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AI-assisted authentic assessment in higher education: Mapping research trends and implications for deep learning

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ABSTRACT

The rapid integration of artificial intelligence (AI) in higher education is fundamentally reshaping traditional assessment practices. This transformation is particularly evident in the development of authentic assessments designed to monitor, support, and strengthen deep learning processes continuously. Consequently, this study investigates current global research trends and explores how AI-assisted authentic assessment frameworks can be strategically designed to optimize student learning outcomes. Employing a comprehensive mixed-methods approach, the research combines a rigorous bibliometric analysis to map historical and emerging publication patterns with a detailed narrative literature review to extract deeper thematic insights. The collected bibliographic data were systematically analyzed and visualized using VOSviewer software. This quantitative phase was followed by an in-depth qualitative examination of meticulously selected articles, specifically focusing on underlying theoretical frameworks, practical AI-supported assessment models, and their broader educational implications. The findings reveal a significant increase in scholarly interest in real-time AI-enabled feedback mechanisms, the enhancement of task authenticity to mimic real-world scenarios, and their direct connection to holistic 21st-century skills development. By combining these multifaceted insights, the study proposes actionable strategies for educators and institutions to effectively implement AI-driven authentic assessment, ultimately serving to advance deep learning, ensure academic integrity, and better prepare students for future professional challenges.

INTRODUCTION

In recent years, higher education has faced increasing demands to prepare students with competencies that go beyond content mastery. Learners are expected to develop higher-order thinking skills (HOTs), creativity, collaboration, problem-solving abilities, and other 21st-century skills necessary for success in a rapidly changing world (Cahyani et al., 2024). Traditional forms of assessment, which often emphasize memorization and standardized testing, have been criticized for their inability to capture these complex skills. As a result, authentic assessment has gained prominence as an alternative that allows students to engage in meaningful, real-world tasks and demonstrate learning in context. (Parwati et al., 2019).

At the same time, the rise of artificial intelligence (AI) has created new opportunities to redesign assessment practices in higher education. AI tools can provide real-time feedback, track learning progress, and enhance the authenticity of assessment tasks, enabling more effective monitoring of deep learning. Furthermore, AI-supported assessment has the potential to strengthen academic integrity by reducing opportunities for misconduct and offering adaptive, personalized evaluation. (Asyhad & Alimuddin, 2025).

The rapid advancement of AI has significantly influenced the landscape of higher education, particularly in the design and implementation of authentic assessment. Authentic assessment plays a crucial role in fostering deep learning, as it requires students to engage with complex tasks that mirror real-world contexts and be critical about them. (Mubarok et al., 2025). Through this process, students are encouraged to develop Higher-Order Thinking Skills (HOTs), such as analysis, evaluation, and creativity, which are central to academic and professional success. Moreover, authentic AI-supported assessments provide a pathway to cultivating 21st-century skills—including collaboration, communication, and problem-solving—that are increasingly demanded in global education and the workplace. (Arifah et al., 2025). At the same time, integrating AI into assessment design is also essential for maintaining academic integrity, ensuring that learning outcomes are both credible and ethically achieved. Taken together, these six interconnected aspects provide a comprehensive framework for rethinking assessment in the digital era. (Taqiyya et al., 2025).

Recent reports highlight that nearly 70% of higher education institutions worldwide are experimenting with AI-based learning and assessment tools. Yet, only a small proportion explicitly integrate them into authentic assessment practices. In Indonesia, for example, the rapid expansion of digital learning platforms after the COVID-19 pandemic revealed significant challenges in maintaining academic integrity and ensuring meaningful student engagement (Kolade et al., 2024). Surveys conducted by UNESCO and OECD also show that while educators recognize the importance of developing HOTs and 21st-century competencies, assessment practices often lag, relying heavily on conventional examinations that do not adequately capture deep learning outcomes. These conditions demonstrate the urgency of exploring innovative approaches that combine AI technologies with authentic assessment to ensure both integrity and relevance in higher education (Siregar & Badriah, 2025).

Despite its potential, the integration of AI in authentic assessment remains underexplored, particularly in relation to how it can foster deep learning and support the development of HOTs and 21st-century competencies (Rosardi & Widiastuti, 2025). Previous studies have mainly focused on either authentic assessment without technological support, or on AI in education with limited emphasis on assessment design. There is still a lack of comprehensive studies that explicitly connect AI-supported authentic assessment with the monitoring of deep learning and the cultivation of essential 21st-century skills (Asyhad & Alimuddin, 2025).

In response to this gap, the present study aims to examine how AI-supported authentic assessment can be designed and implemented to optimize student learning outcomes. Specifically, the research seeks to identify current trends in authentic assessment research, analyze theoretical frameworks and AI-driven assessment models, and explore their implications

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for fostering HOTs and 21st-century competencies (Mastikawati et al., 2022). By employing a mixed-method approach that combines bibliometric analysis and narrative literature review, this study provides both a broad overview of research patterns and a deeper exploration of key themes. Ultimately, it offers practical recommendations for educators and policymakers to adopt AI-supported authentic assessment as an innovative strategy to promote deep learning, ensure academic integrity, and prepare students for future challenges in the digital era (Mubarok et al., 2025).

METHODS

This research uses a mixed-method approach that combines bibliometric analysis and narrative literature review. Bibliometric analysis is employed to systematically identify research trends, map publication patterns, and highlight the most frequently used keywords in the field of authentic assessment. Meanwhile, the narrative literature review examines in depth the theoretical perspectives, assessment designs, and practical contributions of relevant studies. By integrating both approaches, this research is expected to provide a comprehensive and holistic understanding of the development and implementation of authentic assessment in higher education, particularly in relation to deep learning, academic integrity, and the cultivation of 21st-century skills.

Research Design

This approach integrates two complementary methods. First, a bibliometric analysis is conducted using specialized software to examine research trends, collaboration networks, dominant keywords, and the geographical distribution of studies on authentic assessment, deep learning, and academic integrity. Second, a narrative literature review is employed to synthesize and critically evaluate the content of key publications identified through the bibliometric analysis, with particular attention to their theoretical foundations, methodological rigor, and scholarly contributions.

