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Review Article

Technology-mediated self-assessment in higher education: A critical review

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ABSTRACT

This review critically examines empirical evidence from 50 studies over two decades on technology-mediated self-assessment (TMSA) in higher education, providing a comprehensive overview of the tools used, and the benefits and challenges encountered in its application. The findings suggest that TMSA not only retains the benefits of traditional self-assessment, such as enhancing students' academic performance and fostering long-term learning, but also introduces unique advantages. It amplifies student engagement via interactive and multimedia elements, provides flexibility for self-assessment, and assists educators with data-driven insights while easing administrative tasks. However, it also brings challenges, including technical issues like software glitches, connectivity problems, and compatibility issues with various devices or operating systems. The review concludes with recommendations for optimizing TMSA implementation.

Keywords: technology-mediated self-assessment, higher education, self-assessment, education technology

INTRODUCTION

Self-assessment has long been recognized as a powerful tool for enhancing student learning, fostering self-regulation, and improving academic outcomes (Andrade, 2019; Panadero et al., 2016; Yan, 2016, 2022). Its pedagogical value has been well-documented in empirical research dating back to the 1980s (e.g., Boud, 1986, 1989; Boud & Falchikov, 1989), with recent meta-analyses further underscoring its benefits for academic performance (León et al., 2023; Yan et al., 2022), self-regulated learning (SRL) strategies and desirable affective learning outcomes (Panadero et al., 2017). However, as educational practices increasingly shift toward digital environments, the role of technology in self-assessment has become a critical area of exploration (Raposo-Rivas & Cebrian, 2019; Wylie et al., 2020; Yan, 2022).

The integration of digital tools into self-assessment–referred to as technology-mediated self-assessment (TMSA)–has opened new possibilities for personalized, immediate, and accessible learning experiences (Alenezi, 2023; Ifenthaler et al., 2023; Nieminen et al., 2025; Midoro, 2012). Yet, despite its growing adoption, the research on TMSA remains fragmented, with limited synthesis of its benefits, challenges, and implications for teaching and learning (Debuse & Lawley, 2016). This review seeks to address this gap by examining the current state of TMSA research and identifying ways to optimize its effectiveness in educational settings.

Technological Advancements

The integration of digital technologies into self-assessment practices has transformed how students engage with and reflect on their learning. TMSA leverages a variety of digital tools and platforms, ranging from off-the-shelf applications to custom-designed systems tailored to specific educational contexts. Commonly employed technologies include learning management systems (LMS), adaptive learning platforms, and data analytics tools, which facilitate interactive and personalized assessment experiences (Bennet, 2015; Ifenthaler et al., 2023; Smith Budhai, 2021; Suárez-Álvarez et al., 2022). These tools enable features such as instant feedback, automated scoring, and real-time progress tracking, which enhance the efficiency and accessibility of self-assessment (Koutsopoulos, 2020; Yin et al., 2020; Yong & Gaoxia, 2023).

The pandemic accelerated the adoption of digital assessment methods, as educators sought to maintain continuity in teaching and learning during lockdowns (Haipinge et al., 2022; Panadero et al., 2022). This shift highlighted the potential of TMSA to support flexible and remote learning environments. For instance, digital tools allow for asynchronous self-assessment tasks, enabling students to engage with materials at their own pace (Alenezi, 2023; Nieminen et al., 2025). Additionally, advancements in artificial intelligence (AI) and machine learning have enabled more sophisticated TMSA systems, such as those that provide adaptive feedback based on individual student performance (Smith Budhai, 2021; Suárez-Álvarez et al., 2022).

Despite these advancements, the diversity of TMSA tools and their varying levels of sophistication raises questions about their scalability and accessibility across different educational contexts. While some institutions have access to cutting-edge technologies, others may struggle with limited resources or unreliable infrastructure (Gupta et al., 2023; Khlaif et al., 2021).

Pedagogical Implications

TMSA has significant implications for teaching and learning, particularly in fostering SRL and enhancing academic performance. Empirical studies have demonstrated that digital self-assessment tools can strengthen students' self-regulation skills (Andrade & Brown, 2016; Panadero et al., 2017; Van der Kleij & Lipnevich, 2021), foster a sense of academic learning autonomy (Gholami, 2016; Luu, 2023; Thanh, 2020), or increase metacognitive engagement in the study (Ebrahimi et al., 2021; Janah & Hamami, 2022; Siegesmund, 2016). Students who properly performed self-assessment were found to acquire a greater depth of knowledge (Barana et al., 2022; McDonald et al., 2022; Yan & Brown, 2017).

Moreover, TMSA promotes greater alignment between assessment tasks and learning outcomes, as digital tools can be designed to assess a wide range of competencies, including collaboration, critical thinking, and problem-solving (Smith Budhai, 2021; Suárez-Álvarez et al., 2022). This alignment enhances the authenticity of assessments, making them more relevant to students' academic and professional development (Brown & Harris, 2013; Yang et al., 2022; Yin et al., 2020).

For educators, TMSA offers opportunities to streamline the assessment process, reduce administrative burdens, and gain deeper insights into student learning through data analytics (Haelermans, 2017). However, the effectiveness of TMSA depends on its design and implementation. Poorly designed digital assessments may fail to engage students or provide meaningful feedback, undermining their pedagogical value (Yan et al., 2022).

State of the Art

The current state of TMSA research demonstrates its potential to revolutionize self-assessment practices in higher education compared to conventional paper-pencil mode. Well-established findings include the ability of digital tools to provide immediate feedback, enhance accessibility, and support personalized learning experiences (Ifenthaler et al., 2023; Nieminen et al., 2025). Additionally, TMSA has been shown to improve

alignment between assessment tasks and learning outcomes, fostering greater authenticity and relevance in education (Koutsopoulos, 2020; Yin et al., 2020). However, significant gaps remain in our understanding of TMSA's long-term impact on learning and its influence on cognitive processes. Areas requiring further exploration include the ethical implications of data use, the scalability of TMSA across diverse contexts, and the development of best practices for designing and implementing digital self-assessment tools.

In this paper, we will primarily focus on exploring the role of digital technologies in supporting and facilitating self-assessment practices, rather than delving deep into the internal cognitive processes of self-assessment. We were concerned with how digital tools enable learners to observe, reflect on, and regulate their learning, rather than the unique challenges facing the self-assessment process. By addressing the challenges and gaps identified in this review, educators and researchers can optimize the effectiveness of TMSA and ensure its equitable integration into higher education.

