

## Effectiveness of E-Assessment in Science Learning: Improving the Quality and Efficiency of Assessment in the Digital Era

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### ABSTRACT

**Purpose of the study:** The aim of this research is to provide an overview of how effective the use of e-assessment is in science learning.

**Methodology:** This research is qualitative research with a literature review research method. The data in this research is secondary data where data is obtained from search results for documents related to the research topic. The sample from this research in the form of articles was selected based on several criteria, including publications in journals ranging from 2017-2022. After articles that match the topic and the basis of the data are collected, the researcher then carries out a review using several criteria explained in the descriptive statistics table.

**Main Findings:** Based on the results of a review of several relevant articles, it was found that the use of e-assessment will greatly simplify the assessment process and is useful for quickly providing results for science assessment. So the application of e-assessment for assessing student science is very necessary to be implemented in schools.

**Novelty/Originality of this study:** The novelty lies in its focus on the comprehensive application of e-assessment in evaluating cognitive, affective, and psychomotor aspects of science learning. The results of this research can be a basis for policy makers in developing and implementing e-assessment systems in schools. With evidence that e-assessment can speed up the assessment process and improve learning outcomes, policies that support the digitalization of assessments will be more easily accepted.

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## 1. INTRODUCTION

Natural Sciences (Science) is one of the important subjects in learning. The aim of providing science subjects is for students to understand or master science concepts and their interrelationships, and to be able to use scientific models to solve the problems they face [1], [2]. Science subjects are important because they contain material related to finding out about nature systematically [3], [4]. So that science is not only mastery of a collection of knowledge in the form of facts, concepts or principles but also a process of discovery [5], [6]. With this, teachers need to evaluate students through assessments.

The learning process certainly cannot be separated from assessment. Assessment is the process of collecting data or information used to measure the achievement of a goal [7], [8]. This achievement is seen from the extent to which students have learned the goals set for them. Assessment is an assessment or assessment

carried out by educators or teachers by observing students' activities in carrying out a task. Assessment is a systematic process that involves collecting information, analyzing and interpreting that information to make decisions [9], [10]. Assessment is an integral part of the entire teaching and learning process [11]-[13]. Assessment must be seen as one of the factors that determines the success of the learning process and outcomes, not just as a way to assess student success [14], [15]. For this reason, it will be easier for teachers to develop assessments using E-Assessment.

Currently, teachers are in an era of rapid digitalization, where all educational activities cannot be separated from the use of digital technology. Assessment is an important factor in implementing the learning process, the assessment system must be digital to be able to create an accurate assessment system and save time compared to using a conventional assessment system [16]. In the education sector, the use of e-assessment digitalization technology aims to improve the quality of education [17]. This leads to assessment activities, namely e-assessment. E-assessment is information technology which refers to the electronic assessment process where technology is a means of learning and assessment activities [18]. With e-assessment, it will make the teacher's work easier in carrying out assessments.

Assessment of science learning processes and outcomes requires more comprehensive assessment techniques and methods. In addition to the aspects of learning outcomes assessed that must be comprehensive, namely cognitive, affective and psychomotor aspects, assessment techniques and assessment instruments are more varied. E-assessment in science functions as a tool for planning, guiding and enriching science learning in the classroom, a tool for monitoring science learning outcomes and improving learning [16]. E-Assessments are used to determine what knowledge and understanding a student brings to entering a particular topic [18]. The most important thing in E-Assessment is that teachers must be clear about what they want to do in science learning and know what qualities they expect their students to have [5]. Thus, assessment results appear to have a very broad function, not merely measuring student success in learning.

The research that has been carried out previously is related to the research that the researcher conducted. Previous research has conducted studies in the form of e-assessment-based assessments to assess how students' science learning processes occur at school. Research conducted Mudanta et al., [10] conducting an assessment of student learning motivation in the science learning process. Next, research is carried out Nugroho & Airlanda [11] developed an instrument for assessing students' critical thinking skills in science learning at school. Continue research conducted by Trimawati et al., [12] carried out an integrated science assessment process using the project-based learning (PJBL) learning model. The existence of an E-Assessment based assessment system will certainly help teachers in assessing the science learning process in schools.