Research Process

Bibliometric Analysis

The bibliometric analysis was conducted based on several criteria. The article database was selected as the primary source, with “authentic assessment” used as the main search keyword. The search was limited to English-language publications from 2019 to 2025, restricted to journal articles and conference proceedings. The collected data were enriched with bibliographic attributes and subsequently analyzed using VOSviewer software. The analysis included keyword mapping and identification of dominant themes through co-occurrence analysis. The outputs of this process consisted of visualizations of research trends and keyword network maps.

Narrative Literature Review

The narrative literature review was conducted based on 15 articles initially identified through bibliometric analysis. These articles were retrieved using keywords related to authentic assessment, artificial intelligence in education, and deep learning within higher education contexts. To ensure the quality and relevance of the selected studies, a systematic screening process was applied using predefined inclusion and exclusion criteria. The inclusion criteria consisted of: (1) studies focusing on authentic assessment in higher education, (2) integration of artificial intelligence or digital assessment tools, (3) explicit discussion of deep learning or higher-order thinking skills (HOTs), and (4) publication in reputable peer-reviewed journals between 2019 and 2025.

Meanwhile, articles were excluded if they: (1) focused solely on traditional assessment methods, (2) did not involve AI or technology-supported assessment, (3) were conducted outside

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higher education contexts, or (4) lacked sufficient methodological clarity or empirical contribution. The article selection process followed a structured screening procedure adapted from PRISMA guidelines. A total of 15 articles were initially identified through bibliometric analysis. These articles were then screened using predefined inclusion and exclusion criteria. Inclusion criteria are: 1) Focus on authentic assessment in higher education, 2) Integration of AI or digital assessment tools, 3) Discussion of deep learning or higher-order thinking skills, and 2) Published in reputable peer-reviewed journals (2019–2025). While exclusion criteria are: 1) Studies focusing solely on traditional assessment, 2) Lack of AI or technology integration, 3) A non-higher education context, and 4) Limited methodological rigor or unclear findings. After the screening process, 7 articles were retained for in-depth narrative analysis. In comparison, 8 articles were excluded. Additional supporting literature was used to enrich the discussion, although the core narrative synthesis was based on the 7 selected primary studies. The selection process is summarized in Table 1.

Table 1
Article selection process.

	Author(s) & Year	Focus Area	Decision	Reason
1	Kolade et al. (2024)	AI in education	Excluded	Lacks focus on assessment
2	Asyhad & Alimuddin (2025)	Authentic assessment	Included	Meets all criteria
3	Fathurohman et al. (2023)	STEM-ESD learning	Excluded	Not assessment-focused
4	Koh et al. (2019)	Authentic assessment in STEM	Included	Foundational study
5	Zebua (2025)	Deep learning	Excluded	No assessment component
6	Mabruroh & Ashsiddiqi (2021)	Scientific literacy	Included	Relevant to deep learning
7	Handayani et al. (2024)	SDGs education	Excluded	Not assessment-specific
8	Mastikawati et al. (2022)	Critical thinking	Included	Empirical evidence
9	Nimma et al. (2024)	AI reading skills	Excluded	Not an authentic assessment
10	Garcia (2025)	Authentic assessments	Included	Supports engagement
11	Ferguson et al. (2022)	ESD curriculum	Excluded	No AI/assessment integration
12	Sutadji et al. (2021)	Assessment model	Included	Strong theoretical basis
13	Siregar & Badriah (2025)	AI education	Excluded	Indirect relevance
14	Perla & Vinci (2023)	AI assessment	Included	Direct relevance
15	Fitroni et al. (2025)	Technology education	Excluded	Lacks methodological clarity

The narrative literature review was conducted by selecting 7 primary articles from 15 identified through bibliometric analysis, based on citation counts, publication in reputable journals, and direct relevance to the research focus. The selected articles were then subjected to in-depth content analysis, focusing on the theoretical foundations of authentic assessment, assessment designs that foster deep learning, the interrelationship between authentic assessment and academic integrity, and the identification of research gaps and significant contributions. At the narrative synthesis stage, the findings from the bibliometric mapping were integrated with detailed insights from the reviewed literature, resulting in the development of thematic categories related to authentic assessment, deep learning, and academic integrity.

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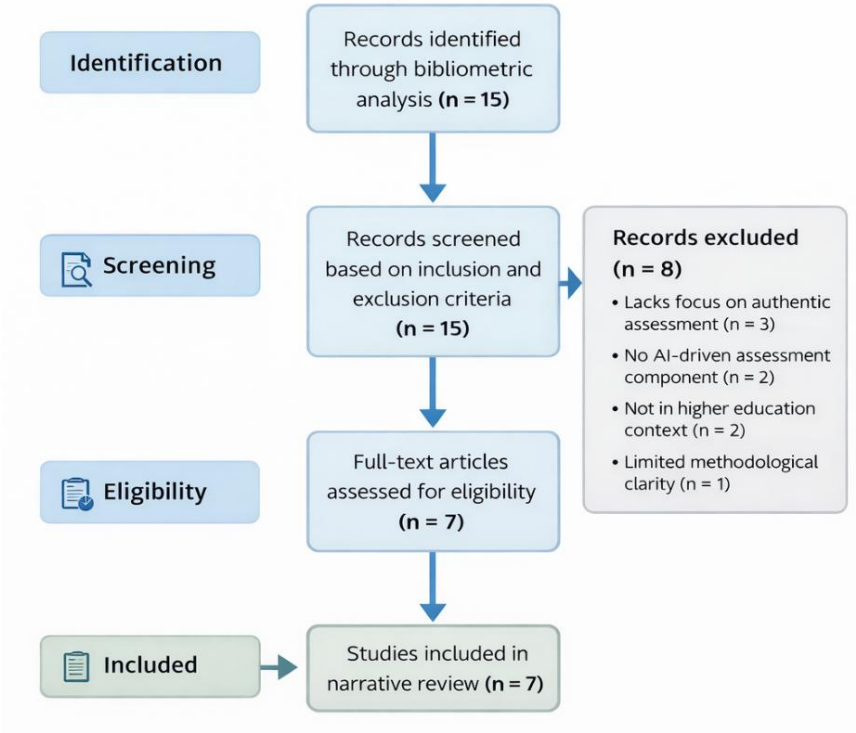
Additional supporting literature was used to enrich the discussion, although the core narrative synthesis was based on the 7 selected primary studies. The article selection process followed a structured procedure adapted from PRISMA guidelines. The process is illustrated in Figure 1.