Aim and Research Questions

This review aims to systematically synthesize the existing empirical research on using digital methods for student self-assessment in higher education. By adopting a rigorous and comprehensive approach, the review seeks to

(a) identify and categorize the various digital tools and platforms employed for TMSA in higher education contexts,

(b) critically analyze the benefits and advantages that the adoption of digital technologies has brought to student self-assessment,

(c) examine the key challenges and limitations associated with implementing TMSA, as documented in the literature, and

(d) synthesize the recommendations and best practices proposed by researchers and educators for the effective design and integration of TMSA in higher education.

In particular, this review is guided by the following research questions:

1. What are the tools used for TMSA in higher education?
2. What are the benefits that the adoption of digital technologies brings to self-assessment?
3. What are the challenges that the adoption of digital technologies brings to self-assessment?
4. What suggestions have been proposed in the literature for implementing TMSA?

METHODS

Search Strategy

Our literature search focused on education and psychology; we searched three databases (i.e., ERIC, PsycINFO, and Web of Science). We limited our search to the context of higher education between 2000 and 2024 in which the usage and advancement of educational digital technologies have proliferated. In addition, we included extra studies recommended by experts.

An initial search keyword was agreed upon based on the combined knowledge of the project team and advice from consulting experts. The basic search keywords were refined by ensuring that search terms were found in the abstract or title of a paper. The subject term "digital" together with its alternative terms (i.e., *digital OR computerized OR computer OR electronic OR automated OR cyber OR online OR technological OR multimedia OR high-tech OR paperless OR web-based OR mobile*) was paired with self-assessment and alternative terms (i.e., *self-evaluation OR self-monitoring OR self-reflection OR self-rating OR self-grading OR self-review OR self-feedback*) (the full search string used for this study is provided in **Appendix A**).

Selecting Studies For Review

The initial literature search was undertaken in the early part of the review period, with a supplementary search conducted using the same database and subject terms later in the review process to capture any more recent publications on the topic. This approach ensured that the review drew upon the most up-to-date evidence available during manuscript preparation. This process yielded a total of 6,497 publications after

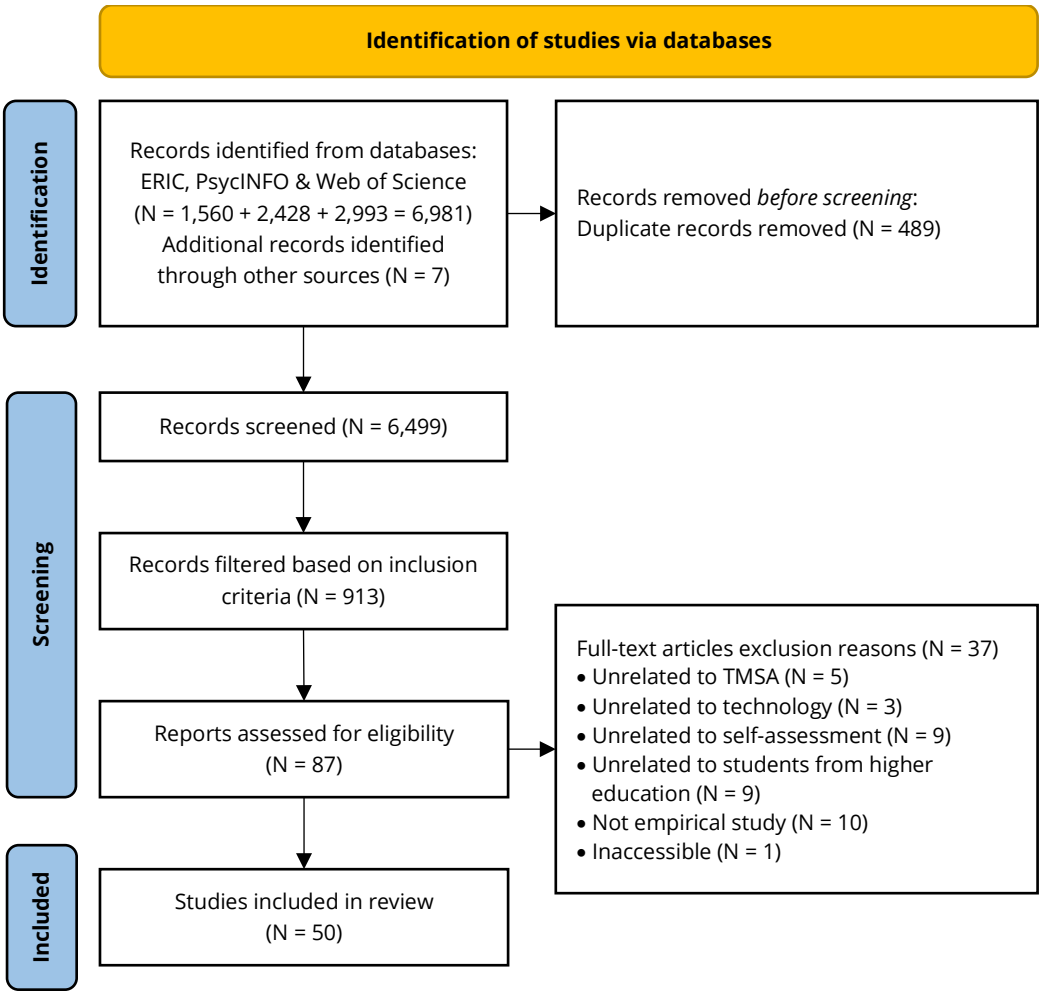

Figure 1. PRISMA flowchart (Page et al., 2021)

removing duplicates. To ensure the selection of high-quality, relevant studies, the screening process was implemented based on six predefined eligibility criteria, that could be classified as technical criteria and content criteria. The technical criteria included:

(1) publication type and date: selected studies were published in peer-reviewed journals between 2000 and 2023,

(2) language: selected studies were written in English, and

(3) full text: selected studies have comprehensive information for a thorough evaluation and analysis of the research findings.

Content criteria included:

(4) study type: selected studies were empirical studies,

(5) research theme: selected studies explored the topic of TMSA, and

(6) participants: selected studies focused on higher education students.

To enhance the reliability of the screen process, 20 randomly selected studies were screened by the first and second authors independently in the first round, achieving an 85% agreement rate. Any disagreements were discussed, and the inclusion criteria were clarified. A second round of screening on another 20 randomly selected studies resulted in a 95% agreement rate.

