In contrast to the first group, some researchers have identified challenges that cast doubt on the effectiveness of e-exams by evaluating the student's performance (17-20). There have always been such contradictions. Proponents and opponents have their views and arguments. The critical point is that the education system is moving towards an intelligent future and institutionalization of these university tools. Thus, identification and analysis of the advantages and challenges of e-exams, particularly for the education system of developing countries, can be a problem solver.

The second necessity is the prevalence of COVID-19, which requires students to take exams and courses virtually. In this regard, there have been many arguments about the quality of education, the actual level of students' learning, how to evaluate students' performance, and so on (21-23). This is a critical issue, as e-exams are the final step and measure students' knowledge and cognitive ability. Accordingly, a significant problem in the current situation is that the use of electronic platforms to assess and give exams in all universities worldwide is inevitable. If the exams cannot evaluate the student's knowledge, irreparable consequences will occur. Many case studies have dealt with the issue of online assessment of students using different methodologies (24-28). Accordingly, this study aimed to identify the advantages and challenges of electronic exams based on Iranian and international studies.

Methods

The methodology of this research consists of six sections as follows:

Conceptual Framework

This research is based on an interpretive paradigm. Qualitative research is related to the paradigm of interpretivism. In this paradigm, unlike the paradigm of positivism, there is a belief that things are different from physical phenomena and meanings stem from the human's mind and perception. Therefore, it pays special attention to the conditions and context (29).

Method

This research was conducted using the meta-synthesis method of Sandelowski and Barroso (30). The meta-synthesis research method is one of the types of meta-study methods and is considered a qualitative research method. Indeed, meta-synthesis is a type of qualitative study that uses the information of the findings extracted from other studies in the field of the related topic. In the meta-synthesis method, the researcher combines the secondary data of the results of other studies to respond to the results of his study and obtain new results. In the next step, we used the Shannon entropy technique for weighting. Shannon's entropy is a method used to measure the weight of elements based on the degree of dispersion and frequencies observed in a table of values. This method is mostly used to measure the importance of criteria in a decision matrix in multi-criteria decision-making. Also, the use of Shannon's entropy in content analysis is of interest to researchers.

Data Collection

Meta-synthesis method of Sandelowski and Barroso with seven steps was used in the first step (30). In the first step, research questions were designed. In the second step, a systematic literature review was performed. Keywords such as electronic exams, online exams, electronic assessment, and

online assessment in Iranian databases including Magiran, Noormags, SID and Comprehensive Portal of Humanities, and international databases including Science Direct, Springer, Wiley Online Library, ERIC, Sage, Taylor & Francis, PubMed and Emerald from 2005 to 2021 were used. In the third step, suitable research was selected; the inclusion criteria of the articles were as follows: the type of study: quantitative, qualitative, and mixed, considering the desired time limit and access to the full text of the article. The criterion for excluding articles was articles that did not fit the topic and use of the PRISMA form. In this way, by extracting the findings of qualitative, quantitative, and mixed studies, these findings were integrated into each other as key concepts based on similarities and differences. These findings were used to answer the first and second research questions in identifying advantages and challenges. Based on PRISMA screening, 94 articles were selected, including 37. In Figure 1, the screening steps of articles are displayed.

The fourth step was extracting and taking notes from the information in the article. Nevertheless, for the sake of brevity, the details of the articles (referring to the extracted codes separately from the articles) have been avoided. The bibliographic characteristics of the selected articles are shown in Table 1.

Data Analysis

The fifth step was to compile, synthesize, and analyze the research findings. In this step, for qualitative content analysis, Graneheim et al.'s model method (63) was employed. This model has six stages. In this research, in the first stage, after selecting the selected articles, the key parts of the articles were implemented in a Word file. In the second step, the texts of the articles were read several times, and meaning units were

extracted. In the third stage, meaningful units were abstracted, and the codes were selected, whereby obvious and hidden concepts were identified. In the fourth step, the researchers categorized the codes that indicated the same topic into classes and subclasses by constantly comparing the differences and similarities. In this process, if there were any ambiguous cases, it was reviewed by the research team members. In the fifth stage, at the interpretation level, the classes were summarized so that the abstract and main concepts were extracted. In the final stage, the information obtained from the interpretation and report was presented. Below is a practical example of the data analysis process (Figure 2).