Figure 1
Prisma flow diagram of article selection.



The PRISMA flow diagram illustrates the systematic process of article selection in this study. In the identification stage, 15 articles were retrieved through bibliometric analysis using predefined keywords and database criteria. During the screening stage, all identified articles (n = 15) were evaluated based on the inclusion and exclusion criteria. As a result, 8 articles were excluded due to lack of relevance to authentic assessment, absence of AI integration, non-higher education context, or insufficient methodological rigor. In the eligibility stage, the remaining 7 articles were assessed for full-text eligibility and relevance to the research objectives. Finally, in the inclusion stage, 7 articles were selected for in-depth narrative analysis. This systematic process ensures transparency, consistency, and methodological rigor in selecting the most relevant studies to support the research findings.

Research Outputs

Bibliometric Analysis Results

The findings present an overview of global and local research trends related to authentic assessment, highlight collaboration networks among key authors and institutions, and identify emerging research themes in the field.

Narrative Literature Review Results

The results provide an in-depth understanding of the theoretical foundations, methodological approaches, and practical applications of authentic assessment in higher education. In addition, this stage produces recommendations for designing authentic assessments that foster deep learning while safeguarding academic integrity.

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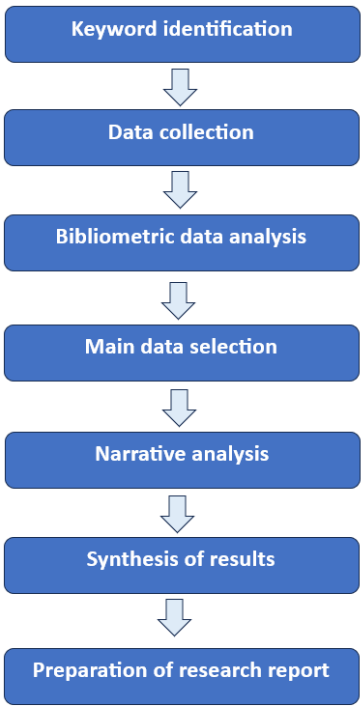
This method guarantees that the study addresses both a macro-level perspective through bibliometric analysis and a micro-level perspective through narrative review. Such integration strengthens the comprehensiveness of the findings and ensures meaningful contributions to both academic literature and practical applications in the field. The overall research flow is illustrated in Figure 2.

Figure 2
Research flow.



This study adopts a mixed-method approach to provide a comprehensive understanding of AI-assisted authentic assessment in higher education. By integrating bibliometric analysis with a narrative literature review, the study captures both macro-level research trends and micro-level conceptual insights. The overall research flow is illustrated in Figure 1. In the keyword identification stage, relevant keywords such as authentic assessment, artificial intelligence in education, deep learning, and higher-order thinking skills were systematically identified based on the research objectives. This process resulted in a refined, structured set of search terms to ensure comprehensive database retrieval. During the data collection stage, scholarly articles were retrieved from major academic databases, yielding an initial corpus of publications on AI-assisted assessment and deep learning in higher education.

In the bibliometric data analysis stage, the collected dataset was analyzed and visualized using VOSviewer to identify publication trends, influential authors, collaboration networks, and dominant research themes. The results of this stage revealed a growing global interest in AI-driven feedback systems and authentic learning environments. Subsequently, the main data selection stage applied strict inclusion and exclusion criteria to filter the most relevant and high-quality studies. This process resulted in a focused dataset for in-depth qualitative analysis.

In the narrative analysis stage, the selected articles were critically examined to identify key theoretical frameworks, practical implementations of AI-assisted authentic assessment, and the role of these approaches in enhancing deep learning and higher-order thinking skills. This stage also highlighted emerging challenges and research gaps. Finally, in the synthesis of results stage, findings from both bibliometric and narrative analyses were integrated to generate a

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comprehensive understanding of the field. The synthesis produced actionable insights, particularly regarding the design of AI-supported authentic assessment strategies that promote continuous feedback, real-world task engagement, and holistic skill development. The study concludes with the preparation of the research report, which systematically presents the findings and offers practical recommendations for educators and institutions to implement AI-assisted authentic assessment effectively.

RESULTS AND DISCUSSION

Current Directions in Research on Deep Learning and Authentic Assessment

The results and discussion of this study are presented by integrating findings from both bibliometric analysis and narrative literature review to provide a comprehensive understanding of authentic assessment in higher education. The bibliometric analysis offers a macro-level perspective by identifying research trends, dominant themes, and the evolving role of artificial intelligence (AI) in assessment practices. Meanwhile, the narrative literature review provides a micro-level analysis by examining selected studies in depth, focusing on theoretical frameworks, implementation strategies, and their contributions to enhancing deep learning, higher-order thinking skills (HOTs), and academic integrity.

By combining these two approaches, this section highlights not only current research directions but also the practical implications of AI-assisted authentic assessment for fostering meaningful and sustainable learning. The discussion is structured around several key themes: research trends in authentic assessment and deep learning; the integration of authentic assessment in higher education; the role of assessment in embedding academic ethics; and the challenges and opportunities in its implementation.

Using VOSviewer as a bibliometric analysis tool has enabled researchers to identify emerging patterns and themes related to this issue in higher education. Mapping relationships among publications, authors, and keywords provides a detailed understanding of the evolution and focus areas of current research. At the outset, the research process began by searching for the term "Deep learning" in the Publish or Perish application, focusing on Scopus-indexed publications from 2019 to 2025. The resulting data were organized and enriched in Mendeley Desktop by verifying essential bibliographic attributes, including titles, authors, volumes, issues, publication years, and article keywords. The prepared dataset was then subjected to bibliometric analysis using VOSviewer software. The relationships among keywords identified by the VOSviewer analysis are presented in the network visualization displayed in Figure 3.