Based on this rigorous screening process, 913 studies were filtered for failure to meet the inclusion criteria, and 86 studies were retained for full-text review. A total of 50 studies were selected for data extraction, and 37 studies were excluded due to the lack of empirical evidence (N = 10), insufficient alignment with the research questions (N = 26), and the inaccessibility of the full text (N = 1) (**Figure 1**).

Data Extraction

All selected studies were coded with a structured data extraction form developed explicitly for this review. The data extraction form consisted of the study background and study detail section. The study background section includes title, author name, year of publication, country/region, and abstract; the study detail section includes sample size, subject area and topic of study, level or course, research design, technology support, the platform used for self-assessment, the benefits and challenges of technology-enhanced self-assessment and suggestions for future improvement. Using the template, the first and second authors conducted an independent pilot coding of 15 randomly selected studies. The inter-rater reliability was .91 (kappa coefficient). After all disagreements were reviewed, consensus was reached, and the coding template was further refined accordingly.

RESULTS

This section is organized around our research questions. We first describe the characteristics of the included studies (**Table 1**) and then report the results associated with the four research questions.

Table 1. An overview of the included studies

No	Reference	Country/region	Disciplines	Tools used	Methods	Analysis methods
1	Antal and Koncz (2011)	Romania	Computer science in engineering	Video-based self-assessment system "intelligent"	Educator-created	Qn
2	Bakx et al. (2002)	Netherlands	Social work	Multimedia assessment system	Employed	Qn
3	Barry (2012)	Australia	Business	ICT-video recording	Employed	Mixed
4	Bhandary et al. (2015)	Nepal	Medical	Web-based self-assessment system, MSQ&SISAQ	Employed	Qn
5	Bull et al. (2006)	United Kingdom	Electronic, electrical and computer engineering	Open learner models (OLMs)	Educator-created	Qn
6	Cedazo et al. (2015)	Spain	Programming courses in the field of industrial engineering	Online C compiler	Educator-created	Mixed
7	Chang (2007)	Taiwan	English language	Web-based interactive instructional program	Educator-created	Qn
8	Chen (2010)	Taiwan	Teacher-education courses	Web-based mobile assessment participation system (MAPS)	Educator-created	Mixed
9	Cheng and Chau (2009)	Hong Kong	English language	Digital video	Employed	Mixed
10	Cosi et al. (2020)	Spain	Teaching	Socrative application & Moodle questionnaires	Employed	Mixed
11	Ćukušić et al.	Spain	Information technology	Moodle	Employed	Qn
12	Debuse and Lawley (2011)	Australia	Marketing education	Computer-based marking tool, SuperMarkIt	Educator-created	Mixed
13	Di Meo and Martí-Ballester (2020)	Spain	Economics and business-accounting course	Online technology	Employed	Qn
14	Dikici (2009)	Turkey	Art teacher training	Digital portfolio	Employed	Mixed
15	Fagerholm et al. (2023)	Finland	Geoinformatics education	Geoportti self-assessment tool	Educator-created	Mixed
16	Garcia-Beltran and Martinez (2006)	Spain	Engineering Computer programming	AulaWeb system	Educator-created	Mixed
17	Hung (2021)	Vietnam	Natural science/social science	Moodle	Employed	Qn
18	Hung (2009)	Taiwan	English as a foreign language	E-portfolio	Employed	Ql
19	Ibabe and Jauregizar (2010)	Spain	Data analysis course for psychology degree	Hot Potatoes	Employed	Qn

Table 1 (Continued).

No	Reference	Country/region	Disciplines	Tools used	Methods	Analysis methods
20	Khan et al. (2001)	United Kingdom	Clinical course	Web-based formative assessment system	Educator-created	Qn
21	Körkkö et al. (2019)	Finland	Teacher education	Video mobile application-VEO	Employed	Ql
22	Leaf et al. (2009)	USA	Medical education	SOMOMAT	Employed	Qn
23	Lee (2023)	Singapore	Primer course about ethics and reasoning	AI technology-machine learning	Employed	Mixed
24	Liao (2023)	Taiwan	English	Online platform, VoiceThread	Employed	Mixed
25	Lowry (2005)	United Kingdom	Environment science	Computer-aided assessment	Employed	Mixed
26	Martínez et al. (2020)	Spain	Primary and early childhood education	Moodle	Employed	Qn
27	Mason and Williams (2016)	Australia	Emergency health and paramedic practice	ePortfolio	Employed	Ql
28	Mettiäinen (2015)	Finland	Nursing	Electronic assessment and feedback tool–eTaitava,	Employed	Ql
29	Mort and Hansen (2010)	USA	Pharmacy	Digital video recorder	Employed	Qn
30	Nieminen and Tuohilampi (2020)	Finland	Mathematics course	Online assessment with digital feedback	Employed	Ql
31	Nix and Wyllie (2011)	United Kingdom	Social work	Online assessment system-OpenMark	Employed	Mixed
32	Ozarslan and Ozan (2016)	Turkey	Project culture course for all departments	Sakai LMS	Employed	Qn
33	Pando Cerra et al. (2020)	Spain	Engineering	Interactive web-learning tool–DIBUTE	Educator-created	Qn
34	Pillai (2022)	USA	Veterinary nursing curriculum	Video-recording technology	Employed	Mixed
35	Raposo Rivas and Gallego Arrufat (2016)	Spain	Education	Electronic rubric	Employed	Mixed
36	Schmidmaier et al. (2011)	Germany	Construction Management	Electronic flashcards	Employed	Qn
37	Seifert and Feliks (2019)	Israel	Education	Online assessment	Employed	Mixed
38	Shek et al. (2021)	Hong Kong	Education-comprehensive school guidance	Video annotation tool	Employed	Mixed
39	Stanković et al. (2017)	Republic of Serbia	Economics	Moodle platform	Employed	Qn
40	Sung et al. (2003)	Taiwan	Experimental psychology	Web-based self- and peer-assessment system	Employed	Qn
41	Taghizadeh et al. (2014)	Croatia	English language	Web-based assessment tool–DIALANG	Employed	Qn
42	Thompson et al. (2008)	Australia	Business education	Online assessment system 'ReView'	Employed	Mixed
43	Tucker et al. (2019)	USA	Dental hygiene education	E-portfolio	Employed	Mixed
44	Tulgar (2017)	Turkey	English education	selfie@ssessment system	Employed	Ql
45	Utz and Bernacki (2018)	USA	Human anatomy and physiology	Online assessment	Employed	Qn
46	Willey and Gardner (2009)	Australia	Engineering	SPARK plus	Employed	Mixed
47	Witchel et al. (2018)	United Kingdom	Medical	MATLAB	Employed	Mixed
48	Yoo (2016)	USA	Music education	Digital video and web-based technology	Employed	Mixed
49	Yoo et al. (2009)	Korea	Nursing	Video-based self-assessment	Employed	Qn
50	Zheng et al. (2023)	China	English learning	Digital video	Employed	Mixed

Note. The methods of using TMSA were categorized as "educator-created" and "employed". The "educator-created" referred to the technology/digital tools specifically designed by the educators for self-assessment; the "employed" meant the educators directly adopted the existing technology/digital tools developed by the third-party for conducting self-assessment.