Sejalan dengan penelitian terdahulu yang meneliti terkait penilaian elektronik yang merupakan teknologi modern yang mencakup segala bentuk penilaian, termasuk penilaian berbasis pendekatan kolaboratif, penilaian interaktif, portofolio, dan proyek kelompok [22]. Kemudian penelitian terdahulu menemukan bahwa respon siswa pada saat menggunakan penilaian e-interest mendapat respon yang baik dilihat dari sikap siswa yang senang, bersemangat dan mempunyai rasa ingin tahu yang tinggi terhadap E-Assessment ini. Dapat disimpulkan bahwa pengkajian e-interest perlu dikembangkan secara besar-besaran [23]. The rapid digitalization in education necessitates the integration of digital technologies in all aspects of the learning process, including assessment. Traditional assessment methods are becoming increasingly inadequate in addressing the needs of modern educational environments, especially in subjects like science, which require comprehensive and dynamic assessment techniques.

This research explores the relatively under-explored area of e-assessment specifically within the context of science education. While previous studies have touched on various aspects of e-assessment, this research aims to provide a more holistic understanding of its impact on assessing science learning outcomes. The novelty lies in its focus on the comprehensive application of e-assessment in evaluating cognitive, affective, and psychomotor aspects of science learning. Furthermore, it builds on previous studies by examining not just the implementation of e-assessment but also its effectiveness and potential for enhancing the overall quality of science education. The findings from this research have significant implications for educators, policymakers, and educational technology developers [24]. For educators, it provides insights into how e-assessment can be integrated into their teaching practices to improve the accuracy and efficiency of assessments. For policymakers, the research offers evidence to support the adoption of digital assessment tools in educational curricula. For developers of educational technology, the study highlights the features and functionalities that are most beneficial in e-assessment tools, guiding future innovations.

Ultimately, the research aims to contribute to the improvement of science education by demonstrating the effectiveness of e-assessment in fostering a more comprehensive and engaging learning experience. As education systems evolve, there is an urgent need to adopt e-assessment to ensure that assessments are accurate, efficient, and reflective of students' understanding and skills in science. This urgency is underscored by the increasing reliance on technology in classrooms and the demand for more effective and streamlined assessment processes. So the aim of this research is to provide an overview of how effective the use of e-assessment is in science learning.

## 2. RESEARCH METHOD

This research is qualitative research with a literature review research method. Literature review is library research and research by examining and reading various journals, books and various published manuscripts that are related to the research topic to produce writing that has a strong theoretical basis related to a particular topic or issue [25]. This research is qualitative in nature, employing a literature review methodology. A literature review involves a comprehensive examination and synthesis of existing research and publications relevant to a specific topic or issue [26]. This approach allows for a thorough understanding of the theoretical foundations and existing knowledge on e-assessment in science education.

The population for this research includes all articles related to the research topic available on Google Scholar. The sample consists of articles selected based on specific criteria:

1. Publication Date: Articles published between 2017 and 2022.
2. Accreditation: Articles published in journals accredited by Sinta
3. Relevance: Articles must be directly related to the use of e-assessment in science education.

From the search results, eight articles that met these criteria were chosen for analysis. The data for this research is secondary data obtained through a systematic search for relevant documents on Google Scholar. The following steps were taken during data collection; Keyword Search: Keywords related to e-assessment and science education were used to identify relevant articles. Selection Criteria: Articles were filtered based on publication date, journal accreditation, and relevance to the research topic.

A data collection instrument in the form of a checklist was used to ensure that each selected article met the predefined criteria. The checklist included the following items:

1. Title and Abstract Review: Initial screening for relevance.
2. Publication Year: Ensuring the article was published between 2017 and 2022.
3. Journal Accreditation: Verification of the journal's accreditation status by Sinta.
4. Content Review: Detailed examination of the article's content to confirm its focus on e-assessment in science education.