Comparison of Learning Outcomes Between Experimental and Control Groups

The VOSviewer bibliometric analysis shows two main thematic clusters: (1) education and authentic assessment and (2) deep learning and detection systems. The educational cluster centers on keywords such as authentic assessment, learning process, teaching, and learner, reflecting a growing focus on performance-based and student-centered evaluations. The technological cluster, with terms such as deep learning, quality assessment, and architecture, highlights the integration of AI into educational assessment, especially in higher education. These interconnected clusters indicate a research trend linking pedagogical authenticity with technological innovation. Authentic assessment promotes deep learning by engaging students in real-world, complex tasks that develop higher-order thinking and 21st-century skills. Meanwhile, AI-based detection systems help maintain academic integrity through tools such as plagiarism detection, automated grading, and learning analytics. The combination of authentic assessment and AI technologies represents a shift from traditional testing to technology-enhanced authentic evaluation. This hybrid model not only strengthens conceptual understanding and learner engagement but also safeguards fairness and credibility in higher education assessment practices.

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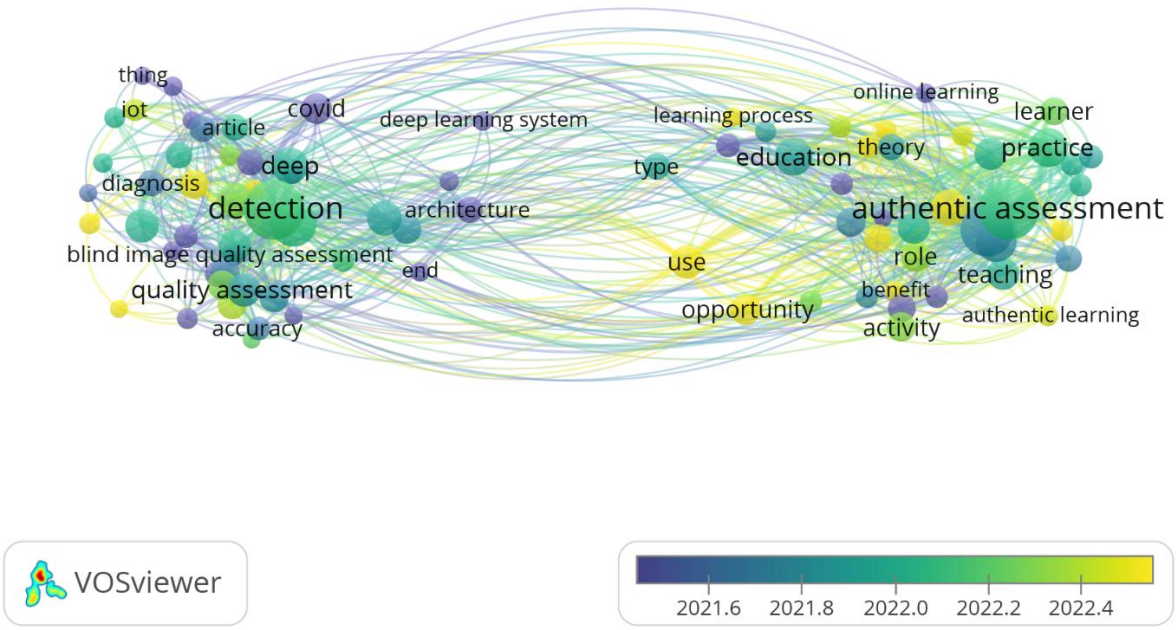
Figure 3
The keyword linkage of the VOSviewer through network visualization.



The bibliometric visualization generated by VOSviewer identifies two dominant thematic clusters: (1) education and authentic assessment and (2) deep learning and detection systems. The first cluster emphasizes keywords such as authentic assessment, learning process, teaching, and learner, showing a consistent shift toward student-centered and competency-based assessment models. The second cluster, featuring terms like deep learning, quality assessment, and architecture, illustrates the expanding role of artificial intelligence in enhancing assessment reliability and precision, particularly in the post-pandemic era. The link between these clusters indicates that recent studies increasingly connect pedagogical innovation with technological advancement. Authentic assessment fosters deep learning by encouraging students to engage in complex, real-world tasks that require analysis, creativity, and reflection. Meanwhile, AI-supported systems strengthen academic integrity by providing transparent feedback, detecting plagiarism, and objectively tracking learners' progress.

Overall, authentic assessment can be viewed as an effective and ethical approach to improving the quality of learning in higher education. When combined with intelligent technologies, it not only nurtures deeper understanding and meaningful learning but also sustains credibility and fairness in the assessment process, making it a powerful solution for promoting both academic excellence and integrity.

Integrating Authentic Assessment to Enhance Deep Learning in Higher Education

Recent educational research emphasizes that authentic assessment is not merely an evaluative tool but a key pedagogical approach that facilitates deep learning in higher education. The bibliometric mapping results demonstrate the growing intersection between the concepts of authentic assessment and deep learning, indicating a shift in assessment practices from measuring surface knowledge toward fostering higher-order thinking, creativity, and problem-solving abilities (Zebua, 2025). This integration aligns with the current demand for 21st-century competencies, where learning is expected to produce adaptable, reflective, and ethically responsible graduates. Authentic assessment promotes deep learning by engaging students in real-world and contextually meaningful tasks (Ruhalahti et al., 2018). Unlike traditional

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examinations that often test memorization, authentic tasks—such as projects, case analyses, research portfolios, and simulations—require students to apply knowledge in complex situations. These tasks encourage critical reflection, collaboration, and metacognitive awareness, allowing learners to connect theory with practice. Through this process, students develop conceptual understanding and transferable skills that are essential for lifelong learning and professional readiness (Vlachopoulos & Makri, 2024).