Data Validation

The sixth step was to validate the findings. In this step, peer debriefing of the findings was used. This is one of the validation techniques in qualitative research and is considered one of the accreditation approaches to qualitative data (64).

In the second phase, to answer the third research question, "which of the challenges and advantages of electronic exams are more important and weighted?", the Shannon entropy technique was used. Shannon's entropy method is powerful in data processing in content analysis. Shannon's entropy in information theory is an index to measure uncertainty expressed by a probability distribution. There are several methods to determine the weight of indicators. One of the best methods is Shannon's entropy (65), and the findings are analyzed using the following formula:

$$E_j = -k \sum_{i=1}^{m} P_{ij} * LnP_{ij}^i = 1.2....mk = \frac{1}{Lnm}$$
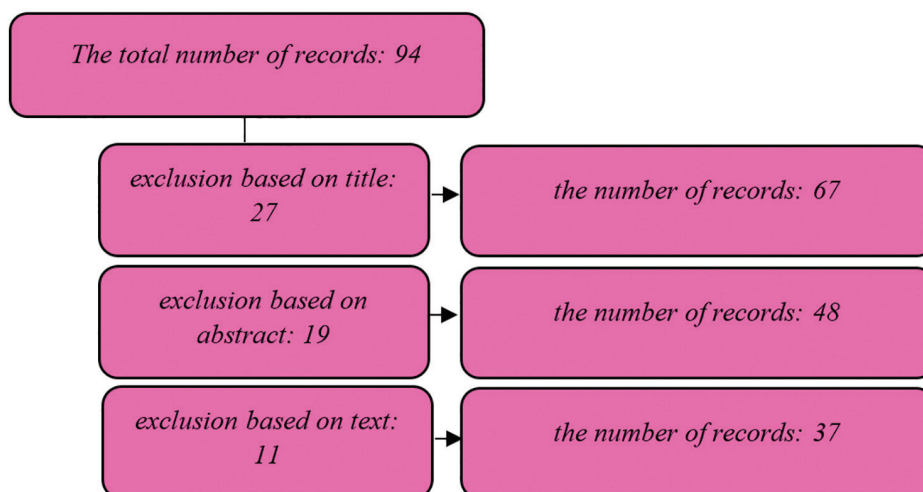
$$w_j = \frac{d_j}{\sum d_j} d_j = 1 - E_J$$

