RESEARCH ARTICLE

BON VIEW PUBLISHING

An Overview of the Adoption of eAssessment Among Moroccan Primary School Teachers: Factors and Challenges

Abdelghani Es-sarghini[1],* and **Abdelaziz Boumahdi[1]**

[1]*Faculty of Educational Sciences, Mohammed V University, Morocco*

Abstract: This study provides a comprehensive investigation of how primary school teachers in the Marrakech-Safi region of Morocco integrate information and communication technologies (ICTs) into their assessment practices. Gathering data through a questionnaire disseminated via email, the research garnered 346 valid responses, indicating a modest implementation of ICTs in assessment processes, with a small fraction of teachers applying them consistently. Interestingly, the findings demonstrate that experienced educators are more inclined to employ ICT in assessments. Despite the prevalent practice of offering eAssessment training to Moroccan primary school teachers as a means to bolster their capabilities in technology-enhanced assessment, such professional development has not been a significant factor in encouraging the use of ICT-based assessment tools among teachers who do not already utilize them. The investigation also delves into the types of eAssessment methods employed, including interactive tests, simulations, and problem-solving activities. The research underscores the necessity for additional exploration and support systems to advance effective ICT adoption in educational assessments. The research has substantial implications for the enhancement of educational assessment practices, informing policy-makers and practitioners about the current state of eAssessment and guiding future efforts to optimize the evaluation of student knowledge in a digital era.

Keywords: eAssessment, educational assessment, formative assessment, summative assessment, ICT

1. Introduction

Assessment is a fundamental aspect of teaching and learning, as it enables the evaluation and improvement of the quality of education and learning [1]. It is often used to determine teaching priorities [2]. It relies on approved criteria to appraise a value, enabling an evaluation of the accuracy of a conduct, procedure, or connection [3], and always has an impact on practice and learning [4]. It influences what and how we learn [5]. The method of assessment used has an impact on the types of tasks that learners can be assigned and the responses that can be collected formats [6].

While oral and written assessments are the traditional formats, the integration of information and communication technologies (ICTs) has introduced a third format (ICT-based assessment) that presents unique opportunities for both teachers and students [7]. The proliferation of ICTs has provided educators with an opening to reexamine the entire issue of assessment and to investigate novel deliverables that foster and encourage learners' ingenuity [8]. Technology-enabled assessment offers pupils an organic setting to engage in intricate tasks and allows for the presentation of tasks that are

challenging to present through traditional paper-and-pencil formats [6].

In Morocco, the inception of the "Genie" program in 2005 marked a significant stride toward the incorporation of ICT in the country's education system, and particularly in elementary schools. This initiative has been instrumental in outfitting schools with multimedia classrooms connected to the internet and establishing network infrastructure, alongside providing digital training for teachers and administrative staff, and curating digital educational content that aligns with the Moroccan school curriculum [9]. The Ministry's commitment to integrating ICT into education extends beyond simply introducing technology into classrooms. Instead, it aims to modernize traditional assessment techniques, aligning them with the realities of the digital age. This initiative seeks to provide primary school students, "who are increasingly likely to have openhanded access to technology" [10], as well as educators, with innovative tools for evaluation and feedback.

Given the above, our research aims: (a) to investigate the implementation of eAssessment within primary schools' classrooms, (b) to identify the factors influencing the integration of ICTs in educational assessments, (c) to unveil the challenges and constraints associated with eAssessment practices among elementary school teachers, and (d) to examine the impact of professional experience, and age, and training on the adoption and readiness to adopt eAssessment practices.

*Corresponding author: Abdelghani Es-sarghini, Faculty of Educational Sciences, Mohammed V University, Morocco. Email: abdelghani_essarghini@um5.ac.ma

To fulfill the aims of our study, we sought to answer a set of research questions that will illuminate various aspects of eAssessment practices in primary schools:

(1) What prevailing practices and frequency of eAssessment usage can be observed in primary schools?
(2) What are the principal factors that contribute to the integration of ICT in educational assessments?
(3) What challenges and constraints are reported by teachers when implementing eAssessment in their teaching practice?
(4) How do individual differences among teachers, such as their professional experience, age, and received training, affect their willingness and ability to adopt eAssessment practices?

2. Literature Review

Assessment is a process that involves using students' responses to determine their knowledge, skills, or emotional state, and it is not solely a measure of performance [11]. The primary purpose of assessment is to improve learning outcomes, and it is often crucial to students' understanding of the goals and results of a course [8]. Two main types of assessment exist: formative and summative assessments, with the former being carried out during a program, and the latter at the end of a program for certification or accountability reasons [12].

Formative assessments and feedback are beneficial for learning, as they enable critical thinking and analysis. Additionally, they serve as valuable analytical instrument to identify and address inaccuracies effectively [13]. Summative assessments, on the other hand, provide a way to gauge individual and inter-group comparative advancement [14]. Classroom assessment is a type of formative assessment that is critical in providing teachers with information for making instructional decisions [15].

The alignment of assessment techniques with learning objectives is critical for changing learning and teaching processes and goals [16]. The incorporation of technological tools in assessment has the potential to enhance learning for both teachers and students, as it offers a range of possibilities, including the use of ICTs in delivering assessments, simulating real-life situations through simulators, providing engineering design and evaluation tools, as well as mind-mapping tools and electronic portfolios (e-portfolios) [17]. Moreover, these tools can be used for continuous monitoring of student progress, making the learning process more personalized.

The integration of ICTs in assessment creates possibilities beyond grading purposes and can become as prognostic instrument for tailoring the learning experience [18]. ICT-based assessment is effective in evaluating challenging-to-assess elusive competencies and procedures through classic appraisals, such as computer simulations of problem situations [11]. Text-to-speech audio instruments can also be helpful for struggling readers [19]. The incorporation of specific features into ICT-based assessments can assist students in gaining a deeper understanding of the assignments and reduce mental burden, especially for underperforming learners [20].

The use of ICTs in assessment enables asynchrony, fostering pondering of significance, and purpose, and methodology of the assessed content [17]. It also provides opportunities for in-depth examination, reasoning, and assimilation of knowledge, thus transcending the informative level of traditional assessment forms [18]. Although the conventional method of assessing and normalizing levels of knowledge continues to prevail, nontraditional approaches using ICT are exploring new evaluation possibilities and interpretations [21].

Although multiple-choice tests are a cost-effective and efficient way of summative assessment, they do not measure higher-order skills, and their design can be challenging [22]. More complex systems, such as adaptive testing, need to be developed that had the capability to adjust to the complexity of the subsequent task in an assessment and provide specific guidance to the learner [23].