Moreover, the integration of digital and AI-supported assessment tools has enhanced the implementation of authentic assessment in higher education. Learning analytics, automated feedback systems, and AI-based evaluation mechanisms can provide continuous and personalized feedback that supports deeper cognitive engagement (Nimma et al., 2024). These technologies also help maintain academic integrity by ensuring transparency and preventing academic misconduct, creating a trustworthy learning environment. As a result, the fusion of authentic assessment and technological innovation not only enhances the depth of learning but also strengthens the credibility and fairness of the academic evaluation process (Kolade et al., 2024). In summary, integrating authentic assessment into higher education represents a transformative strategy for achieving deep learning outcomes. It bridges the gap between learning and assessment, promotes student agency, and cultivates critical and ethical academic cultures. As universities continue to adapt to digital transformation, authentic assessment will play a central role in redefining how learning is demonstrated, validated, and sustained (Zebua, 2025).

Embedding Academic Ethics through Authentic Assessment

In recent years, the discourse on assessment reform in education has increasingly emphasized the need for approaches that do not merely measure learning outcomes but also cultivate ethical and responsible learners. In the context of science education, this call becomes particularly urgent (Sutadji et al., 2021). Science as a discipline is inherently tied to truth-seeking, empirical honesty, and ethical responsibility in experimentation and reporting. Therefore, embedding academic ethics into the assessment process is not an auxiliary goal but a fundamental aspect of developing scientifically literate and morally grounded students (Koh et al., 2019). Authentic assessment, which mirrors real-life practices and professional contexts, has emerged as a pedagogical strategy capable of integrating these cognitive and ethical dimensions within the science classroom. (Perla & Vinci, 2023).

Traditional science assessments often focus on rote memorization, emphasizing factual recall rather than conceptual understanding or ethical reasoning. Such practices can inadvertently distance students from the moral dimensions of scientific inquiry-honesty, fairness, and accountability (Vlachopoulos & Makri, 2024). In contrast, authentic assessment provides opportunities for learners to engage in real-world scientific problems, conduct experiments, or develop projects that demand original work and reflective thought. These activities require students not only to apply scientific knowledge but also to make ethical decisions regarding data collection, teamwork, and reporting. Through this process, authentic assessment nurtures both deep, meaningful, integrated, and transferable learning and ethical consciousness aligned with the core values of academic integrity (Parwati et al., 2019).

Moreover, integrating authentic assessment into science learning has been shown to reduce instances of academic misconduct, such as plagiarism or data fabrication, by fostering a sense of ownership and transparency in student work. When students understand that assessment tasks reflect genuine scientific challenges, they are more motivated to produce original outputs and take responsibility for their learning outcomes. (Hu et al., 2025). This pedagogical approach transforms assessment from a static evaluation tool into a dynamic process of ethical formation. As highlighted by recent educational reforms in Indonesia and globally, authentic assessment not only strengthens students' scientific competencies but also contributes to building a culture of honesty and integrity in education (Perla & Vinci, 2023). The following section presents a synthesis of empirical studies that support the integration of authentic assessment as a vehicle for

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embedding academic ethics and promoting deep learning in science education. These conceptual and empirical insights are further illustrated in Table 2 which highlights relevant studies examining authentic assessment in science learning contexts.

Table 2
Empirical studies supporting the integration of authentic assessment to enhance deep learning in higher education.

Author(s) & Year	Context / Country	Focus of Study	Key Findings	Relevance to Current Article
Asyhad & Alimudin (2025)	Science learning, Indonesia	Implementation of authentic assessment in science classes under *Kurikulum 2013*	Authentic assessment procedures strengthen students' responsibility and engagement in science learning.	Shows practical application of authentic assessment at school level — supports the "integration" dimension.
Sutadji & et al. (2021)	Senior high school science, Indonesia	Development of authentic assessment model for science competencies	The model was valid and effectively enhanced science learning outcomes and problem-solving skills.	Demonstrates that authentic assessment fosters *deep learning* and scientific reasoning.
Mabruroh & Ashsiddiqi (2021)	University science education, Indonesia	Development of authentic assessment instruments based on scientific literacy	Instruments effectively measure science process and literacy skills, aligning with real-life contexts.	Reinforces that authentic assessment evaluates higher-order thinking rather than rote memorization.
Mastikawati et al. (2022)	High school science (topic: global warming), Indonesia	Authentic assessment for critical thinking skills in science	Authentic assessment significantly improved students' critical and analytical skills.	Supports the idea that authentic assessment cultivates *deep learning* through critical inquiry.
Garcia (2025)	Grade 11 Biology	Students' perceptions of authentic assessment in biology	Students found authentic assessments meaningful, motivating, and ethically engaging.	Indicates that authentic assessment promotes both engagement and academic honesty.
Koh et al. (2019)	STEM learning, USA / international	Beyond Memorization: The Power of Authentic Assessments in STEM Learning"	Authentic assessments reduce stress, enhance engagement, and	Highlights how authentic tasks support deep, ethical, and self-directed learning

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Author(s) & Year	Context / Country	Focus of Study	Key Findings	Relevance to Current Article
			foster genuine understanding and creativity in STEM.	across science disciplines.
Perla& Vinci (2023)	Science courses, United Kingdom	Case study on authentic assessment design in science	Authentic assessment models resistant to AI-generated content help preserve originality and trust.	Demonstrates that authentic assessment strengthens academic ethics amid digital challenges in science education.

The synthesis of recent research underscores that embedding academic ethics through authentic assessment represents not merely an assessment reform but a transformative pedagogical paradigm in science education. Within the Indonesian context, studies by Setyawarno & Kurniawati (2018) reveal that authentic assessment significantly enhances students' engagement, sense of responsibility, and scientific reasoning. Instead of emphasizing standardized tests, authentic assessment immerses students in realistic scientific contexts—such as laboratory investigations, environmental analyses, and problem-solving projects—that require them to demonstrate conceptual understanding rather than rote memorization. These contextualized experiences help learners internalize ethical values such as honesty in reporting data, respect for scientific evidence, and accountability in collaborative endeavors.