Regions and Countries

A review of 50 studies on TMSA highlighted its widespread use, particularly in Western nations. Spain had the highest number of studies (N = 9), followed by the United States (USA) (N = 6), Australia (N = 5), and the United Kingdom (UK) (N = 5). Other European contributions included Turkey (N = 3), Finland (N = 4), and single studies from Romania, Serbia, the Netherlands, Germany, and Croatia. In Asia, Taiwan engaged significantly (N = 5), with additional studies from Hong Kong (N = 2) and one each from Nepal, Vietnam, Singapore, Korea, China, and Israel. This analysis is limited to 50 English-language publications; a broader review may better capture TMSA's global reach.

Disciplines in Higher Education

The application of TMSA covers a range of academic disciplines. A notable emphasis is seen in the medical and health sciences (N = 10), including nursing and pharmacy, where TMSA is used to enhance educational outcomes. Engineering and computer science disciplines also show substantial engagement with TMSA (N = 9), particularly in technical subjects like electrical engineering and computer programming. The field of education (N = 10), including teacher training, uses TMSA to support pedagogical development. Business and economics (N = 4) and English language studies (N = 7) employ TMSA to assist in skill development in themes such as communication and business understanding. In the social sciences (N = 7), social work and psychology use TMSA to explore social dynamics and human behavior. Additionally, TMSA is applied in more specialized fields like geoinformatics and environmental science, demonstrating its utility across diverse academic disciplines.

What Are the Tools Used For Technology-Mediated Self-Assessment in Higher Education?

The studies indicate that educators utilize various digital tools to support TMSA practices, which, while varying by region and discipline, can be categorized into three types. First, LMS, such as Moodle (Hung, 2021; Martínez et al., 2020; Stanković et al., 2017), commonly feature built-in assessment tools like quizzes and tests. Second, standalone self-assessment tools, including the Geoportti self-assessment tool (Fagerholm et al., 2023), eTaitava (Mettiäinen, 2015), and SOMOMAT (Leaf et al., 2009), are specifically designed for online self-assessment, offering diverse question types for evaluating knowledge, skills, or competencies. Third, educational applications with self-assessment functions, like DIBUTE (Pando Cerra et al., 2020) and MAPS (Chen, 2010), provide supplementary content and assessment features, such as flashcards and quizzes, to facilitate self-guided learning.

Among the 50 studies, 40 reported that educators directly employed existing digital tools with necessary modifications, while 10 indicated the creation of bespoke digital self-assessment tools. Popular tools for student self-assessment included video technology (N = 10), Moodle (N = 5), e-Portfolios (N = 4), and various other software (N = 21).

What Are the Benefits That the Adoption of Digital Technologies Brings to Self-Assessment?

The review reveals that while TMSA maintains the benefits of conventional self-assessment, it also introduces unique advantages that are not present in traditional self-assessment methods.

Benefits to Students

Improving students' academic performance

TMSA can enhance students' academic performance when effectively implemented, considering factors such as duration and frequency. Khan et al. (2001) identified the TMSA system as a valuable tool for medical students to recognize their strengths and weaknesses, promote directed study, and facilitate learning. Weekly web-based self-assessment tests improved students' confidence in selecting correct answers, which is crucial for future clinical decisions. The SOMOSAT TMSA system (Leaf et al., 2009) offers self-assessments for each module and comprehensive self-tests in an exam-style setting. Repeated self-testing familiarizes students with exam conditions, leading to improved performance on graded examinations compared to previous years. This approach helps students identify areas for directed study. Bull et al. (2006) noted that the TMSA

system fosters student autonomy, as they must independently engage with the material. Motivated by the direct relationship to forthcoming tests, students participated in online self-assessments to improve their scores. Pando Cerra et al. (2020) explored the use of self-assessment CAD tools in an interactive web environment for engineering drawing, suggesting that this method transforms students from passive learners to active inquirers, increasing study time, particularly before exams, and resulting in high final scores. Cosi et al. (2020) found that many students utilized the "Socrative" app for self-assessment shortly before exams, leading to an average increase of one point out of ten in academic performance and high satisfaction levels among students and educators.

Developing students' long-term learning capacities

TMSA promotes SRL by aiding students in developing study plans and strategies and enhancing (meta)cognitive abilities, critical thinking, and reflection skills. Willey and Gardner (2009) demonstrated that the online tool SPARK (self- and peer assessment resource kit) effectively supports student learning and the development of generic attributes, including reflection, critical evaluation, and feedback skills, thereby improving performance. Tucker et al. (2019) found that e-portfolio self-assessment enables students to close learning gaps and recognize the value of their educational journey as they transition to private practice and lifelong learning. Bhandary et al. (2015) highlighted that a web-based self-assessment system is instrumental in fostering self-directed and lifelong learning habits among medical students in Nepal.

Enhancing desirable affective and motivational outcomes

TMSA also enhances students' affective and motivational outcomes. Mort and Hansen (2010) implemented a video self-assessment process to improve understanding and learning related to group presentations. This approach allowed students to evaluate their group performance critically, build confidence in interpersonal skills, and foster more significant concern and engagement with group members, promoting awareness of their interactions. Barry (2012) developed a protocol involving video recordings of students' group oral presentations, which were subsequently reviewed. Students reported high levels of engagement during this self-assessment process, which heightened their awareness of practical skills and strategies for effective and collaborative group presentations.