Providing feedbacks to pupils, both encouraging and meaningful, is of paramount importance in nurturing and enhancing learning [24–27]. Therefore, test designers should focus on enhancing learning and promoting active learning experience by integrating qualitative feedbacks into assessments made online [28]. While the utilization of basic computer-assisted assessment employing multiple choices and short answers as responses continues to evolve, more complex systems must be developed to ensure that feedback is provided beyond just scores [25, 29].

The development of technology-enabled assessment follows the SAMR-model [30] and has gone through four generations: (a) computerized testing, (b) computerized adaptive testing, (c) continuous measurement, and (d) intelligent measurement. While the first two generations focus on testing efficiency, the third and the fourth generations combine inclusive and tailored assessment environments.

Embedded assessment, based on learning analytics, allows for continuous monitoring and guidance of learners within the learning process. This shift is in line with the pedagogical move from a knowledge-centered approach to a competence-based learning paradigm. Assessment instruments have been enhanced to incorporate a greater number of authentic tasks, and item selection procedures assume a pivotal function in the process of assessment.

The computer-based assessment's transformational approach involves utilizing intricate simulations, regularly sampling student performance, integrating assessment with instruction, and measuring novel skills in more advanced manners. Embedded assessment eliminates the need for traditional tests and, instead, relies on data generated throughout the learning process to offer feedback and guidance Pellegrino [31–34]. In this context, Heuvel-Panhuizen et al. [5] explain that the use of ICTs in assessments provides the ability to closely monitor and record the students' activities using software that allows for audio and screen recordings, as well as the production of log files. This level of detail enables the tracking of the students' actions on the computer screen during problem-solving activities. Consequently, ICTs allow large-scale assessments to focus on more than just the students' answers by providing access to their strategies and thought processes.

3. Methodology

3.1. Research design

The research design for this study is a cross-sectional, descriptive quantitative approach focusing on primary school teachers' use of eAssessment in Morocco's Marrakech Safi region. This design involves the systematic collection of data through a structured questionnaire, which allows for statistical

analysis to identify patterns, frequencies, and correlations related to the implementation of ICT in educational assessments. The design is appropriate for investigating the extent of eAssessment adoption, the factors influencing its use, and the perceived challenges by educators. The quantitative nature of this research provides a broad overview of the current state of eAssessment practices and offers findings that can inform policy and practice.

3.2. Instrument

3.2.1. Instrument design

For the purpose of collecting data that can answer our research questions, the study utilized a questionnaire designed specifically for teachers. The questionnaire was designed by the researchers based on literature review to gather data on the integration and impact of ICT in eAssessment practices in Moroccan primary schools. It surveys teachers regarding their use of ICT tools for student evaluations (question 1), the frequency of such usage (question 2), and their opinion on whether ICT integration is influenced by educational policy directions (question 3). It also asks teachers to detail the variety of technological tools provided by the Ministry of National Education and how these tools facilitate eAssessment (question 4). Furthermore, the questionnaire explores the opportunities provided by ICT, such as facilitating creative learner outputs and complex task management, and the ability to offer continuous monitoring for personalized assessment (question 5). It queries about the specific ICT tools used (question 6), and the types of eAssessment implemented, such as interactive tests and real-life simulations (question 7). The questionnaire also seeks to understand the challenges faced by teachers (question 8), their professional opinions on successful eAssessment (question 9), the reasons for not adopting eAssessment practices (question 10), and their willingness to adopt ICT-enabled assessment in the future (question 11). Lastly, it collects demographic data and teacher training background to analyze the impact of experience, age, and professional development on eAssessment adoption (questions 12, 13, 14, 15, 16, 17, 18, and 19).

3.2.2. Content validation

To ensure content validity, the draft questionnaire was evaluated by five experts consisting of two university teachers and three educational inspectors. Feedback was solicited regarding the relevance and clarity of the questions, as well as the comprehensiveness of the topics covered. Based on the panel's recommendations, revisions were made to refine the wording, sequence, and structure of the questionnaire items.

3.2.3. Pilot testing

Prior to full-scale distribution, a pilot test was conducted with six teachers. This test served to identify any issues with question interpretation, estimate the time required to complete the questionnaire, and assess the overall clarity of the 19 questions. Adjustments were made to the instrument based on the outcomes of the pilot test to enhance it.

3.3. Participants

The sample population consisted of 376 primary school teachers from 8 provincial directorates in the Marrakech-Safi region in Morocco. The participants were selected using the cluster sampling method [35]. In our case, each school is a cluster. Sixteen clusters were selected randomly (Table 1).

Table 1
Distribution of selected schools in the region

Provincial directorate	Selected schools
Rhamna	2
Marrakech	2
Safi	2
Essaouira	2
Kelaat Sraghna	2
Youssoufia	2
Chichaoua	2
Al Haouz	2
Total	**16**

The participants ($n = 376$) (Table 2) were reached via email through the assistance of 14 National Education Inspectors.

Table 2
Demographic characteristics of the sample

Demographic characteristics	Percent	Median
Gender		
Female	48.27%	
Male	51.73%	
Age (in years)		37
Years of teaching experience		12.57
Duration of eAssessment training (in months)		2

3.4. Procedure

The research process was initiated by the electronic distribution of the questionnaire, facilitated by the collaboration with 14 educational inspectors to ensure a wide reach. Teachers were provided with a 1-month window to complete the survey, with regular weekly reminders to enhance the response rate. Upon the conclusion of the collection period, the responses were systematically compiled and the database was rigorously cleaned to ensure the validity of 346 responses for subsequent analysis.

3.5. Ethical considerations

Our research adhered to the ethical standards in line with international guidelines for academic research. We followed protocols, as described by Petousi and Sifaki [36], to ensure responsible research practices that respect the rights of all participants involved.

Informed consent was acquired from all participants prior to their involvement in the study, with assurances given regarding the confidentiality and anonymity of their responses. Data were handled with strict adherence to privacy regulations, and personal identifiers were removed during the analysis phase to maintain participant anonymity.

3.6. Data analysis

Data analysis was conducted in several stages:

Descriptive statistics: We used mean and percent to provide a baseline understanding of the frequency, the main practices of eAssessment, the factors explaining eAssessment adoption, and the barriers impeding ICT-based evaluations ebracement.

Inferential statistics: Chi-square tests were used to examine the relationship between professional experience, and age, and

eAssessment training on the one hand, and the adoption and readiness to adopt eAssessment practices on the other hand.

Software utilization: All statistical analyses were performed using SPSS.

4. Findings

### 4.1. The implementation of eAssessment within primary schools

The current research aimed to inquire the utilization of ICTs among educators for assessing students' learning outcomes. The findings revealed that the majority of respondents (82.37%, $n = 285$) indicated no utilization of ICTs for assessment purposes, while a minority (17.63%, $n = 61$) reported incorporating ICTs in their assessment practices (Figure 1).