Figure 1: Flow diagram illustrating the screening process

Table 1: A Summary of Selected Articles

The Author/ Authors	References	Research Type	Population	Goal
Reedy, et al. (2021)	(31)	Quantitative	Faculty members (73), University students (2239)	Studying the perception of students and faculty members of cheating in e-exams.
Heidarzadeh, et al. (2021)	(32)	Quantitative	*	Opportunities and challenges of online take-home exams in medical education.
Ebaid, (2021)	(33)	Quantitative	University students (101)	Identifying the cheating in online exams among accounting students in Saudi Arabia as a developing country.
Qalawa, et al. (2021)	(34)	Quantitative	University students (1574)	Studying the nursing students' satisfaction of electronic exams in selected universities.
Abdelrahim & How (2021)	(35)	Qualitative	University students (23)	Identifying the factors of cheating in electronic exams during Covid-19 in Bangladesh.
Elsalem, et al. (2020)	(36)	Quantitative	University students (1019)	Studying the medical students' experience in electronic exams in one the universities in Jordan during the Covid-19 pandemic.
Ngqondi & Maoneke (2021)	(37)	Quantitative	*	To offer a framework for online exams based on the characteristics of the universities in South Africa.
Elsalem, et al, (2020)	(38)	Quantitative	University students (730)	A cross-sectional study to assess the medical students experience in terms of their preferences in distance e-exams and academic dishonesty at the time of Covid-19.
Sharma (2020)	(39)	Quantitative	*	Using the technologies based on CNN through using new methods to recognize cheating in e-exams.
bin Muhammad, et al. (2021)	(40)	Quantitative	Faculty members (297)	Identifying the availability of skills needed to develop and use electronic exams for the faculty members of University of Jeddah based on the global trend of electronic exams.
Allan (2020)	(19)	Qualitative	8 practitioners	Studying the practitioners' experiences with e-exams.
Clark, et al. (2020)	(41)	Qualitative	*	Analyzing the challenges of electronic chemistry exams in the time of Covid-19.
Meridani, et al. (2020)	(42)	Quantitative	University students (200)	Designing and implementing an online examination system to give continuous exams during the semester and comparing the educational quality of students with other classes that have not participated in these exams.
Ilgaz & Adanır (2020)	(43)	Quantitative	online learners (163)	Comparing the success of online learners in online exams with traditional exams.
Afacan Adanır, et al. (2020)	(44)	Quantitative	University students (370)	Studying the students' perception of online exams in universities of Turkey and Kyrgyzstan and comparing the results.
Shraim (2019)	(45)	Quantitative	University students (342)	Studying the perception of Palestinian learners of implementation of online exams.
Simsek, et al. (2019)	(46)	Quantitative	*	Creating and developing an individual e-exam module where the questions are categorized based on cognitive levels.
Cramp, et al. (2019)	(47)	Qualitative (case study)	Focus group (Not mention the number of people)	Analyzing the main topics of remote online examination and providing methods for its implementation.
Aisyah, et al. (2018)	(48)	Quantitative	*	Studying the security of electronic exams.
James (2016)	(18)	Quantitative	University students (125)	Implementing a trial examination of electronic examination in regional universities in Australia and studying its outcomes.
Habibi (2017)	(24)	Quantitative	University students (340) And University staff (120)	Studying the pathology of implementing e-exams in Payame Noor universities.
Ranjdoost (2018)	(49)	Quantitative	University students (380)	Comparison of students' satisfaction with electronic and traditional exams in Tabriz University of Medical Sciences.
Wibowo, et al. (2016)	(25)	Qualitative	University students (27)	Studying the faculty members and students' point of view about the challenges and advantages of electronic exam system.