The data analysis process involved several steps: 1). Content Analysis: Each selected article was thoroughly reviewed to extract relevant information about the use and impact of e-assessment in science education.; 2). Thematic Analysis: Common themes and patterns were identified across the articles. This involved coding the data and organizing it into thematic categories such as the benefits of e-assessment, challenges in implementation, and its impact on learning outcomes.; 3). Synthesis: The findings from the thematic analysis were synthesized to provide a comprehensive overview of the effectiveness of e-assessment in science education.

By following these methodological steps, the research aims to provide a well-rounded and theoretically grounded understanding of how e-assessment can enhance the assessment process in science education.

The flow of this research can be seen in Figure 1.

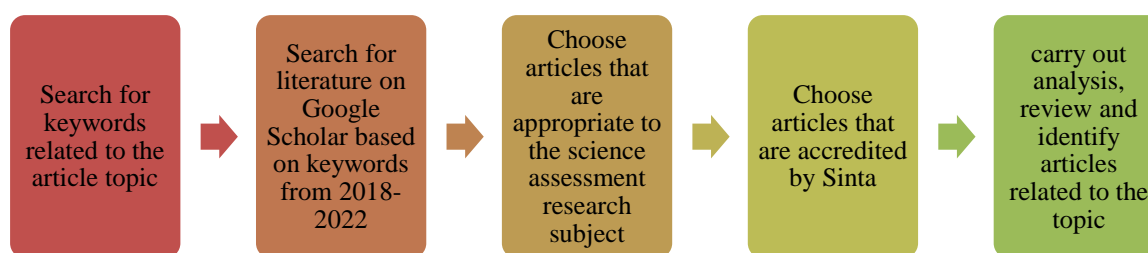


Figure 1. Literature review research flowchart

After articles that match the topic and the basis of the data are collected, the researcher then carries out a review using several criteria explained in the descriptive statistics table.

## 3. RESULTS AND DISCUSSION

Based on the results of the literature search that was carried out, the researcher obtained 8 articles that met the criteria and research topic. The grouping of articles can be classified based on the following criteria: 1) based on the year the article was published, 2) based on the synta index of the published article, and 3) based on the objectives achieved by the article. The results of the classification of articles that have been obtained based on year of publication can be seen in table 1.

Table 1. Grouping of articles by Year of Publication

Year	Frequency	Percentage
2018	1	12,5%
2019	2	25%
2020	0	0%
2021	0	0%
2022	5	62,5%
Amount	8	100%

The results from table 1 explain the year of publication of the articles in the literature in this research. From the table it can be seen that e-assessment in science learning in 2018 was 12.5% or 1 article, in 2019 it was 25% or 2 articles, and in 2022 it was 62.5% or 5 articles. Next, this article will be grouped based on the Sinta index. The results of grouping based on the Sinta index can be seen in table 2.

Table 2. Grouping of articles based on Sinta Index

Indexed Sinta	Frequency	Percentage
Sinta 1	0	0%
Sinta 2	3	37,5%
Sinta 3	2	25%
Sinta 4	3	37,5%
Amount	8	100%

Based on table 2, it can be seen that from the 8 articles used as references from the literature, 37.5% of the articles indexed by Sinta 2 were 37.5% or 3 articles, for articles indexed by Sinta 3 it was 25% or 2 articles and articles indexed by Sinta 4 were 37.5% or 3 articles. Next, the researcher carried out an analysis based on the purpose of the article. The results of the objectives of the article can be seen in table 3.

Table 3. Grouping of Articles based on Achieved Capability Targets

Target E-assessment	Frequency	Author
Learning Outcomes	3	(Laksono & Widiyatmoko, 2022; Nurhidayah & Ardi, 2022; Widiana, 2022; Pursitasari et al., 2022)
Speed up assessments	4	(Wulan et al., 2018, Dewi, 2022; Sahidu et al., 2019; Astalini et al., 2019)

Details of the articles reviewed and analyzed can be seen in table 4.