Regarding the frequency of ICT usage in assessment, the results indicate that while a small but notable portion of teachers (19.67% of the respondents) reported utilizing ICTs frequently or very frequently for assessment purposes, the majority of teachers (65.57% of the respondents) indicated using ICTs occasionally or sometimes for assessment. In contrast, a minority of teachers (14.75% of the respondents) reported using ICTs rarely (Figure 2).

4.2. The main factors influencing the integration ICTs in educational assessments

The investigation into teachers' reasons for not utilizing ICT in their assessment practices yielded noteworthy results. A considerable proportion of teachers (29.82% of the respondents) indicated the

Figure 1
Rate of eAssessment adoption
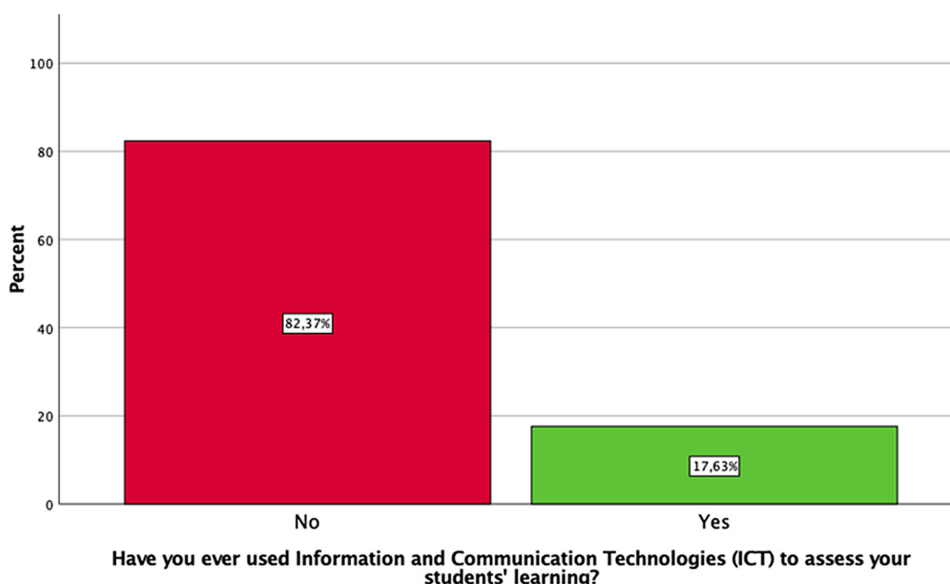
Figure 2
**Frequency of ICT usage in assessment practices**
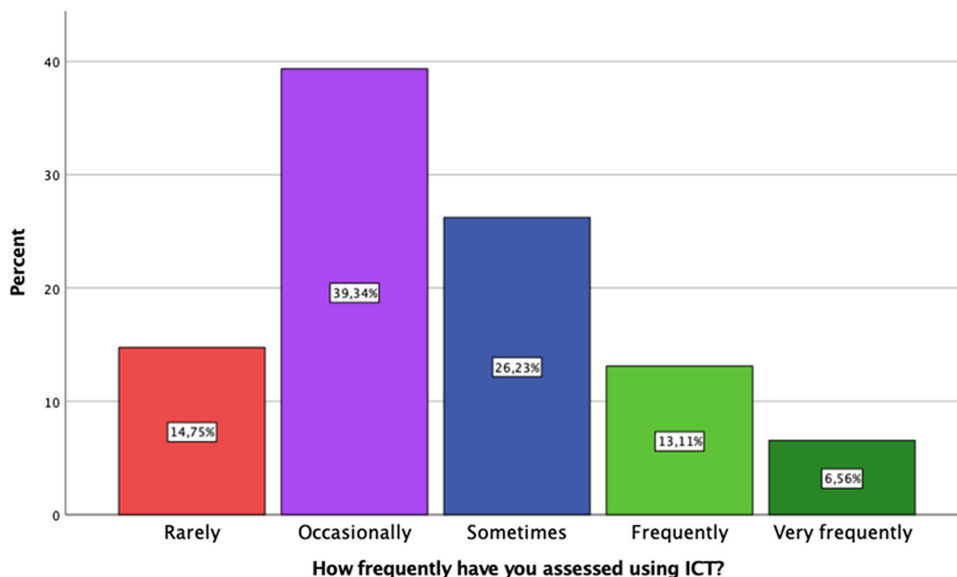
absence of necessary equipment in their classrooms as a primary factor. Additionally, a notable percentage of teachers (28.42% of the respondents) expressed uncertainty regarding the added value that ICT could bring to the assessment process.

Time-related concerns were also prevalent, with 14.74% of the respondents expressing apprehension that integrating ICT would lead to classroom time loss. Furthermore, a subset of educators (12.63% of the respondents) conveyed a lack of comfort in using ICT tools, while a smaller fraction (4.91% of the respondents) believed ICT to be inconsequential for evaluation purposes. Another contributing factor was the limited exposure to eAssessment training, as mentioned by 4.21% of the respondents.

Lastly, 3.57% of the respondents attributed their non-use of ICT to the school's inadequate electrical connectivity, which posed a barrier to incorporating technology into evaluation practices (Figure 3).