Benefits to Educators

Facilitating instruction plans

TMSA facilitates educators' instructional planning by providing accessible information on student achievement. Ćukušić et al. (2014) noted that educators can reflect on their instructional effectiveness and timely adjust teaching plans based on student self-assessment results through TMSA tools. Cedazo et al. (2015) highlighted that the TMSA system enables educators to propose additional exercises to reinforce theoretical concepts. Tucker et al. (2019) observed that students' e-portfolios allow educators to evaluate critical thinking and health promotion skills in dental hygiene education.

Similarly, diagnostic tools like Hot Potatoes (Ibabe & Jauregizar, 2010) offer insights into students' prior knowledge, informing supplementary teaching content. In the Moodle system, educators can access valuable statistics that reveal students' responses to online self-assessments, enabling them to address learning needs effectively (Stanković et al., 2017). Many researchers agree that TMSA provides real-time data, allowing educators to tailor teaching content and track student progress and achievement effectively (Cosi et al., 2012; Khan et al., 2001; Raposo-Rivas & Gallego-Arrufat, 2016; Yoo et al., 2009).

Reduction in workload

Besides, the studies included show that TMSA reduces the workload of educators in different aspects, such as human resources and time requirements, specifically within the context of self-assessment (Debuse & Lawley, 2011). When arranging students' self-assessments, educators can leverage TMSA to enhance the process and streamline certain administrative tasks. One notable advantage of TMSA is its ability to eliminate the need for printing or photocopying self-assessment papers/worksheets and distributing and collecting physical copies. This not only saves valuable resources but also simplifies the logistics of self-assessment administration. Additionally, TMSA tools can automate certain tasks that would otherwise require manual

supervision of student work and individualized feedback provision (Cedazo et al., 2015). This automation helps educators improve efficiency by reducing repetitive work, particularly in large classes (Cedazo et al., 2015). Moreover, TMSA systems can aid in detecting plagiarism, providing educators with an additional means of maintaining academic integrity in self-assessment (Cedazo et al., 2015).

Enhancing educator-student online interaction

TMSA also enhances interaction between educators and students, facilitating more effective online collaboration. Stanković et al. (2017) noted that Moodle promotes student-educator interaction through features like chat, forums, and online discussions. Debuse and Lawley (2011) and Antal and Koncz (2011) emphasized that the TMSA system significantly improves connections between educators and students through personalization. This supports Wei et al. (2015), who argued that interactivity is essential in the learning process among learners, educators, and learning content.

What Are the Challenges That the Adoption of Digital Technologies Brings to Self-Assessment?

While TMSA brings benefits to users, it is also associated with some challenges. The major types of challenges reported in the included studies can be summarized as follows:

Technological issues

Students and educators may lack the technical skills necessary to maximize the benefits of TMSA (Fidan et al., 2020). Poor computing experience and insufficient technical skills among students (Antal & Koncz, 2011; Stanković et al., 2017) hinder their ability to navigate self-assessment tools, leading to frustration and anxiety that can compromise the accuracy of self-assessment results (Lowry, 2005). Additionally, educators' limited technological knowledge can result in time-consuming delays during TMSA implementation, as they may need to invest extra time learning to install and use the system effectively (Debuse & Lawley, 2011).

Hung (2021) further emphasized that valid TMSA results depend on well-prepared tools, which may be susceptible to technical issues such as software glitches, hardware malfunctions, or compatibility problems. Students may face challenges accessing self-assessment tools due to unreliable internet connectivity or digital device errors, potentially hampering the self-assessment process and affecting the accuracy and usefulness of their results.

Academic dishonesty

The possibility of academic dishonesty may appear (Cedazo et al., 2015). Students may be tempted to cheat on their online self-assessments without proper oversight and accountability. They may probably copy and paste answers from online resources without their own thinking, undermining the validity and reliability of the TMSA.

Lack of face-to-face interaction

TMSA may reduce face-to-face interactions between students and educators (Cedazo et al., 2015). As self-assessment shifts online, students may engage less directly with educators, diminishing opportunities for discussion, instant clarification, and emotional support. This reduction in interaction can hinder deep learning, particularly for younger or less experienced students, potentially impacting their ability to improve.

Limited question types and feedback

TMSA often relies on a limited range of question types, making it challenging for educators to assess certain skills, such as critical thinking, problem-solving, and performance-based abilities (Mort & Hansen, 2010; Pillai, 2022; Raposo-Rivas & Gallego-Arrufat, 2016; Schmidmaier et al., 2011; Shek et al., 2021). Additionally, TMSA tools may provide inadequate feedback (Bhandary et al., 2015; Ćukušić et al., 2014). For instance, a multiple-choice quiz may only yield a score and correct answers, lacking detailed feedback on areas needing improvement. This limitation can hinder students' ability to identify focus areas, impacting their progress and growth.

Suggestions For Improving the Implementation of Technology-Mediated Self-Assessment

Given the challenges associated with TMSA, several studies offer suggestions for improving its implementation.

To address educators' insufficient technological capacity, it is essential that they receive adequate professional training on digital assessment tools and complete a mock self-assessment prior to implementation (Debuse & Lawley, 2011). Enhancing user experience can involve providing diverse self-assessment question formats, such as drag-and-drop activities and audio-visual assessments, to increase interactivity (Antal & Koncz, 2011; Stanković et al., 2017). To mitigate plagiarism, technical monitoring mechanisms should be established, such as enabling LAN settings to restrict access to external networks (Cedazo et al., 2015).

For students feeling a reduction in educator interaction due to TMSA, Ibabe and Jauregizar (2010) emphasized the need for educators to consider the teaching/learning climate, including curriculum and assessment methods. Educators should highlight the importance of regular self-assessment, recognize diverse learning needs, and ensure that students engage in meaningful academic activities, fostering a sense of ownership and motivating them to pursue excellence.

DISCUSSION

This review aims to uncover how TMSA is implemented and explore the major benefits and challenges associated with its implementation. Our discussion will follow the research questions.

The Features of Commonly Used Tools for Technology-Mediated Self-Assessment in Higher Education and Their Usage Modes by Educators

Digital technologies tailored to specific needs are increasingly popular in higher education due to their efficiency, accuracy, and effective data management in student assessment (Gartner, 2013). Educators are integrating these tools into self-assessment processes.