| The Author/ Authors	References	Research Type	Population	Goal
Hassanzadeh, et al. (2017)	(50)	Mixed	Experts (10) and Managers of organizations (100)	Identifying and ranking the challenges of implementing e-exams in Technical and Vocational Education Organization.
Faghihi, et al. (2016)	(51)	Qualitative	University students (17)	Studying medical students' experience of participating in electronic pre-internship exams in medical universities of Kashan and Isfahan.
Ganji Arjenaki (2017)9	(52)	Quantitative	University students (250)	Studying the quality of e-exams in Payame Noor university and its impact on the student satisfaction.
Tasdemir, et al. (2015)	(53)	Quantitative	*	Designing and using online exam system supported by databases.
Kuikka, et al. (2014)	(54)	Quantitative	University professors (48)	Describing the teachers' experience in electronic exams at Finland's TUAS university.
Ramu & Arivoli (2013)	(55)	Quantitative	*	Studying the potential threats to student's authentication in online exams and analyzing the advantages and limitations of existing authentication methods.
Ramosb & Velasquez (2013)	(56)	Quantitative	*	Designing and developing an online examination system.
Gehringer & Peddycord (2013)	(57)	Qualitative	University students (315)	Studying the students' experience of electronic and traditional examinations.
Tao & Li (2012)	(58)	Quantitative	University students (81)	Analyzing the Advantages and pitfalls of computerized take-home testing for undergraduate.
Rao, et al. (2011)	(59)	Quantitative	*	Examining the security of electronic exams and providing solutions to create security in these exams.
King, et al. (2009)	(60)	Qualitative	University students (121)	Assessing the attitude of business students towards different issues and manners while participating in online exams and estimating the amount of cheating in traditional courses with that of online courses from students' perspective.
Dermo (2009)	(61)	Quantitative	University students (130)	Studying the students' perception of electronic assessment in online exams.
Jung & Yeom (2009)	(62)	Quantitative	*	Analyzing the security of electronic exams and providing a system for the security of electronic exams.
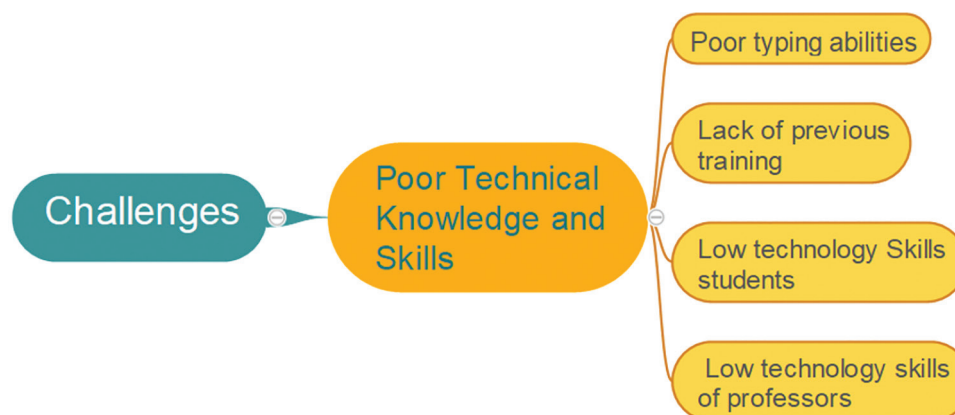
Figure 2: Practical example of the data analysis process

Ethical Considerations

Ethics in education and research is one of the most important components of higher education (66). Ethical considerations have also been taken into consideration in this research. In this study, there was an attempt to carefully extract the concepts from the articles and to observe confidentiality in mentioning the titles of the articles.

Results

The answers to the first research question, "What are the most important challenges of e-exams?", after taking notes of the texts of the articles, the key concepts were counted to answer this question. Then, the key concepts were classified into sub-categories based on their commonalities and differences (Table 2).