When asked about their plans to adopt eAssessment in the future, a significant majority (89.47% of the respondents) of ICT non-users expressed their intention to embrace eAssessment, indicating a strong inclination toward incorporating electronic assessment methods. In contrast, a small percentage (9.47% of the respondents) stated that they do not plan to adopt eAssessment, while a minimal portion (1.05% of the respondents) expressed uncertainty regarding their future adoption (Figure 4).
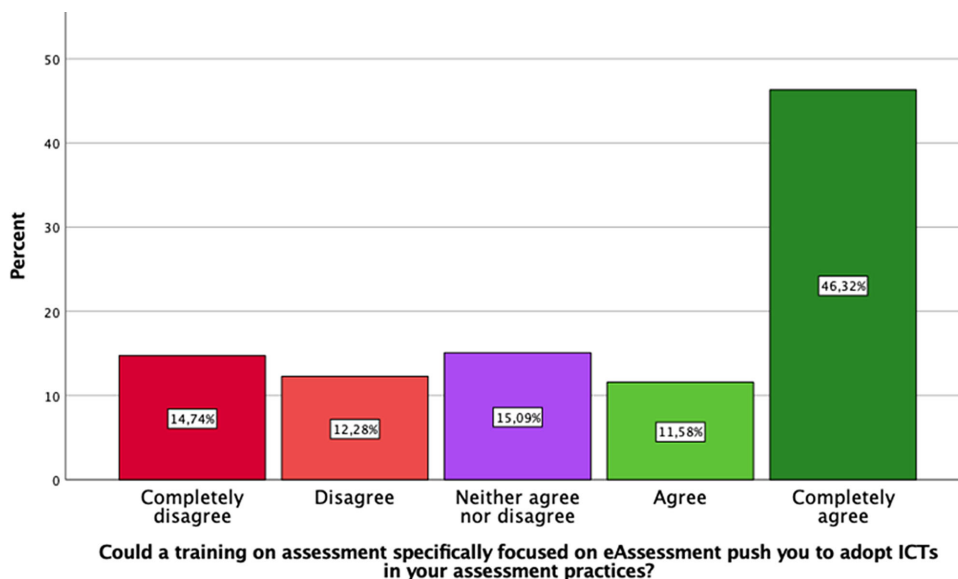
Figure 3
Teachers' reasons for not utilizing ICT in their assessment practices
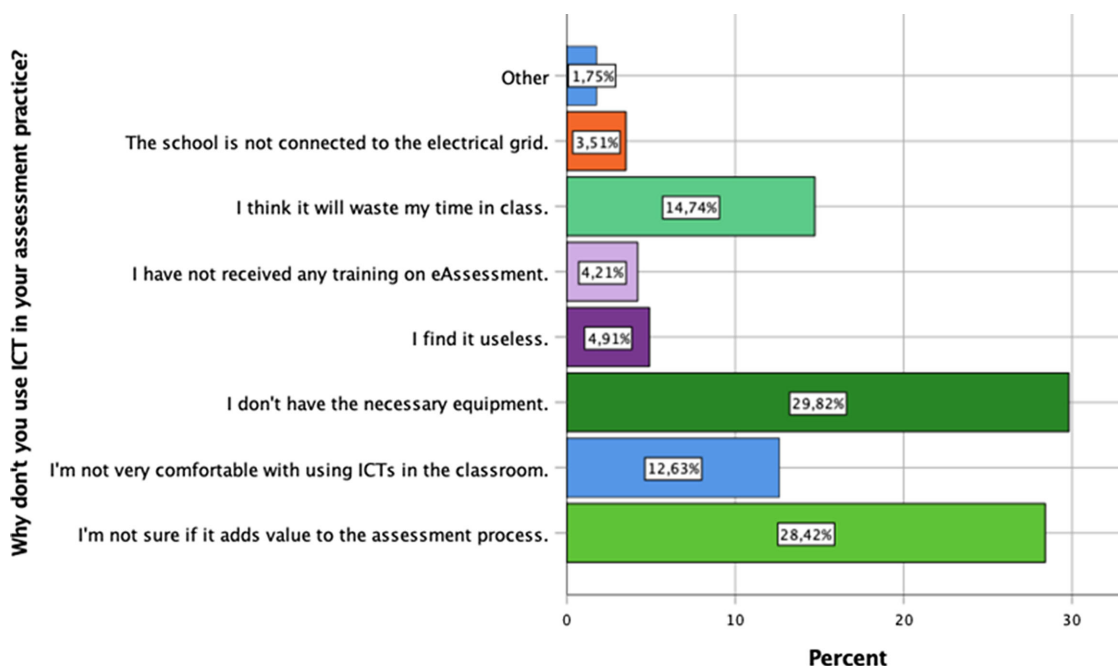
Figure 4
ICTs non-users to embrace eAssessment
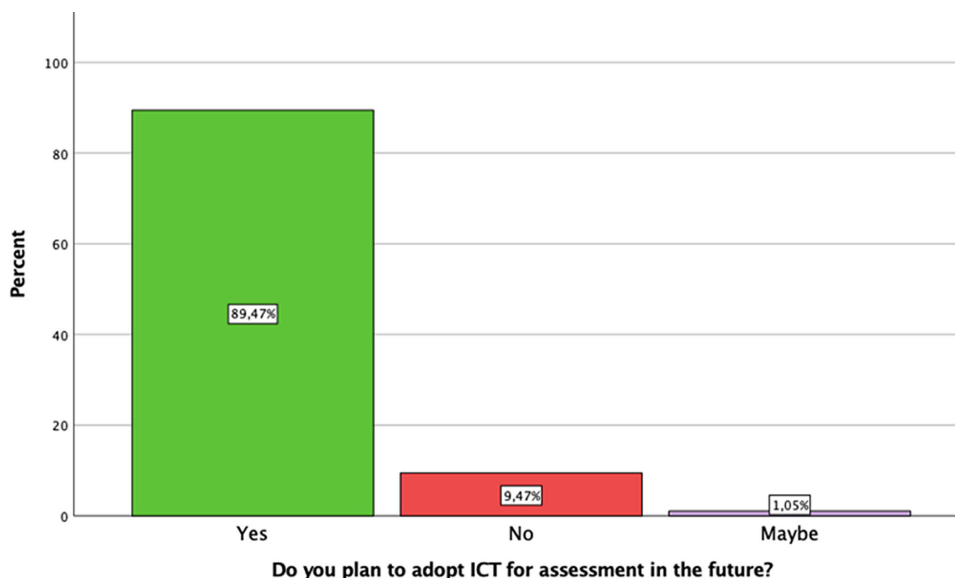
Figure 5
Opinions of teachers about the impact of training on eAssessment embracement

Figure 6
Opinions of teachers about the importance of available technologies in schools for eAssessment

To understand whether training on eAssessment could encourage teachers to adopt this form of evaluation in their assessment practices, their opinions were sought. The majority of teachers surveyed (57.90% of the respondents) agreed or strongly agreed that training can influence their adoption of eAssessment, indicating their willingness to embrace eAssessment through training. On the other hand, a significant proportion of teachers (27.02% of the respondents) disagreed or strongly disagreed with the notion of training influencing their adoption of eAssessment, while a smaller percentage (15.09% of the respondents) expressed a neutral stance (Figure 5).

The survey also shed light on teachers' perspectives regarding the impact of the technological variety provided to schools by the Ministry of National Education on the adoption of eAssessment. Interestingly, a relatively small percentage of the teachers surveyed (21.31% of the respondents) agreed or strongly agreed that the technological variety facilitates the adoption of eAssessment, while a majority of teachers (57.37% of the respondents) disagreed or strongly disagreed with this idea. Additionally, a portion of teachers (21.31% of the respondents) expressed a neutral stance on the matter (Figure 6).