TMSA tools, while categorized into three types, share common features that enhance teaching and learning. Key features include automatic scoring and feedback, which allow instant evaluation of quizzes, tests, and assignments, helping students identify areas for improvement and adjust their study habits. Automated performance reports enable educators to track student progress and tailor their teaching strategies. For instance, a C compiler was developed to provide timely feedback in large programming classes (Cedazo et al., 2015). Additionally, platforms like Moodle facilitate effective interaction, allowing quick feedback through forums and messaging, while recording detailed student activities such as study time and assignment completion rates (Hung, 2021). Another significant feature of TMSA tools is adaptive assessment, which adjusts based on students' responses and performance, customizing difficulty level, timing, and question number to meet individual needs. For example, an algorithm in MATLAB can automatically generate multiple-choice questions on topics like ion transport proteins for medical students (Witchel et al., 2018), and machine learning algorithms can score and provide feedback on students' written essays (Lee, 2023).

Most TMSA tools feature attractive interfaces with graphics, animations, and gamification elements to engage students and enhance their self-assessment experience. In engineering studies, interactive web environments and multimedia tools are prevalent (Garcia-Beltran & Martinez, 2006; Pando Cerra et al., 2020). The 24/7 availability of TMSA tools allows students to self-assess anytime and anywhere, significantly improving their learning experience.

Educators utilize TMSA tools in two ways based on course goals and content: directly using existing digital tools with modifications or creating new tools. Using existing tools saves time, is cost-effective, provides a familiar environment (e.g., Moodle or e-Portfolios), and enhances self-assessment capabilities.

Video technology, widely discussed in literature, has proven effective in developing students' soft skills, particularly in pharmacy education, by facilitating self-evaluation of communication and counselling abilities. Moodle and e-Portfolios enable critical self-evaluation of knowledge and skills, fostering self-awareness and reflective learning. Tools like SOMOSAT and Hot Potatoes enhance interactive learning, helping students identify strengths and weaknesses for exam preparation. Additionally, electronic rubrics and flashcards support repetitive self-testing, which is especially beneficial in medical education.

Table 2. Potential benefits of technology-mediated self-assessment

The benefits TMSA brings compared to conventional self-assessment		
To students		
More efficiency and accuracy	*Enhancing equity and inclusion*	*Engaging and flexible assessment*
To educators		
Workload reduction in human resources and time requirements		
To communities		
Place sustainable and environmentally friendly assessment practices		
The enhancements of conventional self-assessment benefits		
Significantly boosting motivation and performance	*Intentionally fostering self-regulation and academic achievement*	*Continuously tracking progress and sustaining motivation*

Educators have employed existing software with necessary modifications tailored to the self-assessment context. This approach saves time and resources while providing a customized assessment experience. For instance, by incorporating accessibility features such as alternative formats, screen reader compatibility, and language support, educators ensure inclusiveness for all students during self-assessment activities. These modifications create equitable assessment opportunities. Such enhancements benefit students and enable educators to achieve a more accurate evaluation of learning and effectively guide instructional decisions. By aligning software modifications with the self-assessment process, educators can optimize the assessment experience and improve the quality of feedback. Some educators aim to create self-assessment tools that better align with course objectives, such as Antal and Koncz's intelligent video-based system and Pando Cerra et al.'s (2020) multimedia integration for a comprehensive learning experience. Additionally, video playback tools integrated with online self-assessment platforms help minimize distractions by preventing students from switching between applications.

The Unique Benefits of TMSA That Brought to the Users

TMSA offers a range of unique benefits for both students and educators. This section discusses the additional advantages TMSA provides compared to conventional non-tech self-assessment and how it enhances the existing benefits of traditional self-assessment through its features (details in **Table 2**).

Efficiency and accuracy of TMSA

TMSA tools like Moodle and video technology offer automated scoring and immediate feedback, significantly saving time and enhancing accuracy compared to manual assessments. This efficiency also addresses administrative challenges of conventional paper-based methods, such as data collection and analysis (Leaf et al., 2009; Willey & Gardner, 2009). Instant feedback allows students to correct misconceptions and address knowledge gaps quickly, accelerating their self-improvement cycle. Additionally, TMSA tools can automatically analyze assessment results to identify trends and anomalies, providing insights for student growth and alerting educators when performance falls short of expectations.

Enhancing equity and inclusion

In addition to supporting learning, TMSA tools facilitate responsive teaching and assessment that adapt to varying learning capabilities and styles. Based on student responses and progress, these tools provide personalized assessments, feedback, and coaching–an approach not achievable through conventional self-assessment. This personalization enhances equity for students studying online. For instance, some digital tools offer accessibility features such as text-to-speech, larger fonts, and customizable color schemes to promote inclusivity in self-assessment.

Engaging and flexible assessment

The attractive interface and gamification features (scoring, levels, progress bars, badges, etc.) of the TMSA tools maintain students' interest in self-assessment and motivation to improve their performance. TMSA tools offer students more flexibility in when and where assessments can be made and students are not bound by time or location like conventional methods.

Sustainability and environmentally friendly assessment practices

None of the included studies have highlighted a crucial benefit of TMSA tools for the broader community: their environmental sustainability. Unlike conventional evaluation methods, TMSA is paperless, allowing assessments and feedback to be conducted without paper (Lawley et al., 2009). This minimizes the resources used for printing and reduces the transportation required for distributing assignments and collecting feedback. This advantage is especially significant for medical students, who encounter numerous cases during their studies. With TMSA, all cases are displayed online, significantly decreasing the amount of paper needed (Mort & Hansen, 2010).

Enhancement of conventional self-assessment benefits

In addition to its unique advantages, TMSA tools enhance the benefits of conventional self-assessment methods (Nikou & Economides, 2016). The integration of technology, particularly video, significantly boosts student engagement, knowledge retention, and critical thinking skills. As noted by Jurāne-Brēmane (2023) and Nurtayeva et al. (2024), TMSA tools foster self-awareness, efficacy, and the ability to identify areas for improvement, which, in turn, may benefit the development of students' self-assessment literacy (Guo et al., 2021). Digital technology allows for a more comprehensive and timely scaffolding effect, increasing student engagement and enthusiasm for learning. Research shows that students are more engaged in self-assessments with video support than traditional methods, enhancing knowledge retention and critical thinking through visual techniques. Additionally, using video in self-assessment promotes self-awareness and self-evaluation of behaviors, improving students' self-efficacy through repeated viewing.

Video-based self-assessment tools enable students to identify problems, deepen their understanding of the subject, and recognize areas for improvement in body language, speech, and voice. This approach fosters a balanced view of strengths and weaknesses, promoting proper behavioral awareness. Reviewing video recordings allows students to detect errors that may have been overlooked, enhancing their communication and practice skills as well as their confidence in interpersonal interactions (Mort & Hansen, 2010).

