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Open Learning and Adaptive Assessment as Pedagogical Strategies for Fostering Critical Thinking

Muhammad Qadrhizbullah[1*]

[1] Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Abstract

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In the digital era, the ability to think critically has become one of the most essential competencies for students, particularly at the high school level. Critical thinking not only equips students to analyze information and solve problems but also supports them in making rational and responsible decisions. This study aims to examine the role of open learning technologies and adaptive assessments in enhancing students' critical thinking skills. Using a qualitative approach with a literature study method, the research analyzed peer-reviewed articles published between 2020 and 2024 that focus on digital learning practices and assessment models in secondary education. The findings show that open learning provides flexibility and independence, enabling students to access diverse resources and engage more deeply in the learning process. Meanwhile, adaptive assessments offer accurate and personalized evaluations by adjusting to students' abilities and providing real-time feedback. The study concludes that integrating both approaches strengthens critical, analytical, and reflective thinking, while also supporting the goals of the Independent Curriculum.

*Corresponding author:
muhammadqadrhizbullah@gmail.com (Muhammad Qadrhizbullah)

1. Introduction

Critical thinking has become one of the core competencies that students must master in the digital era. At the level of secondary education, particularly in high schools, this skill plays a central role in helping students analyze information, address problems, and make decisions logically and responsibly. Modern education, therefore, is no longer limited to one-way knowledge transmission but is expected to cultivate students' capacity to evaluate information critically and apply it to real-life contexts. This shift aligns with the global demand for human resources equipped with higher-order thinking skills, including the ability to think critically, creatively, collaboratively, and communicatively.

The shift toward 21st-century learning places strong emphasis on technological integration, particularly through open learning and adaptive assessment. Open learning refers to a flexible educational model that accommodates students' learning time, pace, and location, while also granting access to diverse online resources. Technology provides opportunities for learners to independently explore knowledge with the support of digital media such as e-learning platforms, instructional videos, and simulations. In parallel, adaptive assessment functions as an evaluation system that adjusts to the unique abilities of each learner. With the help of technology, this form of assessment can dynamically adapt questions based on students' responses, thus producing results that better reflect actual competence.

A growing body of research highlights the effectiveness of combining open learning with adaptive assessment in creating more personalized and meaningful learning experiences. Rosa et al. (2024) revealed that integrating technology-based

assessments into mathematics classes enhances students' critical thinking by engaging them in open-ended and project-oriented tasks. Similarly, Brahmandika and Sutama (2024) found that the incorporation of technology within the Merdeka curriculum enables teachers to design collaborative and exploratory learning activities that nurture both creativity and critical thinking. Furthermore, adaptive assessment provides students with immediate feedback, allowing them to reflect on their performance in real time and make improvements where necessary.

The use of open learning technology and adaptive assessment in high school settings is inseparable from a number of challenges. Common obstacles include teachers' limited digital literacy, unequal access to devices and internet connections, as well as the lack of proper training for designing and applying technology in learning activities (Al Fadillah & Akbar, 2024). In terms of adaptive assessment, many schools still do not have technology-based evaluation systems that are fully integrated with the learning process. As a result, assessments often fall short of capturing students' cognitive development in a dynamic and individualized way.

On the other hand, the Indonesian government's policy through the Independent Curriculum creates valuable opportunities to advance more flexible and student-centered learning. This curriculum emphasizes formative assessment, project-based learning, and the integration of digital technology in classroom practice. In this respect, the adoption of open learning technology and adaptive assessment aligns with the vision of the Independent Curriculum to cultivate Pancasila student profiles who are critical, independent, and competitive in the global arena.

In light of this background, the purpose of this study is to examine in depth how open learning technology and adaptive assessment can enhance high school students' critical thinking skills. This research employs a literature review approach by analyzing empirical studies and theoretical works published within the last five years. The study is expected to strengthen evidence-based digital learning practices and serve as a reference for developing technology-oriented education policies that foster a generation capable of thinking critically and adapting effectively to the demands of the times.

2. Literature Review

Critical thinking is a cognitive competence that encompasses the ability to analyze, evaluate, and draw logical conclusions from available information. Within the field of education, this skill is regarded as a crucial foundation, as it not only helps students gain a deeper understanding of learning material but also equips them with the capacity to construct arguments, solve complex issues, and make sound decisions. Rosa et al. (2024) emphasize that critical thinking can be cultivated through learning approaches that provide opportunities for exploration, reflection, and active student participation in knowledge construction. One pedagogical strategy that facilitates this is technology-driven open learning, which enables learners to study independently and flexibly while accessing diverse digital learning resources. Such technologies foster an inclusive learning environment and encourage personalization. In practice, open learning is manifested in interactive learning videos, online simulations, discussion forums, and Learning Management System

(LMS) platforms that support autonomous learning. Ashari et al. (2023) found that students exposed to open learning approaches often display stronger reflective and analytical abilities compared to those engaged in conventional learning.