In a similar vein, Mabruroh and Ashsiddiqi (2021) as well as Handayani et al. (2024) assert that authentic assessment cultivates both higher-order cognitive skills and ethical dispositions by aligning learning tasks with scientific literacy and inquiry-based processes. Through activities such as open-ended investigations, project-based tasks, and reflective portfolios, students engage critically with real-world scientific challenges. Such engagement minimizes the likelihood of academic misconduct or plagiarism, as learners view their work as personally meaningful and relevant. Consequently, authentic assessment fosters ethical behavior and learner autonomy—core dimensions of academic integrity—while advancing the principles of deep learning, which emphasize understanding, critical thinking, and knowledge transfer.

Evidence from global research further reinforces these findings. Garcia (2025) reported that students in secondary biology classrooms perceived authentic assessment as both motivational and ethically enriching. Similarly, Marsh and Hagan (2024) demonstrated that authentic tasks within STEM disciplines reduce anxiety, foster genuine comprehension, and promote creative problem-solving. Furthermore (Sintiya et al., 2025) highlighted that thoughtfully designed authentic assessments can mitigate unethical practices—including AI-assisted plagiarism—by emphasizing originality, reflective reasoning, and creativity. Collectively, these studies affirm that authentic assessment operates not only as an instructional strategy but also as an ethical scaffold that nurtures scientific honesty, transparency, and intellectual responsibility. In science education, this dual function—promoting deep learning while embedding academic ethics—positions authentic assessment as a sustainable and ethically grounded approach for cultivating integrity in the digital era (Taqiyya et al., 2025)

Authentic assessment emphasizes learning experiences that mirror real-world contexts, allowing students to connect theoretical knowledge with practical applications and encouraging originality in their work. In this context, Setyawarno and Kurniawati (2018) found that authentic assessment practices foster student engagement and responsibility, particularly in science-related tasks that demand critical observation and experimentation. Similarly, Perla & Vinci (2023) highlighted that authentic assessment contributes to improving both learning quality and ethical

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awareness by situating evaluations in realistic scientific contexts, such as laboratory investigations and environmental projects.Furthermore, Mabruroh and Ashsiddiqi (2021), revealed that transparent and process-oriented assessments help reduce tendencies toward academic dishonesty by emphasizing inquiry, problem-solving, and reflection throughout the learning process. When students perceive that their assessments genuinely represent their effort and understanding, they are more inclined to uphold honesty and accountability—key dimensions of academic ethics.

This finding aligns with international studies by Garcia (2025) and Marsh and Hagan (2024), which demonstrate that authentic assessment strengthens motivation and reduces plagiarism by fostering meaningful engagement. Additionally, Urbano et al (2025) confirmed that authentic tasks emphasizing creativity and critical reflection can minimize unethical academic behaviors, particularly in the context of increasing digital assessment challenges. Therefore, authentic assessment not only enhances the quality of science learning but also serves as an ethical framework that embeds integrity and accountability within students' cognitive and moral development.

Authentic Assessment for Enhancing Students' Career Readiness and Professional Identity

A defining strength of authentic assessment lies in its capacity to cultivate employability skills that mirror real-world professional practices. In this context, employability refers to one's ability to obtain, create, and maintain meaningful work throughout their career, encompassing the integration of knowledge, technical competence, attitudes, and personal characteristics that enhance opportunities for successful and fulfilling employment (Rosardi & Widiastuti, 2025). Developing such competencies requires students to engage in reflective and metacognitive learning that can be transferred to professional settings. For example, Syahrani et al. (2024) demonstrated that authentic assessments in social work education replicate real-world challenges, encouraging learners to perform as active social agents capable of navigating complex workplace dynamics. Employers frequently note that new graduates often struggle with strategic thinking, stress management, and resilience in high-pressure situations (Nimma et al., 2024)

Responding to this concern, Römgens et al. (2020) conceptualize employability as a multi-dimensional construct that integrates disciplinary expertise, transferable skills, social networking abilities, adaptability, and lifelong learning orientation. Within this framework, authentic assessment acts as a pedagogical medium that enhances these employability dimensions by immersing students in realistic, problem-based tasks that demand ethical judgment and independent learning (Mastikawati et al., 2022). Consequently, such assessments not only strengthen students' readiness for professional life but also promote institutional goals of producing adaptable, reflective, and ethically responsible graduates (Liu et al., 2026). Authentic assessment serves as a crucial pedagogical bridge between higher education and the professional world, ensuring that students not only acquire knowledge but also develop the skills and ethical values necessary for future careers. Within the framework of Authentic Assessment as a Solution to Enhance Deep Learning and Maintain Academic Integrity in Higher Education, this approach emphasizes assessments grounded in real-life applications—such as case analyses, project-based tasks, field investigations, and portfolio development (Ruhalahti et al., 2018). These experiences allow students to connect theoretical understanding with authentic practice, fostering both deeper learning and the cultivation of professional dispositions including accountability, collaboration, and ethical awareness (Zebua, 2025).

Empirical findings reinforce the potential of authentic assessment in promoting career readiness and shaping professional identity. Vlachopoulos & Makri (2024) revealed that the incorporation of authentic tasks in science education programs enhanced students' confidence, communication competence, and ethical decision-making in real classroom situations. Likewise, Kotsis (2025) reported that performance-based assessment in science teacher preparation encouraged critical reflection and strengthened moral reasoning—key components of

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professional growth. In another study, Garcia (2025) found authentic projects improved adaptability, teamwork, and integrity in completing complex tasks, aligning academic learning with workplace expectations. Through these learning experiences, students begin to view their academic responsibilities as integral to their future professions rather than isolated academic requirements (Sintiya et al., 2025). This shift supports the internalization of professional ethics and responsibility, which are central to both academic integrity and lifelong learning. Consequently, authentic assessment functions not merely as an evaluative instrument but as a developmental process that equips students to act as competent, ethical, and reflective professionals prepared for the evolving demands of the modern workforce (Siregar & Badriah, 2025).