Furthermore, video reviews not only improve students' skills but also enhance their self-assessment abilities in subsequent reviews. Requiring students to provide evidence for their evaluations–supported by video–makes their self-assessments more persuasive. Given the low cost of video implementation with available computers and network devices, it holds significant practical utility in nursing and psychology education (Yoo et al., 2009).

Motivation and performance boost through TMSA

TMSA significantly boosts students' learning motivation compared to conventional self-assessment methods. The integration of digital technology in higher education is particularly beneficial for self-regulated learners who control the intensity and duration of their learning (Stanković et al., 2017; Yot-Domínguez & Marcelo, 2017). Notably, many students who accessed all tests began using the computer-aided self-assessment system within the first two weeks of the semester. Repeatable TMSAs encourage students to develop self-testing habits earlier than conventional methods, resulting in higher grades on end-of-semester examinations. This suggests that students are enthusiastic about engaging with TMSA. Furthermore, the simulation of test conditions provided by TMSA tools helps students familiarize themselves with assessment formats and timing, thereby reducing anxiety associated with assessments (Hortigüela-Alcalá et al., 2015; Panadero & Romero, 2014).

Fostering self-regulation and academic achievement with TMSA

TMSA also facilitates students' self-regulation skills development in that online tools encourage users to take charge of their learning and progress, leading to better academic achievement. The experiential research conducted by Gámiz-Sánchez et al. (2019) on general accounting courses showed that TMSA and final grades are positively correlated. The TMSA helps students gain control over their learning by setting their own pace and comfortable testing areas while having enough time for reflection, reinforcing students' ability to manage their learning process and their autonomy to continue learning (López et al., 2015).

Tracking progress and sustaining motivation through TMSA

TMSA tools enable students to monitor their self-assessed progress over time, helping to maintain motivation and keep them on track toward their goals. Unlike conventional methods that provide only individual snapshots of performance, technology allows for collecting, storing, and analyzing self-assessment data over extended periods, revealing trends and patterns. This comprehensive view of their development helps students stay engaged in their learning journey, as they can observe incremental improvements and measure progress toward their goals (Mendoza et al., 2023).

Challenges Associated with Implementing TMSA and Suggestions for Improving Its Implementation

Digital technology is not without its difficulties, notably in implementing and using self-assessment. The included studies have identified challenges for students, educators, and software. Apart from these challenges, we supplement the extra challenges different TMSA stakeholders encounter. For each challenge, we present potential solutions mentioned in the included studies and those from the authors' reflections. **Table 3** offers a summary of the challenges and possible solutions.

Challenges presented in the included studies, along with potential solutions

Given students' inadequate digital literacy skills, the included studies did not propose specific interventions. Therefore, we strongly recommend that educators provide comprehensive instruction on relevant knowledge. Educational institutions should implement digital literacy programs, conduct technology orientation sessions, and organize technical skills workshops to enhance students' computer experience and prepare them for success in a digital environment.

For students lacking experience in TMSA, researchers suggest using diverse self-assessment question formats (e.g., drag-and-drop, audio-visual, image-based activities) to make the process more interactive. This approach can increase student engagement and motivation, encouraging more frequent self-assessment. Educators should also clearly explain digital technology and its application in self-assessment to help students navigate TMSA effectively. As technology is only effective when used properly (Haleem et al., 2022), regularly collecting student feedback on online self-assessment activities can help educators enhance the effectiveness of subsequent use and improve the TMSA experience. Methods for gathering feedback may include online polls, weekly surveys, and active participation in discussion boards.

To address academic misconduct that undermines the validity and reliability of TMSA, researchers propose using LAN settings to prevent cheating and plagiarism. This approach can enhance the validity and reliability of assessment results. Additional measures include educators supervising the TMSA process and incorporating plagiarism detection features in the software to identify cut-and-paste responses, thereby discouraging the use of online resources during self-assessments. Furthermore, integrating proctoring services with the TMSA system can improve the credibility of assessments (Johnson et al., 2016). In the absence of face-to-face interaction with educators, the included studies highlight the importance of the teaching/learning climate on student outcomes. We recommend that educators emphasize the significance of frequent and timely self-assessment, accommodating diverse learning needs and preferences to ensure students feel supported throughout the learning process.

Educators encounter challenges related to inadequate technological knowledge and the time-consuming nature of TMSA, which hinders its effective implementation. Some higher education institutions are reluctant to adopt TMSA systems due to a lack of training in digital literacy among educators (Bulatović et al., 2013). To address these gaps and enhance educators' technological competency (Gregory & Lodge, 2015), we recommend that countries develop ICT competency standards to assist in integrating digital technology into curricula and assessments. Additionally, systematically designing instructional materials for TMSA can help educators select suitable self-assessment platforms, enhancing the student experience. Regarding the significant time commitment required for managing TMSA, we suggest that educators participate in mock self-assessments to familiarize themselves with the system. Financial support, such as workload allocations or extra training allowances, can also incentivize educators to implement TMSA modules, especially in extensive courses that demand personalized feedback. Transitioning funding models from student contact hours to student learning outcomes may also be an effective strategy.

Table 3. Challenges posed by TMSA and suggestions for addressing them

Challenges presented in the included studies along with potential solutions		
Challenges	Improvement suggestions from the included studies	Improvement suggestions supplemented by authors
Students		
Poor computing experience and lack of necessary technical skills		*Educators and institutions should provide comprehensive instruction about relevant knowledge.*
Insufficient experience with TMSA	A variety of self-assessment question modes (e.g., drag-and-drop activities, audio-visual assessments, image-based activities, etc.) could be available to make the self-assessment more interactive (Antal & Koncz, 2011; Stanković et al., 2017).	*Educators should explain the TMSA process in detail. A regular collection of student feedback on online self-assessment activities.*
Academic dishonesty	Some technical monitoring mechanism should be in place (Cedazo et al., 2015)	*Educators should supervise students when they are doing TMSA. TMSA software developers can incorporate plagiarism prevention features into the system.*
Lack of face-to-face interaction with educators	Educators should pay attention to the impact of teaching/learning climate (Ibabe & Jauregizar, 2010).	*Educators could emphasise the importance of frequent and timely self-assessment throughout the learning process; recognise and accommodate students' diverse learning needs and preferences.*
Educators		
Insufficient knowledge of technology	Offer adequate professional training on the effective use of assessment technologies (Debuse & Lawley, 2011).	*Refine the ICT competency standards of educators by integrating digital technology skills. Systematically designing and delivering instructional materials.*
Time-consuming dealing with TMSA	Complete a mock self-assessment to familiarise the system (Debuse & Lawley, 2011).	*Financial support is a great way to motivate educators, e.g., financial support and extra training allowance.*
Software		
Technical issues: software glitches, hardware malfunctions, or compatibility problems		*Schools should strengthen the configuration of their network facilities.*
Limited question types and feedback		*Leverage technology for multimedia assessments: Take advantage of technology tools to create multimedia assessments where students can showcase their skills and knowledge through videos, audio recordings, interactive presentations, or online simulations. This allows for more engaging and authentic assessments that can capture a wider range of skills.*