Furthermore, adaptive assessment emerges as a vital tool in identifying and nurturing critical thinking skills. This form of evaluation adjusts the difficulty of tasks according to students' capabilities and offers real-time feedback, which is highly beneficial for self-reflection and learning improvement (Sucipta et al., 2023). Al Fadillah and Akbar (2024) further argue that open-ended and context-based assessments are more effective in capturing students' reasoning processes compared to traditional multiple-choice formats. Through such methods, learners are challenged to articulate their reasoning, justify decisions, and defend perspectives. Thus, the integration of open learning with adaptive assessment provides a comprehensive framework for fostering and enhancing critical thinking skills among high school students.

3. Methods

This research applies a qualitative approach through the literature study method (library research) to explore and analyze how open learning technology and adaptive assessment contribute to enhancing the critical thinking skills of high school students. The literature study approach was selected because it enables the reconstruction of both conceptual frameworks and empirical findings from previous research conducted within a specific timeframe, namely 2020–2024. The primary emphasis of this study is placed on reviewing scholarly articles published in reputable

journals that address the application of digital learning and adaptive evaluation in secondary education. Data collection was carried out by searching for articles via Google Scholar using keywords such as "open learning," "high school education technology," "adaptive assessment," and "critical thinking students."

Articles included in the analysis had to meet several criteria: (1) directly related to high school student contexts, (2) discussing critical thinking or assessment in learning, (3) published between 2020–2024, and (4) employing a technology-based design or implementation. From an initial pool of dozens of publications, a rigorous selection process was undertaken based on abstracts and full-text content, resulting in key articles used as the core references for this study. These articles were further analyzed through thematic content analysis to identify the open learning and adaptive assessment strategies employed, their influence on students' critical thinking, as well as the factors supporting or hindering their application.

Thematic mapping was then conducted to provide a systematic understanding of patterns across the selected studies. Findings were organized according to the relationship between technological interventions and measurable outcomes of critical thinking skills. To ensure credibility, only peer-reviewed articles from nationally and internationally indexed journals were synthesized. The analysis was carried out inductively, moving from data identification to thematic interpretation, in order to minimize potential bias in drawing conclusions. By applying this method, the study aims to present a comprehensive overview of how open learning technologies and adaptive assessments can theoretically and practically strengthen the development of critical thinking among high school students.

4. Results and Discussion

The findings of the literature review indicate that the application of open learning technology combined with adaptive assessment provides a meaningful contribution to enhancing high school students' critical thinking abilities. The reviewed studies show that integrating educational technology not only broadens access to diverse learning resources but also builds a more flexible, interactive, and student-centered learning ecosystem that adapts to individual needs. In open learning settings, technology becomes a key driver in overcoming the boundaries of time and place in education. Tools such as Learning Management Systems (LMS), project-based learning platforms, interactive video materials, and digital modules enable students to engage with subject matter independently and at their own pace. Supporting this, Brahmandika and Sutama (2024) reported that 90% of students engaged in project-based and open learning activities demonstrated stronger skills in constructing arguments and making well-grounded critical decisions.

In addition, technological integration also enables teachers to design learning experiences that are both contextual and collaborative. Here, students act not only as knowledge recipients but also as active participants in problem-solving, discussion, and reflection. Rosa et al. (2024) highlight that project-based open learning stimulates students to approach real-world problems from multiple perspectives, thereby sharpening the depth and direction of their critical thinking. This method also strengthens the relevance of classroom content to daily life, a crucial factor in nurturing critical reasoning. Similarly, Awouda et al. (2024) observed that students involved in exploratory activities via digital platforms showed marked

improvements in evaluation and synthesis, two higher-order skills within Bloom's taxonomy.

At the same time, adaptive assessments supported by digital tools bring distinct advantages through the personalization of evaluation processes. By adjusting question difficulty based on student responses, adaptive systems move beyond the limitations of uniform conventional testing, capturing individual progress more accurately. Ashari et al. (2023) found that technology-driven assessments, which combine adaptive techniques with gamification elements, significantly boosted student motivation and reflective thinking skills. Learners became more engaged and challenged since tasks matched their comprehension level. Furthermore, real-time feedback allowed them to promptly identify weaknesses and make necessary adjustments to improve their performance.