Table 2: The Challenges of Electronic Exams

The Main Category	Sub-categories	The Key Concepts
The Challenges of Electronic Exams	Poor Technical Knowledge and Skills	Poor typing abilities/ Low technology Skills students/ Low technology skills of professors/ Anxiety caused by facing e-exam due to poor technical knowledge/ Students' unfamiliarity and lack of experience / Professors' unfamiliarity and lack of experience with this type of exam/ Lack of previous training.
	Security Challenges	Identity fraud/ Copying exam answers through information exchange or searching/ Exchanging answers and chatting on social media during an exam to cheat/ Searching the internet resources for answers/ Using cellphone for cheating during the exam/ Getting information from others during the exam/ Using books, and personal notes during the exam/ The possibility of hacking e-exams systems/ Access to privacy and personal information/ Difficulties of controlling and monitoring the exam/ Using headphones during the exam/ disconnecting internet by the student to cheat and making excuses/ Showing pre-designed picture in exam to cheat.
	Complexity and Challenges in Designing Exam	lack of ability of some professors in designing standard and quality questions/ The difficulty of standardizing e-exams questions/The process of designing e-exams is time-consuming/ Inconsistency of some majors with e-exams/ The difficulty of designing questions for computational courses/ Difficulty and challenges in designing questions to measure critical and analytical thinking/ Lack of instructions before e-exams/ Lack of specific criterion to assess the quality and design of standard e-exams/ Inconsistency of some internet browsers with e-exams platforms/ Inconsistency of e-exams platforms with some mobile operating systems/ constraining exams to multiple-choice questions.
	Complexity and Challenges during the Examination	Distraction due to the noise caused by the constant use of the keyboard and mouse/ Lack of face-to-face communication of professors with students during the exam/ Confusion of students about how to start the exam/ Having no power to choose the order of answering the questions/ Inability to access to previous questions in some exams/ Being unable to draw diagrams and models to answer the questions/ Anxiety due to time limit of exam/ Inability of students in timing to answer the questions in comparison with the same questions in traditional exams/ Power outage during the exam/ Disconnection and slow speed of internet/ Being unable to see all questions at the same time/ students' fatigue due to excessive use of monitors/ Forgetting the final approval of the answer sheet and leaving the exam/ Low screen resolution and graphics problems of some computers/ Accidental departure of students from exam/ Uninterrupted unavailability of technical support during the exam for all students and professors/ Being unable to take the exam for students who have not logged in at a specified time/ Inappropriate house environment for exams/ Shortage of time to answer the question/ Disability for other family members during the exam.
	Complexity and Challenges after Examination	Impossibility of using the questions extracted from the question bank again due to taking screenshots of them by students/ The ambiguity of the validity of the exams/ Lack of appropriate feedback/ Being unable to assess practical knowledge of students.
	Poor Infrastructure	Lack of sufficient infrastructure in all regions/ Insufficient bandwidth/ Telecommunication restrictions and weak network connections/ Students' need for personal computers.
	Lack of Cultural Readiness	Generation gap between students and university professors to use technology/ Deep habit of taking and giving traditional exam and professors and students resistance to change/ Writing on paper is preferred by some students/Poor university culture in accepting e-exams/ Lack of positive attitude of professors and students towards e-exams/ Distrust of e-exams.

To answer the second question, "What are the essential advantages of e-exams?", after taking notes on the articles, the key concepts were extracted. Then, the key concepts were classified into sub-categories based on their commonalities and differences (Table 3).

Tables 4 and 5 report the results of weighing the most important challenges and advantages of electronic exams. The first column is data normalization. The third column is (E) calculation. The second column is the calculation of the standard error value, and the last column is the value (W), which represents the weight of each of the challenges and advantages.

According to Table 4, the challenges (complexity and challenges after investigation and weak infrastructure) had greater weight and importance based on Shannon's entropy technique than other challenges.

In the ranking based on the table above, the most important advantage of electronic exams is the advantages after exam implementation.