Other associated challenges generated from reviewed studies by the authors and suggested solutions for improvement	
Challenges	Suggestions
Students have limited access to personal devices or the TMSA platform	*Ensuring adequate resources*: *Institutes are responsible for equipping students with the necessary software and hardware resources.*
Students' excessive screen time on TMSA	*Promoting balanced screen time: Schools and educators should remind students to refrain from excessive use of electronic devices.*
Slow set-up and installation difficulty of TMSA	*Improving system usability*: *Streamline the set-up process of TMSA systems*
Data privacy and cybersecurity	*Enhancing data security*: *Schools need enterprise-class security measures and hardware-enabled security to help protect their students, faculty, and data from cyberattacks.*
Limited range of assessment methods of the TMSA system	*Advancing assessment techniques*: *Software developers could combine machine learning technology into the TMSA system to reproduce further questions and assessment methods.*

To address technical issues like software glitches and unstable internet access, educational institutions should enhance their network infrastructure to create a reliable environment for self-assessment activities.

Additionally, to overcome the limitations in question types and feedback within the TMSA system, we recommend that software developers utilize technology to create multimedia assessments. This would allow students to demonstrate their skills and knowledge through videos, audio recordings, interactive presentations, or online simulations.

Challenges presented by the author, along with potential solutions

Apart from the challenges cited in the literature, we posit that several other noteworthy challenges should not be overlooked.

TMSA challenges faced by students with potential solutions

Economic constraints and socioeconomic disparities may restrict some students' access to personal devices, limiting their ability to engage in meaningful self-assessment activities and participate in TMSA. Additionally, unfamiliarity with technology-based instruction and insufficient internet experience can lead to stress and anxiety during online self-assessments. To address this issue, we recommend that institutions provide students with necessary software and hardware resources under certain conditions.

Conversely, excessive use of technology, including prolonged screen time, can negatively impact students' health, leading to short-sightedness and insufficient outdoor exercise (Canadian Paediatric Society, Digital Health Task Force, Ottawa, Ontario, 2019). We suggest that schools and educators remind students to limit their electronic device usage to mitigate these adverse health effects.

The challenges specific to the TMSA system itself and suggestions for its improvement

While TMSA significantly enhances the teaching and learning process, it faces challenges regarding actual usage. Issues such as slow setup (Stevens & Jamieson, 2002) and difficult installation (Debuse et al., 2008) lead to low university adoption rates. Some institutions in countries like Serbia and Tanzania have yet to implement TMSA due to a lack of operational knowledge (Bulatović et al., 2013; Ndibalema, 2021). Streamlining the setup process by improving installation instructions, providing clear documentation, and offering technical support can enhance efficiency and user-friendliness, thereby reducing barriers to adoption.

Additionally, data privacy and cybersecurity are critical concerns for TMSA. The extensive collection of student data raises questions about privacy, which can negatively impact student motivation to engage in self-assessments. To safeguard against data breaches, educational institutions must implement robust security measures and hardware-enabled protection against cyberattacks. Designing the TMSA system focusing on student privacy and security is essential.

Researchers have indicated flaws in the TMSA system, including limited question types and feedback. To address these weaknesses, we suggest that software developers incorporate machine learning technology to diversify question formats and assessment methods. This approach would enable accurate predictions of future results and tailor instruction to meet individual student needs.

CONCLUSIONS

This study highlights the significant role of TMSA in enhancing higher education assessment. TMSA tools like Moodle offer automated scoring and personalized feedback, leading to more engaging learning experiences, improved student outcomes, and reduced educator workloads. However, effective implementation of TMSA requires addressing challenges related to digital literacy and technical support for both students and educators.

Future research should explore the long-term impact of TMSA on learning outcomes and investigate the integration of advanced technologies, such as AI, to further enhance personalized assessment (Lim et al., 2024). First, there is a need to explore the design and implementation of AI-enhanced self-assessment tools that can adapt to individual learner needs and provide real-time, personalized feedback, thereby fostering more effective and tailored learning experiences (Ali et al., 2023; Anggoro & Pratiwi, 2023; Chang et al., 2023). Second, researchers are encouraged to conduct empirical impact studies to assess the effectiveness of AI in

improving self-assessment outcomes, including student engagement, accuracy in self-evaluation, and the development of metacognitive skills (Hapsari et al., 2023; Khojasteh et al., 2025). Finally, it is essential to address the ethical implications of AI in assessment, emphasizing the importance of transparency, fairness, and data privacy to ensure responsible and equitable use of these technologies (Stahl & Karger, 2016).

By focusing on these areas, future research can bridge the gap between technological innovation and educational assessment, paving the way for AI-driven tools that enhance self-assessment practices and foster deeper learning experiences.

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APPENDIX A

Full search string of the paper through the databases of ERIC, PsycINFO, and Web of Science: ("self-assessment" or "self-evaluation" or "self-monitoring" or "self-reflection" or "self-rating" or "self-grading" or "self-review" or "self-feedback") and ("digital" or "computerized" or "computer" or "electronic" or "automated" or "cyber" or "online" or "technological" or "multimedia" or "high-tech" or "paperless" or "web-based" or "mobile") in title OR ("self-assessment" or "self-evaluation" or "self-monitoring" or "self-reflection" or "self-rating" or "self-grading" or "self-review" or "self-feedback") and ("digital" or "computerized" or "computer" or "electronic" or "automated" or "cyber" or "online" or "technological" or "multimedia" or "high-tech" or "paperless" or "web-based" or "mobile") in abstract.