Recent empirical studies have reinforced the pivotal role of authentic assessment in promoting deep learning, ethical academic behavior, and professional readiness across higher education, particularly in science-related disciplines. Research in Indonesian and international contexts demonstrates that authentic assessment not only measures students' understanding of content but also cultivates critical thinking, creativity, and responsibility—skills essential for scientific inquiry and lifelong learning. Moreover, the integration of pedagogical models such as STEM-ESD, project-based learning (PBL), and inquiry-based approaches has strengthened the alignment between assessment and real-world competencies. These models enable students to engage with complex, context-driven scientific tasks that mirror authentic professional challenges (Fathurohman et al., 2023). To provide a clearer overview of these research trends, several empirical studies conducted between 2020 and 2025 are summarized in the table below. The synthesis of these studies illustrates how authentic assessment supports the development of deep learning, academic ethics, and employability skills in science education, as shown in Table 3.

The synthesis of research presented in the table highlights a growing consensus that authentic assessment plays a pivotal role in redefining higher education, particularly within science-based and interdisciplinary programs. Through problem-solving, inquiry, and project-oriented This process not only deepens conceptual understanding but also nurtures essential competencies such as teamwork, critical reflection, ethical reasoning, and adaptability—attributes that are integral to developing career readiness and professional identity (Koh et al., 2019). Across the reviewed studies, authentic assessment emerges as a dynamic pedagogical approach embedded in various educational settings, including STEM disciplines, teacher education, and sustainability learning environments (Sintiya et al., 2025). Although these contexts differ, they share a unifying principle: aligning assessment with authentic performance demands. By doing so, students are evaluated on their capacity to synthesize knowledge, demonstrate applied skills, and act responsibly in complex, real-life situations (Hayati, 2025). This alignment contributes to the cultivation of deep learning, a learning process characterized by conceptual integration, metacognitive awareness, and long-term knowledge retention (Asyhad & Alimuddin, 2025).

Furthermore, many of the selected studies combine authentic assessment with contemporary instructional models such as STEM-ESD integration, project-based learning (PBL), and deep-learning-oriented inquiry approaches. These models encourage learners to investigate real problems, collaborate meaningfully, and construct solutions that reflect sustainable and ethical values (Fathurohman et al., 2023). In science education, such models parallel authentic scientific inquiry, in which observation, experimentation, and reflective analysis are essential. The inclusion of AI-assisted evaluation in some higher education practices further enriches this landscape by enabling adaptive feedback mechanisms, automating parts of the evaluation process, and enhancing transparency and fairness in grading Maulina et al. (2023). The collective findings from these studies suggest that authentic assessment significantly enhances students'-engagement, accountability, and moral responsibility (Setyowati et al., 2022). When students encounter contextually relevant assessment tasks—such as designing experiments, implementing community-based projects, or preparing reflective portfolios—they tend to exhibit stronger intrinsic motivation and ownership of learning (Sihombing et al., 2024).

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Table 3
Empirical studies on challenges and opportunities in implementing authentic assessment in higher education.

Author(s) & Year	Research Context (Science Education & Model Integration)	Main Challenges Identified	Key Findings / Implications
Maulina et al (2023)	Implementation of PBL-based authentic assessment in university science education courses	Limited lecturer competence in designing problem-based, authentic tasks and assessing inquiry process skills	PBL-oriented authentic assessment enhances students' problem-solving and scientific reasoning but requires lecturer mentoring and structured assessment design.
Sihombing et al. (2024)	Integration of STEM-ESD approach in science literacy and environmental education using authentic assessment	Inconsistency between assessment instruments and the measurement of science process skills	Combining authentic assessment with STEM-ESD improves deep conceptual understanding, sustainability awareness, and students' reflective thinking.
Zebua (2025)	Application of Deep Learning–based authentic assessment in biology education	Time constraints and adaptation of rubric for complex cognitive tasks	An authentic assessment designed around deep learning principles supports metacognitive skills and knowledge transfer, but needs efficient rubric development.
Pebriyanti et al (2025)	Implementation of digital inquiry-based authentic assessment in virtual science learning	Maintaining assessment integrity in online and simulation-based evaluations	Digital authentic assessment promotes academic honesty and higher-order thinking, strengthening integrity in remote science learning.
Hu et al (2025)	Development of authentic assessment integrated with reflective STEM projects in science teacher education	Lack of collaboration among assessors and limited standardization	Authentic assessment enhances professional identity and reflective practice among pre-service science teachers within STEM contexts.
Cahyani et al. (2024)	Implementation of project-based STEM assessment aligned with Deep Learning framework	Difficulty in aligning project evaluation with interdisciplinary learning outcomes	Deep Learning–oriented authentic assessment improves creativity, collaboration, and scientific literacy in STEM higher education.
Setyowati et al. (2022)	Evaluation of assessment literacy in STEM faculties and its impact on authentic assessment design	Low assessment literacy and lack of continuous professional development	Strengthening assessment literacy is essential to ensure reliability, fairness, and effective integration of authentic tasks in science disciplines.

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These authentic contexts foster not only the acquisition of scientific knowledge but also the ethical and professional dispositions necessary for future employment. As a result, assessment becomes both a measure of learning and a catalyst for character formation. Equally important are the institutional and pedagogical implications (Handayani et al., 2024). Implementing authentic and AI-assisted assessments effectively requires that educators possess adequate assessment literacy and the capacity to design meaningful, discipline-relevant tasks. This necessitates continuous professional development and supportive institutional policies that promote innovation and ethical evaluation practices (Kolade et al., 2024). Through this systemic effort, higher education institutions can create an environment that sustains deep learning, fosters integrity, and strengthens students' transition from academic settings to professional life (Ferguson et al., 2022). In conclusion, the studies consolidated in the table reinforce the argument that authentic assessment represents a transformative pathway for enhancing the quality and relevance of higher education (Retnosari et al., 2025). When integrated with AI-assisted tools, authentic assessment not only provides a more comprehensive understanding of student learning but also promotes reflective thinking, ethical awareness, and professional growth (Vilmala et al., 2025). Such integration positions authentic assessment as a central strategy for building adaptive, future-ready graduates capable of thriving in dynamic and ethically complex work environments (Perla & Vinci, 2023).