Furthermore, the survey results indicate that a majority of the teachers (62.30% of the respondents) believe that eAssessment is an integral component of the official guidelines provided by the supervising ministry, while a minority (37.70% of the respondents) do not share this belief (Figure 7).
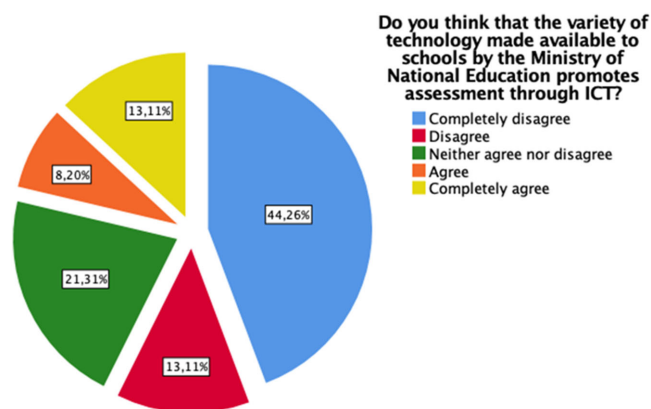
The study investigated factors influencing teachers' preference for eAssessment. Key factors identified include as follows.

4.2.1. Enhanced task presentation

Approximately 11.7% of teachers highlighted the benefits of using ICTs for dynamic and interactive task presentations, engaging students in immersive learning experiences.

Improved task comprehension: About 11.3% of teachers noted that ICTs contribute to better understanding of assessment tasks, alleviating cognitive load, and benefiting students who may struggle with conventional assessments.

4.2.2. Creativity in assessment design

Around 10.5% of teachers emphasized ICTs' potential to explore innovative assessment formats that foster learners' creativity, moving beyond traditional question-and-answer formats.

4.2.3. More effective feedback provision

Similarly, 10.5% of teachers underscored ICTs' ability to track students' actions during problem-solving, enabling the collection of actionable data and providing targeted feedback.

These factors highlight the perceived advantages of incorporating eAssessment methods and can inform the development of strategies to support teaching and learning processes (Table 3).

Figure 7
Teachers' perspectives on the recognition and endorsement of eAssessment as a prevalent practice within the educational system
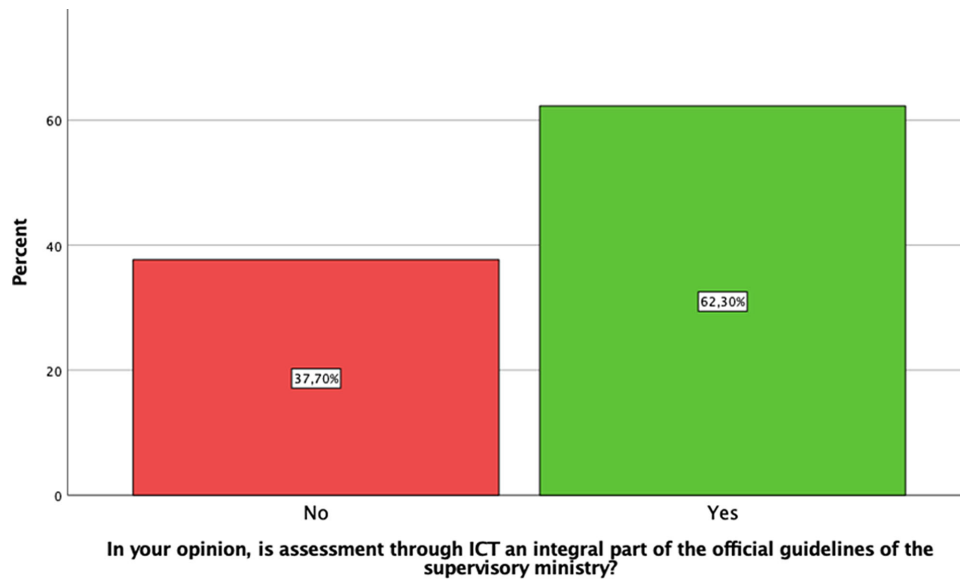

In your opinion, is assessment through ICT an integral part of the official guidelines of the supervisory ministry?

Table 3
Explanatory factors for the adoption of eAssessment

Factors	Responses		Percent of cases
	N	Percent	
ICTs offer the opportunity to reconsider the question of evaluation as a whole and explore new forms of deliverables that foster learners' creativity	28	10.5%	45.9%
ICTs enable the creation of conducive environments for students to work on complex tasks	19	7.1%	31.1%
ICTs facilitate the presentation of tasks that are difficult to present using traditional evaluation formats such as pen and paper	31	11.7%	50.8%
ICTs can be used to continuously monitor students' progress, thereby making the evaluation process more personalized	21	7.9%	34.4%
ICTs can help learners better understand tasks and reduce cognitive load, especially for struggling students	30	11.3%	49.2%
ICTs provide opportunities for critical analysis, argumentation, and reflective appropriation of knowledge, surpassing the informative level of traditional forms of evaluation	18	6.8%	29.5%
ICTs can adjust the complexity of the upcoming task based on the learner's progress in a test	22	8.3%	36.1%
ICTs can automatically generate scores at the end of tests	25	9.4%	41.0%
ICTs can automatically provide targeted feedback to the evaluated individual	21	7.9%	34.4%
ICTs allow the simulation of real-life situations in assessments	23	8.6%	37.7%
ICTs enable the tracking of students' actions on the computer screen during problem-solving activities, thus collecting valuable data for generating better feedback	28	10.5%	45.9%
Total	266	100.0%	436.1%

4.3. Common eAssessment methods utilized in primary schools and the challenges impeding them

The survey results (Table 4) offer valuable insights into how teachers implement eAssessment in their classrooms, using various methods to assess student learning outcomes. The most prevalent approach is administering interactive tests with closed-ended questions, employed by approximately 23.0% of respondents. Another common practice is interactive tests with open-ended questions, adopted by about 12.4% of teachers. Notably, 11.5% of teachers use simulations of real-life situations with closed-ended questions. Additionally, approximately 9.7% employ simulations with open-

ended questions. Providing tests in "digital documents" format is also popular (22.1%). A small percentage (0.9%) uses cards for scanning.

The findings from Table 5 highlight the constraints faced by teachers in adopting ICTs for assessments. A significant portion (32.4%) reported limited access to necessary technological tools, hindering the integration of ICTs. Approximately 25.0% expressed challenges with students' technology proficiency, impacting the implementation of ICT-based assessments. Time management issues were cited by 22.1% of teachers, indicating additional time needed for preparation, implementation, or grading with technology. Some educators (5.9%) felt limited in offering diverse assessment tasks through ICT-based methods. About 8.8% mentioned difficulties with automatic grading of open-ended questions, potentially affecting the grading process. Feedback generated by ICTs

Table 4
Ways eAssessment is being conducted by teachers

eAssessment practices	Responses		Percent of cases
	N	Percent	
By administering interactive tests with closed-ended questions	26	23.0%	42.6%
By administering interactive tests with open-ended questions	14	12.4%	23.0%
By offering simulations of real-life situations with closed-ended questions	13	11.5%	21.3%
By offering simulations of real-life situations with open-ended questions	11	9.7%	18.0%
By presenting problem-solving scenarios	23	20.4%	37.7%
By delivering tests in the form of "digital documents"	25	22.1%	41.0%
By using cards to scan	1	0.9%	1.6%
Total	113	100.0%	185.2%