Journal Name	Author (Year)	Title	Finding
Jurnal Pendidikan Sains Indonesia	Laksono & Widiyatmoko, (2022)	Development of Science Digital Scrapbook as Authentic Assessment to Measure Learning Outcome of Junior High School Students	The results show that student learning outcomes calculated using digital media as an authentic assessment medium show that 83.3% of students are complete in the knowledge domain, 100% are complete in the attitude domain and 100% are complete in the skills domain. So the digital media used is suitable for use as a medium for measuring student learning outcomes.
Jurnal Ilmiah Pendidikan Profesi Guru	Nurhidayah & Ardi (2022)	Instrumen E-Assessment Berbasis Quizizz tentang Materi Sistem Koordinasi untuk Kelas XI SMA/MA	The results show that the results of the feasibility test of the e-assessment instrument show that the practicality score for teachers is 97.70% with very practical criteria and students are 84.40% with practical criteria, so that the Quizizz-based e-assessment instrument is very practical to use and can be applied at school in the assessment process.
Jurnal Pemberdayaan Masyarakat	Pursitasari et al., (2022)	Pelatihan Penyusunan E-Asesmen Literasi Sains Berbasis AKM Bagi Guru IPA SMP di	The results show that the teacher's understanding of e-assessment and scientific literacy has increased with an N-gain of 61.1%, so that the preparation of scientific literacy e-assessments has been able to improve teachers' skills in compiling tools in the form of e-assessments.

Journal Name	Author (Year)	Title	Finding
Indonesian Journal of Educational Assessment	Wulan et al., (2019)	Kabupaten Bogor Penggunaan Asesmen Elektronik Berkas Edmodo Sebagai Assessment for Learning Keterampilan Abad 21	The results show that current global challenges, this research develops an ICT-based assessment that not only measures students' cognitive skills, but also develop them. The assessment model was developed using Edmodo based website application.
Jurnal Penelitian dan pengembangan pendidikan	Widiana (2022)	Dampak Penggunaan E- learning Berbasis Asesmen Proyek Terhadap Kemandirian Belajar dan Hasil Belajar Siswa Selama Pandemi Covid-19	The results show that the research results show that the significance value of the Manova analysis is 0.000 (<0.05). This means that simultaneously and partially there is an influence of the use of project assessment-based elearning on student independence and learning outcomes during the Covid-19 pandemic. Therefore, the use of project assessment-based e-learning can be used as a reference for implementing learning and assessment.
Jurnal Pendidikan Sains dan Matematika	Dewi (2022)	Pengembangan Instrumen E-Quiz Pada Pembelajaran Daring Materi Ekosistem Kelas Vii Smp	The results show that the product in the form of an E-Quiz which is used as an assessment instrument is suitable for use based on teacher responses. The average percentage score is 85% in the very practical category, while the average percentage obtained from the student response questionnaire is 85% in the very practical category practical.
Jurnal Pendidikan Fisika dan Teknologi	Sahidu et al., (2019)	Respon Calon Guru Terhadap Model E- Assessment Dalam Pembelajaran Fisika	The results show that respondents' perceptions gave a positive response to the development of this model. Student responses were in the interval 86% to 94%, in the very good category. This model has the opportunity to continue to be developed for more effective and efficient assessment.
Jurnal Ilmu Pendidikan	Astalini et al., (2020)	E-Assessment on Student's Self- Concept for Physics Learning	The results show that SESKA-based e-assessment received a good response and needs to be developed on a large scale so that it will make assessments more efficient and effective

Based on table 3 and table 4, it can be seen that e-assessment in science learning is used to support the assessment of student learning outcomes, speed up assessment, and assess scientific literacy. By using e-assessment, students and teachers will experience the use of new assessment media so that assessments can be more effective, efficient and save costs in assessment.

E-assessment is an important part of education where one of the most important things about e-assessment is the user's response. A person's response to the use of technology will improve the results in the assessment and the ease response is the level of a person's confidence that the use of technology will make it less necessary to use a lot of effort to carry out the assessment [21] - [23]. By using e-assessment, it will reduce waste in the form of paper which is usually used to carry out assessments. Therefore, implementing e-assessment is seen as one way to reduce waste and excessive spending. Another reason is that by implementing e-assessment you will be able to make assessments real time and effective [35]. This is in line with the statement by Darmaji et al., (2019) that the use of the web as an assessment medium will be accessible anywhere and you only need to click to be able to fill in the answers [25].