Obstacles to Integrating Authentic Assessment in Higher Education

Despite its proven potential to enhance deep learning and strengthen academic ethics, the integration of authentic assessment in higher education, particularly in science learning, faces a range of structural and pedagogical obstacles. Studies by Handayani et al. (2024) and Perla & Vinci, (2023) reveal that many instructors still rely heavily on traditional, test-based evaluations due to limited understanding of authentic assessment principles and a lack of institutional support for innovative assessment practices. This reliance on conventional methods often hinders the cultivation of higher-order thinking and ethical reasoning that authentic assessments are designed to promote.

In science education, Mabruroh and Ashsiddiqi (2021) noted that implementing authentic tasks such as inquiry projects or laboratory-based assessments requires substantial time, resources, and teacher competence in designing contextually relevant evaluation criteria. Similarly, Fitroni et al. (2025) emphasized that many educators struggle to develop rubrics that fairly measure both conceptual understanding and process skills without oversimplifying complex scientific inquiry. These practical constraints often lead to inconsistencies in assessment quality and reduced opportunities for students to demonstrate deep conceptual understanding. Designing authentic assessment in higher education presents several critical challenges, particularly related to the time, expertise, and institutional resources required to create meaningful, real-world learning tasks (Ali et al., 2022). These obstacles often hinder effective implementation and, consequently, impact the quality of student learning outcomes. In the context of science education, Setyawarno and Kurniawati (2018) emphasized that authentic assessment must be carefully constructed to align with inquiry-based and experimental learning processes an approach that demands extensive preparation, clear rubrics, and ongoing feedback mechanisms (Vlachopoulos & Makri, 2024).

From a broader perspective, Garcia (2025) and Marsh and Hagan (2024) found that large class sizes, rigid curriculum structures, and assessment standardization policies in higher education limit the feasibility of authentic, performance-based assessments. Moreover, Ruhalahti et al. (2018) highlighted the emerging challenge of digital integrity, where the increasing use of online tools and AI-assisted platforms can undermine the authenticity of student outputs if not accompanied by reflective and process-oriented evaluation. A major challenge lies in the time-intensive nature of developing authentic, context-based tasks that assess both conceptual understanding and scientific process skills. Sutadji et al. (2021) noted that such assessments

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require longer design cycles than traditional testing because they must simulate complex real-world situations and promote deep learning engagement. Similarly, Mabruroh and Ashsiddiqi (2021) highlighted that resource limitations—including insufficient access to laboratory facilities, digital tools, and scientific data—often constrain lecturers' ability to implement authentic assessment effectively.

A key challenge in implementing authentic assessment is the limited training and experience of lecturers in designing effective assessment tasks. Many educators still lack a clear understanding of authentic assessment principles and how to apply them in practice. Ueda & Ye (2024) found that structured training significantly improves lecturers' competence in developing assessments that evaluate both learning outcomes and learning processes. Without adequate preparation, lecturers often struggle to design authentic tasks that capture students' critical thinking and problem-solving abilities. Continuous professional development and institutional support are therefore essential to ensure consistent and meaningful implementation (Janssens et al., 2022).

Overall, the main obstacles—time demands, limited resources, and insufficient lecturer training, must be addressed to maximize the benefits of authentic assessment in higher education. Investing in training and resource development will enable educators to design high-quality assessments that not only improve learning outcomes but also strengthen students' character and ethical awareness (Kotsis, 2025). Addressing these obstacles requires systemic change, embedding authentic assessment within curriculum design, teacher professional development, and institutional policy frameworks. By fostering assessment literacy among educators and prioritizing reflective, inquiry-based tasks in science education, higher education institutions can overcome these barriers. Doing so will not only promote deeper learning but also embed ethical awareness and scientific integrity as central values in academic practice (Sopa et al., 2025). In addition, Kolade (2024) found that educators frequently lack adequate training in assessment design, particularly in constructing valid and reliable rubrics for evaluating inquiry-based learning. This pedagogical gap can reduce the consistency and fairness of assessment practices. Supporting evidence from Mastikawati et al. (2022) and Hamimi et al. (2021) suggests that the successful application of authentic assessment requires institutional commitment to lecturer professional development and curriculum flexibility. Without these supports, authentic assessment risks becoming a superficial exercise rather than a transformative practice that fosters deep learning and academic ethics.

Therefore, addressing these challenges is essential to ensure that authentic assessment fulfills its dual purpose: enhancing students' critical and scientific thinking while embedding values of honesty, responsibility, and ethical conduct, principles central to academic integrity in higher education. In conclusion, authentic assessment functions as more than an evaluation tool; it is a transformative approach that strengthens deep learning and academic ethics in higher education. Though its implementation faces challenges of time, resources, and educator readiness, evidence shows that it effectively fosters inquiry, critical thinking, and integrity, particularly in science learning. With institutional support and thoughtful design, authentic assessment can cultivate students who are not only intellectually competent but also ethically responsible, positioning it as a key driver of sustainable and meaningful learning in the 21st-century academic landscape.

CONCLUSION

Based on the research results, it can be concluded that the research authentic assessment offers a transformative pathway for advancing both deep learning and academic ethics in higher education. By emphasizing real-world relevance, reflective inquiry, and process-based evaluation, authentic assessment moves beyond traditional testing toward a more holistic understanding of student learning. Evidence from recent studies demonstrates that when learning tasks are contextual, transparent, and aligned with scientific inquiry, students exhibit greater motivation,

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integrity, and responsibility for their academic work. However, the integration of authentic assessment remains constrained by institutional barriers such as limited time, inadequate resources, and insufficient lecturer training. Addressing these challenges through systematic professional development and policy support is crucial to ensure effective and sustainable implementation. In science education, authentic assessment not only deepens conceptual understanding but also nurtures ethical reasoning, cultivating learners who are both intellectually capable and morally grounded. Ultimately, embedding authentic assessment into the fabric of higher education represents a strategic commitment to quality learning and ethical scholarship. It serves as a foundation for developing future graduates who can think critically, act responsibly, and contribute meaningfully to sustainable scientific and societal advancement.

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