Table 5
Constraints that hinder teachers from adopting ICTs in their assessment practices

Type of constraints	Responses		Percent of cases
	N	Percent	
Constraints related to the availability of technological tools	44	32.4%	72.1%
Constraints related to students' use of technological tools	34	25.0%	55.7%
Constraints related to time management	30	22.1%	49.2%
Constraints related to the diversity of tasks that can be proposed	8	5.9%	13.1%
Constraints related to automatic grading of open-ended questions	12	8.8%	19.7%
Constraints related to the feedback generated by information and communication technology (ICT)	7	5.1%	11.5%
Constraints related to the large number of students being taught	1	0.7%	1.6%
Total	136	100.0%	223.0%

posed constraints for 5.1% of teachers, possibly not adequately addressing students' learning needs. Notably, only 0.7% identified the large student population as a barrier to adopting ICTs in assessments.

4.4. Impact of professional experience, and age, and training on the adoption and readiness to adopt eAssessment practices

We have analyzed data to explore correlations between some factors related to eAssessment adoption. Specifically, we investigated the relationship between professional experience, and age, and training focused on eAssessment, and the willingness to embrace eAssessment. The data collected from two distinct groups, eAssessment adopters and eAssessment non-adopters, provide valuable insights into potential associations between these variables.

4.4.1. Correlation between professional experience and eAssessment adoption

The data analysis reveals that eAssessment adopters have a median professional experience of 14 years, while eAssessment non-adopters have a median experience of 7 years (Figure 8). This suggests a correlation between higher professional experience and eAssessment adoption. The adopters' group, with a median of 14 years, shows more experienced individuals compared to the non-adopters' group with a median of 7 years. This information is relevant to our research, indicating that greater experience may influence the adoption of eAssessment methods.

4.4.2. Correlation between age and eAssessment adoption

The analysis focused on the variable "age," representing participants' ages. The median age of eAssessment adopters was 39, and for non-adopters, it was 36 (Figure 9). This suggests that, on average, adopters were slightly older than non-adopters. The correlation between age and eAssessment adoption is implied by the difference in median ages, but it does not provide direct evidence of the strength or direction of the correlation. Older individuals may be more inclined to adopt eAssessment practices, but further investigation is needed to confirm this relationship.

4.4.3. Correlation between receiving training focused on eAssessment and the adoption of eAssessment practices

The analysis examined the correlation between "receiving eAssessment training" and "eAssessment adoption." Both variables are categorical, and a Chi-square test yielded a non-significant p-value of 0.163 ($\alpha = 0.05$). This demonstrates that these variables do not significantly correlate with one another based on the data analyzed (Table 6). However, the lack of significance does not rule out the possibility of a relationship; other factors or sample size could have influenced the test's sensitivity.

Table 6
Correlation between eAssessment training and the adoption of eAssessment practices

Chi-square tests					
	Value	df	Asymptotic sig. (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-square	1,942	1	0.163		
Continuity correction	1,370	1	0.242		
Likelihood ratio	1,780	1	0.182		
Fisher's exact test				0.181	0.123
No. of valid cases	346				

4.4.4. Correlation between receiving training focused on eAssessment and the willingness of adopting eAssessment practices

After conducting the analysis, we obtained a Chi-square value of 5.414 and a significance value (p-value) of 0.144, which is greater than the common threshold of significance ($\alpha = 0.05$ or 5%) (Table 7). This means that there is no statistically significant correlation between receiving eAssessment training and planning to adopt eAssessment in the future at the 5% level of significance. However, it is

Table 7
**Correlation between eAssessment training and the planning to adopt eAssessment in the future**

Chi-square tests			
	Value	df	Asymptotic significance (2-sided)
Pearson Chi-square	5,414	3	0.144
Likelihood ratio	8,605	3	0.035
No. of valid cases	346		

important to note that a lack of statistical significance does not necessarily imply the absence of any relationship between the variables. There could still be other factors influencing participants' adoption intentions that were not considered in this analysis.

5. Discussion

Our study shows limited adoption of ICTs in assessment among teachers. This result agrees with Pellegrino et al. [11]. Most teachers (82.37%) do not utilize ICTs for assessment, while a minority (17.63%) incorporate them. Consequently, the adoption of eAssessment in Morocco can be categorized at the "early adopters" stage, according to Rogers' theory of innovation diffusion [37]. The

Figure 8
Comparison between eAssessment adopters' and non-adopters' professional experience
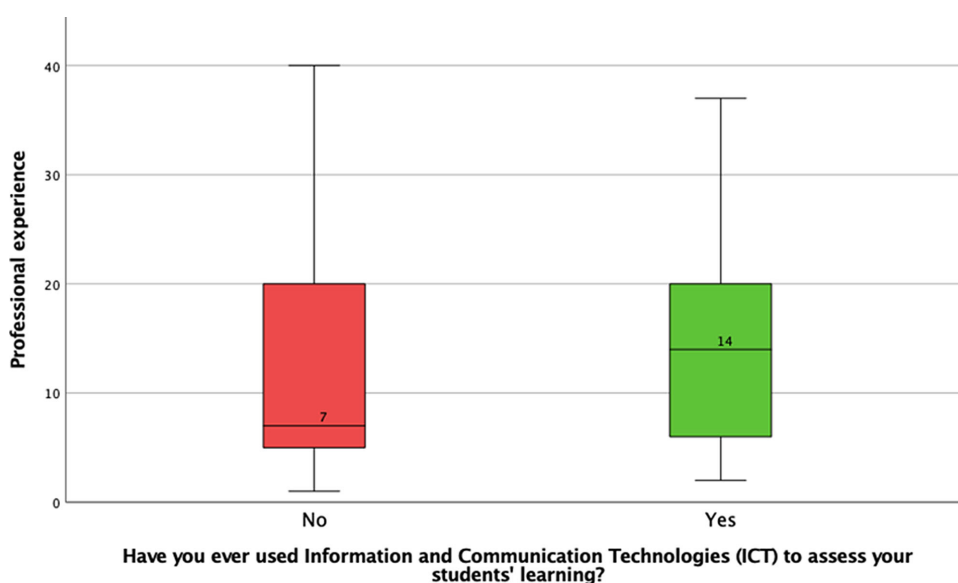
Figure 9
Comparison between eAssessment adopters' and non-adopters' age
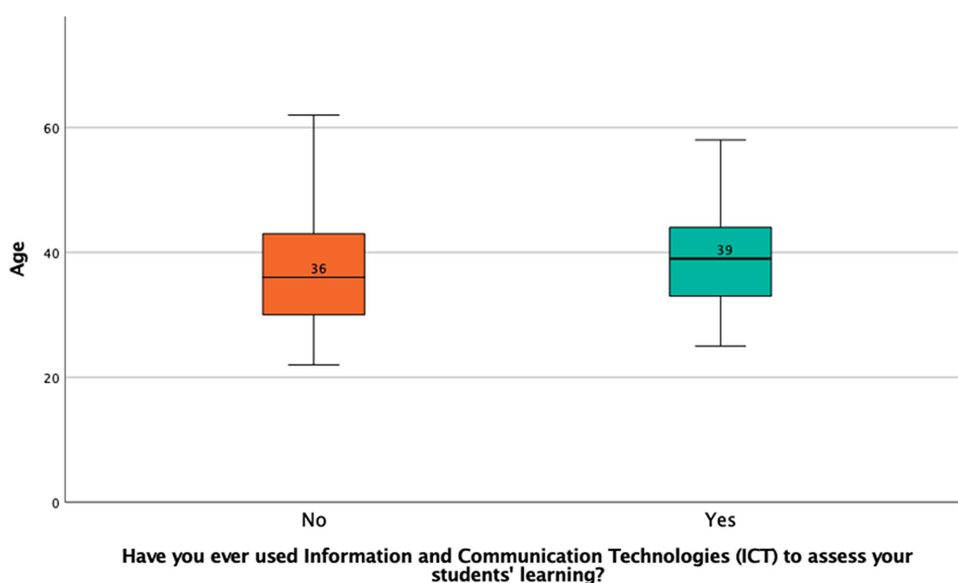
potential benefits of ICT integration in assessment have been highlighted by researchers [8, 17]. However, many teachers have not fully embraced these possibilities, indicating the need for further investigation and support. Some teachers (19.67%) enthusiastically adopted ICTs in assessment, but a significant proportion (65.57%) only use them occasionally. Addressing challenges like resource limitations and uncertainty about ICT benefits is crucial to promote successful ICT integration. A majority of ICT non-users (89.47%) express willingness to embrace eAssessment, aligning with personalized learning trends [34].