Sucipta et al. (2023) underline that adaptive assessment functions not only as a measurement tool but also as an essential component of the learning process itself. By engaging in open and reflective evaluation, students are encouraged to assess their own reasoning, recognize underlying assumptions, and refine their perspectives using stronger arguments. Such reflective practice is a cornerstone of critical thinking development. Similarly, Al Fadillah and Akbar (2024) discovered that learners who participated in digital-based open assessments exhibited notable progress in logical reasoning and in drawing evidence-based conclusions. These findings demonstrate that adaptive assessment serves as both an instrument for measurement and an effective avenue for fostering cognitive growth.

The integration of these two strategies is closely aligned with the Independent Curriculum that has recently been adopted in Indonesia. This curriculum highlights differentiated instruction, formative assessment, and technology integration to advance student-centered learning. Within this framework, open learning technology and adaptive assessment emerge as highly suitable tools for realizing these goals. Anggraini et al. (2022) showed that digital project-based assessments implemented under the Independent Curriculum enable teachers to design tasks that challenge students' critical thinking, while simultaneously strengthening their engagement and responsibility for learning outcomes.

Nevertheless, applying open learning and adaptive assessment in high schools still faces multiple challenges. Key barriers include infrastructure limitations, such as inconsistent internet connectivity, restricted access to digital devices, and disparities in teachers' digital competence. Research by Ardiansyah et al. (2023) indicates that many teachers in less-developed regions still struggle to design effective technology-driven learning activities and assessments. Additionally, the entrenched school culture that prioritizes cognitive test scores over reflective and open-ended evaluation remains a significant obstacle in adopting more progressive approaches.

Research conducted by Sucipta et al. (2023) revealed that students who participated in adaptive assessments experienced an 18% improvement in their critical thinking abilities when compared to peers assessed through conventional methods. The most significant progress was observed in the domains of analytical skills, logical reasoning, and decision-making capacity. These results provide clear evidence that adaptive assessment can effectively enhance the quality of students'

cognitive processes. Complementing this finding, Riadi and Hidayatullah (2024) emphasized that the incorporation of artificial intelligence (AI) into adaptive learning enables the delivery of personalized materials and continuous assessments that challenge students' logical thinking in a more targeted way. At the same time, the literature highlights a notable shift in the role of teachers, from traditional knowledge providers to facilitators of learning. This transformation requires teachers to be able to utilize technology in a creative and strategic manner, particularly in designing meaningful learning experiences and assessments that encourage higher-order thinking.

Further support is offered by Mirata et al. (2020), who found that teachers who underwent training in adaptive technologies were better equipped to design varied and intellectually stimulating learning scenarios for their students. Such practices fostered higher levels of cognitive engagement and helped cultivate a classroom culture that values and promotes critical thinking. Taken together, the synthesis of these studies suggests that the integration of open learning technologies with adaptive assessment establishes a powerful synergy for strengthening the critical thinking abilities of high school students. While open learning tools create opportunities for independent exploration and reflective learning, adaptive assessment ensures that evaluation processes remain flexible and responsive to individual progress. These insights reaffirm the idea that education in the 21st century must extend beyond content mastery, shifting instead toward approaches that prioritize processes of inquiry, reflection, and the cultivation of advanced cognitive skills.

5. Conclusion

From the findings of the literature review, it can be inferred that the integration of open learning technologies and adaptive assessments plays a crucial role in enhancing high school students' critical thinking abilities. Open learning platforms provide students with access to diverse, flexible, and self-directed learning resources, which in turn promote autonomy and stimulate more in-depth engagement with knowledge. At the same time, adaptive assessments enable a more precise and individualized evaluation process, presenting questions tailored to each learner's level of understanding and offering immediate feedback that supports reflective learning. Together, these two strategies foster an educational process that emphasizes not only academic achievement but also the cultivation of analytical, evaluative, and reflective thinking skills.

Evidence from various studies demonstrates the effectiveness of this approach, particularly when implemented within a flexible framework such as the Independent Curriculum. Nevertheless, the overall success of these practices is highly dependent on the availability of technological infrastructure, the preparedness of teachers, and sustained policy support. Accordingly, it is essential for educational institutions to design policies that systematically facilitate digital transformation, ensure continuous professional development for teachers in technology use, and provide equitable access to the necessary infrastructure. With such support, technology-based learning can evolve into more than just a response to contemporary challenges, it can serve as a strong foundation for nurturing a generation of learners who are critical, creative, and independent thinkers.

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