Student responses were good regarding the use of e-assessment because students felt more comfortable and enjoyed the features and convenience after using e-assessment. By including technology in filling out assessment sheets, students will increasingly enjoy the efficiency and convenience of assessment. Convenience means the extent to which individuals are able to carry out activities using technology that are able to please them [36]. Convenience is also an important factor in making students serious about filling in answers. Research conducted by Rojas-Osorio & Alvarez-Risco, (2019) shows that the behavioral intention to continue using a smartphone as a device in using e-assessment is significantly influenced by the response to ease of use and perceived usefulness [27].

Based on the research that has been carried out, it is necessary to update this research on the application of e-assessment. Previous research conducted Winda et al., (2021), explained that e-assessment can be used as a medium for assessing students' mastery of science process skills, where the response from students who use the website will be seen [28]. Research from Wang, (2018) also explained about the application of the web as a medium for conducting practicums where Wang uses the WSP system to run it which only uses PHP language and a database so that the e-assessment can run [29]. The web can also be used as a portfolio medium for assessing students and can also be a learning medium that can increase students' interest in learning [40], [31]). In the research conducted by the researcher, the researcher did not conduct research on students' science process skills or as a learning medium, but the researcher carried out a science assessment using e-assessment. The use of e-assessment as a science assessment medium is to provide a medium that is able to accurately and quickly carry out science assessments.

By implementing e-assessment as a medium for student assessment, it will certainly make it easier for students to carry out assessments and get feedback as soon as possible. So that later a good student response in using e-assessment will be able to make students realize how necessary it is to implement e-assessment as a science assessment medium because of its ease, speed and effectiveness in use. Assessment has so far been carried out in a conventional way, namely using paper, so this will have an impact on the effectiveness of carrying out the assessment process. So far, the assessment process using paper will of course take a very long time to carry out the assessment process. This long assessment process is due to the difficulty of teachers in correcting answers one by one without assistance from media that can make the process easier. If this continues, it will have an impact on the length of the process of identifying students' science assessment results so that it will hinder the improvement of students' science from conventionally assessed science assessment results. So a media was created that was able to overcome this problem, namely e-assessment. E-assessment will be able to display the results of students' science assessments in a very fast time because the e-assessment system does not need to carry out assessments manually but uses sophisticated technology so that assessment results can be displayed in real time. From the results of this research, it can be seen that students' responses are very good in using e-assessment as an assessment medium. This can be a consideration for permanently implementing e-assessment as an assessment medium.

This research presents several new aspects in the use of e-assessment for science learning. First, this research provides an in-depth analysis of the effectiveness of e-assessment not only from the cognitive aspect, but also from the affective and psychomotor aspects. Second, this research utilizes the most recent and accredited literature to provide a comprehensive understanding of how e-assessment can improve science learning outcomes. Finally, this research shows the positive impact of user responses (both teachers and students) on the use of e-assessment, which has not previously been discussed in much detail in the literature.

This research provides practical guidance for teachers in integrating e-assessment into the science learning process. With a better understanding of the benefits and challenges of e-assessment, teachers can design more effective and efficient assessment strategies. The results of this research can be a basis for policy makers in developing and implementing e-assessment systems in schools. With evidence that e-assessment can speed up the assessment process and improve learning outcomes, policies that support the digitalization of assessments will be more easily accepted. This study only used 8 articles as a sample, which may not represent the entire spectrum of research on e-assessment in science learning. This limited number of articles may affect the generalization of research findings.

#### 4. CONCLUSION

The application of e-assessment in science learning has been proven to increase the effectiveness of assessing learning outcomes by providing fast and accurate results, improving students' critical thinking skills and scientific literacy, and getting positive responses from teachers and students. E-assessment also helps save resources and speed up the assessment process. However, this research has limitations in the number of samples and methods that only use literature reviews. Recommendations for future research are to collect empirical data directly from the field with a larger sample and conduct comparative studies between e-assessment and conventional assessment to gain a more comprehensive understanding of the effectiveness of e-assessment.

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