The importance of training on eAssessment is evident [28]. While most teachers (57.90%) believe training can influence adoption, some (27.02%) hold a negative view, indicating the need to address concerns and understand neutral perspectives. The relationship between technological variety and eAssessment adoption requires further investigation as shown in agreement with Xiong and Suen [21]. The recognition of eAssessment within the educational system by a majority of teachers (62.30%) aligns with efforts to establish eAssessment as a recognized practice [15]. However, some teachers do not view eAssessment as part of the official guidelines, indicating the need for further awareness and clarification.

In line with Torres-Madroñero et al. [17], this study showcases diverse eAssessment methods, highlighting interactive tests with closed-ended questions as prevalent for assessing fundamental knowledge. The adoption of interactive tests with open-ended questions and problem-solving scenarios promotes critical thinking and practical skill development. Challenges like limited access to technological tools and students' technology proficiency need to be addressed to facilitate ICT integration.

Professional experience correlates with eAssessment adoption, suggesting experienced teachers are more inclined to adopt ICTs (median professional experience: adopters – 14 years, non-adopters – 7 years). The relationship between age and eAssessment adoption is complex, requiring further statistical analyses to understand better.

The potential correlation between receiving eAssessment training and adoption intentions among non-adopters was not statistically significant, warranting exploration of additional variables in future research.

6. Conclusion

Our study sheds light on the state of eAssessment adoption among primary school teachers in Morocco's Marrakech Safi region. While there is an increasing focus on integrating technology into assessment practices, the utilization of ICTs in assessments remains limited among educators. The survey indicates a significant majority of teachers have yet to incorporate ICTs, highlighting the need for further investigation and support to promote successful integration.

The importance of targeted training to address concerns and promote eAssessment benefits is evident. Recognizing eAssessment in official guidelines can encourage its wider adoption, but clarification and awareness efforts are necessary for non-adopters.

Our study showcases a wide array of eAssessment methods employed by teachers to cater to diverse learning styles and assessment needs. The prevalence of interactive tests with closed-ended questions reflects the significance of assessing fundamental knowledge, while interactive tests with open-ended questions and problem-solving scenarios prioritize critical thinking and practical skill development.

Despite challenges, a majority of non-adopters express a willingness to embrace eAssessment in the future, aligning with the trend of personalized learning and continuous monitoring through embedded assessment and learning analytics.

The correlation between professional experience and eAssessment adoption indicates that educators with more experience are more inclined to adopt ICT-based methods, potentially due to their deeper understanding of benefits and familiarity with assessment techniques. The relationship between age and eAssessment adoption is complex, with adopters tending to be slightly older, suggesting experienced professionals' receptiveness to technology integration or younger educators' early embrace of eAssessment.

Although statistically insignificant, the potential correlation between receiving eAssessment training and adoption intentions among non-adopters warrants further investigation, considering additional variables to better comprehend this relationship.

In conclusion, this paper provides valuable insights into the current landscape of eAssessment practices among teachers, emphasizing the need for continued exploration, support, and training to fully harness the potential of ICTs in assessments. Addressing challenges and promoting effective integration will enable educational institutions to create innovative and meaningful assessment experiences, ultimately enhancing student learning and progress.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data is not available.

References

[1] Ferrari, A., Cachia, R., & Punie, Y. (2009). *Innovation and creativity in education and training in the EU member states: Fostering creative learning and supporting innovative teaching.* Retrieved from: https://api.semanticscholar.org/CorpusID:18132342

[2] National Advisory Committee on Creative and Cultural Education (NACCCE). (1999). *All our futures: Creativity, culture and education.* Retrieved from: http://sirkenrobinson.com/pdf/allourfutures.pdf

[3] Richmond, G., del Carmen Salazar, M., & Jones, N. (2019). Assessment and the future of teacher education. *Journal of Teacher Education*, *70*(2), 86–89. https://doi.org/10.1177/0022487118824331

[4] Ellis, S., & Barrs, M. (2008). The assessment of creative learning. In J. Sefton-Green (Ed.), *Creative learning* (pp. 73–89). Creative Partnerships.