Table 3: The Classification of the Advantages of Electronic Exam

The Main Category	Sub-categories	The Key Concepts
The Advantages of Electronic Exams	Improvement in Teaching and Learning Process	Improvement in the quality of learning/ Strengthening students' creativity and innovation/ Strengthening active learning/ Effectiveness in achieving the goals of the courses/ Strengthening the student's cognitive and perceptual level/ No need to memorize unnecessary information/ Increasing student motivation/ Students are more attentive in the classroom to better prepare for the e-exams/ Improvement in students' educational performance.
	More Effective and Analytical Student Assessment	Accelerating the student assessment process / The capacity to profile and archive the performance of each student based on the analysis of exam results / Accurate analysis of the advantages and challenges of each student/ Possibility of analyzing the students' academic progress over time based on the information archive / Possibility of comparing students' exam results with each other easily and ranking them based on their performances/ Providing a more comprehensive perspective for students to analyze their performance/ Improvement in students' performance for the next exams due to real-time feedback .
	Advantages in Designing Exams	Being time-independent/ Being location-independent/ Possibility of using multimedia in designing/ Ease of covering a larger population of students simultaneously/ Possibility of giving simultaneous exams for several fields of study/ Saving time/ Saving the use of papers and helping to preserve the environment (sustainable development)/ Elimination of students' commuting to the exam centers and reduction of air pollution/ Leaving the workplace to be in exam center is not needed/ More flexibility in designing various questions/ Possibility to design questions in accordance with the level of students' information/ Possibility to randomize the order of questions and choices/ Developing a comprehensive and diverse question bank/ Possibility of implementing a mock examination in large extent/ Possibility to use other facilities to give the exam (cellphone, laptop, tablet)/ Diversity in presenting questions based on the question bank/ Consistency of e-exams with up-to-date changes in higher education/ Being suitable for all levels of education and courses/ The capacity to adapt to specific groups of students (disabled)/ Designing questions in accordance with exam time/ Designing questions in accordance with course/ Overcoming resistance to make changes in faculty members and students/ Designing questions based on the content presented in the course/ Giving an appropriate weight to each question/ Providing guidance/ Determining a certain time for each question/ Submitting a non-fraud commitment letter form to inform students of the consequences of cheating/ Taking pictures and fingerprints of candidates at the beginning of the examination/ Disabling right and left click on software/ Restricting the copy and paste.
	Advantages during Exams Implementation	Improvement in the performance of students with illegible handwritings during the examination/ Having more concentration during the exam as less writing is needed/ The same length of exam for all students/ Ease of using computational software such as calculators during examination/ Developing more discipline in implementing / Facilitating the process of holding and implementing the exam/ Automatic and effective management of exam venue/ Time management of examination.
	Advantages after Exams Implementation	Visibility of questions and answers immediately after the examination/ Ease of instant and systematic correction of exam sheets/Minimizing human error in correcting answer sheets/ Transparency and fairness in marking/ Giving immediate feedback to students/ Helping students in planning for the rest of exam based on immediate feedback/ Cost saving and effectiveness/ Easily integrating the information obtained from different exams/ Easy and secure data management.

Table 4: Shannon entropy results of the most important challenges of electronic exams

The Challenges of Electronic Exams	Normalized value	Value (E)	Standard Error (Dj)	Value (W)
Poor Technical Knowledge and Skills	0.106	0.065	0.935	0.141
Security challenges	0.196	0.088	0.912	0.138
Complexity and Challenges in Designing Exam	0.166	0.082	0.918	0.138
Complexity and Challenges during the Examination	0.318	0.100	0.9	0.136
Complexity and Challenges after Examination	0.060	0.008	0.992	0.150
Poor Infrastructure	0.060	0.008	0.992	0.150
Lack of Cultural Readiness	0.090	0.060	0.94	0.142

Table 5: Shannon entropy results of the most important advantages of electronic exams

The advantages of Electronic Exams	Normalized value	Value (E)	Standard Error (Dj)	Value (W)
Improvement in Teaching and Learning Process	0.142	0.076	0.924	0.198
More Effective and Analytical Student Assessment	0.111	0.067	0.933	0.200
Advantages in Designing Exams	0.476	0.097	0.903	0.194
Advantages during Exams Implementation	0.126	0.072	0.928	0.199
Advantages after Exams Implementation	0.142	0.037	0.963	0.207

Discussion

Today, university systems are faced with a complex situation. On the one hand, there are technological developments that progressively open new fields and horizons for academic systems. It has forced university systems to make changes in their specialties, governance methods, and infrastructures by using these technologies. Meanwhile, unknown crises such as the Covid-19 pandemic have plagued the world. Academic systems have also faced special conditions (67). In line with these changes and developments, e-exams had a significant impact on the trend in the history of education as today they are used at all higher education levels around the world (68).

Note that electronic exams have received more attention after the outbreak of the COVID-19 epidemic. Another critical point is the contradictory views on e-exams despite the inevitable action of academic systems after the epidemic. In the section on challenges of e-exams, in the sub-category of poor technical knowledge and skills manpower is not trained enough in technological fields. Faculty members, students, and staff need more skills to use new technologies. Inadequate experience plays a key role in the technical knowledge of manpower corresponds to the findings of several studies (5, 11, 18, 19, 47, 69). In line with the findings of this research, in a study, one of the serious weaknesses of the electronic exams was the technical knowledge of faculty members and the resistance in changing and accepting this type of exam (54).

The sub-category of security challenges: One of the most important challenges in the field of new technologies is the challenge of security and privacy. This sub-category is in accordance with the findings of some studies (3-5, 8, 11, 14, 19, 24). The sub-category of complexity and challenges in designing exams considers that if the questions are not designed correctly, it is not possible to accurately evaluate the students. Due to the nature of e-exams, it is difficult to design questions for some fields of study. sub-category corresponds to the results of several studies (11, 17-19, 24, 26). The criticisms include designing standard questions, the compilation of questions for technical-statistical courses, and the capacity of these exams to evaluate and measure the real achievements of students' learning.

The sub-category of complexity and challenges during the exam: Challenges during the implementation of e-exams are significant. Some of these challenges are related to students, and others are linked to technological facilities. The sub-category corresponds to the findings of other studies (2, 4-6, 9, 17, 20, 69). In the sub-category of complexity and challenges after the examination, there are also problems after the exam. The main challenges are related to the feedback from the exam and the evaluation of the student's learning. The sub-category is in accordance with the results of other research (5, 6, 25, 69). The sub-category of the lack of infrastructure corresponds to the findings of other investigations (6, 11, 16, 19, 24). The sub- category of the lack of cultural readiness corresponds to the results of (6, 7, 9, 11, 19, 24, 26, 47, 69). The sub-category of improvement in in teaching and learning process is in the same line with the findings of (3, 4, 10, 12, 19, 24, 26). The sub-category of the effectiveness of student assessment is consistent with the results of (3, 6, 19, 20, 26). For example, nowadays AI technologies, such as Writerly, Google Docs, and Perceptive, are being utilized to provide timely and effective feedback, facilitate peer assessment across various disciplines (70). The sub-category of advantages in designing exams corresponds to the findings of (4, 10-12, 15, 16, 18, 19, 69). The sub-category of advantages during exam implementation corresponds to the results of (4, 6, 9, 11-13, 18, 20). Finally, the sub-category of advantages after exam implementation corresponds to the results of (6, 10-12, 18-20).

Conclusion

Using a content analysis-based comprehensive literature review, this research attempted to reveal the most important challenges and advantages of e-exams from different aspects due to the existing contradictory views. There were some limitations in this study. Only the published articles in the abovementioned databases, in both English and Persian languages, were selected. There might be other studies that have been published in other languages and have not been

considered. In this research, books, dissertations, and research projects that have been published as research libraries, and are known as gray literature, have yet to be addressed. Therefore, the subsequent research is suggested to monitor the current situation of medical universities and the universities by quantifying one of the sub-categories of this study. Finally, policy recommendations for Iran's health higher education system are provided.

§ Using technology acceptance models tailored to the organizational structure of each university to better adapt to the implementation of electronic exams.

§ Holding students' digital skills empowerment workshops to enhance their digital literacy in applying electronic exams.

§ Designing smart security systems to prevent cheating on electronic exams.

§ Developing deterrent laws in the event of cheating on electronic exams and facilitating laws in the implementation of electronic exams in universities.

§ Employing specialists in designing standard electronic exam questions by holding courses for developing the design skills of standard online faculty members.

§ Making changes in university culture to create digital culture as well as reducing academic resistance to adopting new technologies and electronic exams by applying change management processes.

§ Recruiting new specialist human resources in universities with the development of digital skills of current employees through a variety of strategies such as reverse mentoring.

§ Developing a standard guide and principles in the field of designing and implementing electronic exams.

Authors' Contribution

All authors listed have contributed sufficiently to the project to be included as authors. To the best of our knowledge, no conflict of interest, financial or other, exists. All authors have agreed to the submission and that the manuscript is not currently under submission in any other journal.

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Conflict of Interest

The authors declare no conflicts of interest.

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