[5] van den Heuvel-Panhuizen, M. (2011). Using ICT to improve assessment. In B. Kaur & K. Y. Wong (Eds.), *Assessment in the mathematics classroom* (pp. 165–185). World Scientific. https://doi.org/10.1142/9789814360999_0008

[6] Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children*, *10*(2), 76–101. https://doi.org/10.2307/1602690

[7] van den Heuvel-Panhuizen, M., & Elia, I. (2012). Developing a framework for the evaluation of picturebooks that support

kindergartners' learning of mathematics. *Research in Mathematics Education*, *14*(1), 17–47. https://doi.org/10.1080/14794802.2012.657437

[8] Heap, N. W., Kear, K. L., & Bissell, C. C. (2004). An overview of ICT-based assessment for engineering education. *European Journal of Engineering Education*, *29*(2), 241–250. https://doi.org/10.1080/0304379032000157204

[9] Nejjari, A., & Bakkali, I. (2017). L'usage des TIC à l'école marocaine : état des lieux et perspectives. *Hermès, La Revue*, *78*, 55–61. https://doi.org/10.3917/herm.078.0055

[10] Neumann, M. M., Anthony, J. L., Erazo, N. A., & Neumann, D. L. (2019). Assessment and technology: Mapping future directions in the early childhood classroom. *Frontiers in Education*, *4*, 116. https://doi.org/10.3389/feduc.2019.00116

[11] Pellegrino, J. W., Chudowsky, N., & Glaser, R. (2001). *Knowing what students know: The science and design of educational assessment*. USA: National Academy Press.

[12] Scriven, M. (2017). The failure of higher education to follow the standards it has established in methodology and evaluation. In C. Secolsky & D. B. Denison (Eds.), *Handbook on measurement, assessment, and evaluation in higher education* (pp. 3–10). Routledge. https://doi.org/10.4324/9781315709307-2

[13] Sambell, K., Sambell, A., & Sexton, G. (1999). Student perceptions of the learning benefits of computer-assisted assessment: A case study in electronic engineering. In S. Brown, J. Bull & P. Race (Eds.), *Computer-assisted assessment in higher education* (pp. 179–191). Routledge. https://doi.org/10.4324/9780203062340-23

[14] Ryan, S., Scott, B., Freeman, H., & Patel, D. (2013). *The virtual university: The internet and resource-based learning*. UK: Routledge. https://doi.org/10.4324/9781315042022

[15] Assessment Reform Group. (2002). *Testing, motivation and learning*. Retrieved from: http://assessmentreformgroup.files.wordpress.com/2012/01/tml.pdf

[16] JRC Scientific and Technical Reports. (2010). *Creative learning and innovative teaching: Final report on the study on creativity and innovation in education in the EU member states*. Retrieved from: https://publications.jrc.ec.europa.eu/repository/handle/JRC62370

[17] Torres-Madroñero, E. M., Torres-Madroñero, M. C., & Botero, L. D. R. (2020). Challenges and possibilities of ICT-mediated assessment in virtual teaching and learning processes. *Future Internet*, *12*(12), 232. https://doi.org/10.3390/fi12120232

[18] Spector, J. M., Ifenthaler, D., Sampson, D., Yang, L., Mukama, E., Warusavitarana, A., . . . , & Gibson, D. C. (2016). Technology enhanced formative assessment for 21st century learning. *Journal of Educational Technology & Society*, *19*(3), 58–71.

[19] Elbaum, B., Vaughn, S., Tejero Hughes, M., & Watson Moody, S. (2000). How effective are one-to-one tutoring programs in reading for elementary students at risk for reading failure? A meta-analysis of the intervention research. *Journal of Educational Psychology*, *92*(4), 605–619. https://doi.org/10.1037/0022-0663.92.4.605

[20] Bottge, B. A., Rueda, E., Serlin, R. C., Hung, Y. H., & Kwon, J. M. (2007). Shrinking achievement differences with anchored math problems: Challenges and possibilities. *The Journal of Special Education*, *41*(1), 31–49. https://doi.org/10.1177/00224669070410010301

[21] Xiong, Y., & Suen, H. K. (2018). Assessment approaches in massive open online courses: Possibilities, challenges and future directions. *International Review of Education*, *64*(2), 241–263. https://doi.org/10.1007/s11159-018-9710-5

[22] Bennett, R. E. (2005). Inexorable and inevitable: The continuing story of technology and assessment. In D. Bartram & R. K. Hambleton (Eds.), *Computer-based testing and the internet: Issues and advances* (pp. 201–217). Wiley. https://doi.org/10.1002/9780470712993.ch11

[23] Bennett, R. E. (2002). *Using electronic assessment to measure student performance: Online testing*. Retrieved from: https://www.researchgate.net/publication/234574465

[24] Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. https://doi.org/10.1080/0969595980050102

[25] Ecclestone, K. (2002). *Learning autonomy in post-16 education: The policy and practice of formative assessment*. UK: Routledge. https://doi.org/10.4324/9780203994306

[26] Gipps, C. V. (2005). What is the role for ICT-based assessment in universities? *Studies in Higher Education*, *30*(2), 171–180. https://doi.org/10.1080/03075070500043176

[27] Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin*, *119*(2), 254–284. https://doi.org/10.1037/0033-2909.119.2.254

[28] Buckley, D. P. (2002). In pursuit of the learning paradigm: Coupling faculty transformation and institutional change. *Educause Review*, *37*, 28–39.

[29] Bull, J., & McKenna, C. (2003). *A blueprint for computer-assisted assessment*. UK: Routledge. https://doi.org/10.4324/9780203464687

[30] Puentedura, R. R. (n.d.). *Transformation, technology, and education*. Retrieved from: http://hippasus.com/resources/tte/puentedura_tte.pdf

[31] El-Alfy, E. S. M., & Abdel-Aal, R. E. (2008). Construction and analysis of educational tests using abductive machine learning. *Computers & Education*, *51*(1), 1–16. https://doi.org/10.1016/j.compedu.2007.03.003

[32] European Education and Culture Executive Agency. (2012). *Developing key competences at school in Europe: Challenges and opportunities for policy*. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/47063155-d7f7-4de8-87b0-8103e8b84197/language-en

[33] Pellegrino, J. W. (2010). Technology and formative assessment. In P. Peterson, E. Baker & B. McGaw (Eds.), *International encyclopedia of education* (pp. 42–47). Elsevier. https://doi.org/10.1016/B978-0-08-044894-7.00700-4

[34] Redecker, C., & Johannessen, Ø. (2013). Changing assessment–Towards a new assessment paradigm using ICT. *European Journal of Education*, *48*(1), 79–96. https://doi.org/10.1111/ejed.12018

[35] Kanaki, K., & Kalogiannakis, M. (2023). Sample design challenges: An educational research paradigm. *International Journal of Technology Enhanced Learning*, *15*(3), 266–285. https://doi.org/10.1504/IJTEL.2023.131865

[36] Petousi, V., & Sifaki, E. (2020). Contextualizing harm in the framework of research misconduct. Findings from discourse analysis of scientific publications. *International Journal of Sustainable Development*, *23*(3-4), 149–174, https://doi.org/10.1504/IJSD.2020.10037655

[37] Rogers, E. M. (2003). *Diffusion of innovations*. USA: Free Press.