Research Article

Integration of Technology in Learning: Enhancing Higher Order Thinking Skills (HOTS) in Secondary School Students

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Abstract:

The integration of technology, particularly Artificial Intelligence (AI), in secondary education has shown significant potential in enhancing students' higher-order thinking Skills (HOTS). This study regularly reviews 18 articles to examine how digital platforms and AI tools are being used to support critical, analytical, and creative thinking among students. Findings indicate that AI-enhanced learning environments stimulate deeper engagement with learning content, foster independent problem-solving, and encourage reflective thinking. Beyond facilitating access to information, technology is also reshaping students' mindsets, shifting them from passive consumers to active thinkers. Despite its growing adoption, research on AI's direct impact on HOTS remains limited. This study contributes to the existing literature by exploring not only the benefits but also the pedagogical implications of AI integration in secondary education. Through this, the study aims to inform educators and policymakers about strategies to optimize technology use for cognitive development in learners.

1. Introduction

In recent years, technology, especially artificial intelligence (AI), has advanced rapidly and changed the way we live, work, and learn. In the world of education, technology has made it easier to access various information and learning materials. With the presence of various digital platforms and AI-based applications [1], students now have unlimited resources to study certain topics. However, although technology offers various conveniences, its impact on the development of higher-order thinking Skills (HOTS) in students is a concern.

Many students now tend to rely on technology to get quick answers without going through a deep critical or analytical thinking process. As a result, higher-order thinking skills, such as the ability to analyze, evaluate, and create new solutions, are increasingly neglected. The availability of AI technology that automatically provides information and solutions for students can reduce their motivation to think more deeply or develop creativity in solving problems [2]. This situation adds new challenges for educators to utilize technology optimally, not only as a tool to convey information but also as a means to improve HOTS in students, especially at the secondary school level [3].

Although there is Already Much research exploring the integration of integration technology, most big studies previously tend to focus on using technology to support understanding or strengthen low-level skills or strengthen skill memorizing and understandings memorizing and understanding [4]. In-depth research shows how very in-depth research technology can, in a way, direct higher-order Thinking Skills in students Thinking (HOTS) in students' school medium.

Besides that, a lot of existing research has Not yet considered the impact intelligence artificial intelligence (AI), which is increasingly massive in education, which may precisely be at risk of worsening conditions, with give solution instant that reduces the chance for students to think

critically and creatively [5]. Research previously also limited to general technology, without considering How AI technology and more digital tools can used to develop skills more cognitively in context learning school medium.

Study This aims to fill in the gap by focusing on integrating technology, especially artificial intelligence (AI), in learning to improve HOTS in students' school medium [6]. The novelty of this study lies in the emphasis on how technology, in particular AI technology, can be used not only to make learning easier but also to stimulate students to think more critically, creatively, and analytically.

Study This will explore how AI-powered digital learning platforms can push students for more active in solving problem complex, evaluating various alternatives, and creating innovative solutions [1]. In addition, the research will also evaluate the impact of technology on change patterns, thinking students who often rely on convenience access information offered by technology are invited. To focus more on the thinking process and development skills, think level tall.

Study This aims to fill in the gap in existing literature related to integration technology, in particular intelligence artificial intelligence (AI), in learning to increase Skills in higher-order thinking (HOTS) in students' school medium [7]. Although technology has Lots applied in education, in-depth research about the impact on HOTS development is still very limited. Research This will study How technology, especially AI, can used not only to make it easier to access information but also to stimulate students to think more critically, creatively, and analytically. With understanding the impact technology has on pattern thinking students, research Aims To explore ways innovative in optimizing the use of technology to increase the ability to think level high in students.

Based on objective research that has been mentioned, as follows is the hypothesis beginning that can submitted :

- **Q1.** Technology integration, especially artificial intelligence (AI), in learning can increase Skills of higher-order Thinking (HOTS) in students' school medium.

- **Q2.** Technology, especially AI, can stimulate students to think more critically, creatively, and analytically in context learning at the school medium level.

- **Q3.** Digital learning platforms supported by AI technology can push students for more active in solving complex, evaluating alternatives, and creating innovative solutions.

- **Q4.** Using technology in learning can change the pattern of thinking of students who tend to depend on convenience to access information, which pushes them to focus more on the thinking process and development skills at a high level.

2. Background literature

Technology in Learning in Secondary School Students

The integration of technology in education has become a crucial aspect in shaping learning environments in secondary schools. In recent decades, technological advancements have significantly transformed how we access and deliver education, providing various tools and platforms that enhance students' learning experiences. Secondary school students, growing up in a digital environment, are increasingly accustomed to using technology, making it essential for educational institutions to leverage these tools in the teaching and learning process. Technologies such as Artificial Intelligence (AI)-based platforms, virtual learning environments (VLEs) [8], and gamification have been employed to support more dynamic learning experiences, offering more varied and interactive content. One of the primary benefits of technology is its ability to personalize the learning experience, allowing students to progress at their own pace, revisit difficult topics, and move ahead when they master concepts [9].

This personalized approach is crucial in catering to a wide range of learning styles and abilities. Technology also allows students to access a wealth of information beyond traditional textbooks, enriching their learning through online databases, academic journals, and multimedia. This encourages students to engage in active research and inquiry-based learning, which helps develop their critical thinking, analytical, and reflective skills. Furthermore, technology facilitates collaboration among students through digital platforms that enable them to work together on projects, discuss, and share ideas in real time, fostering communication and teamwork skills. In terms of developing higher-order thinking skills (HOTS), technology, especially AI, plays a vital role in stimulating students to think more critically, creatively, and analytically. By using AI-based platforms, students engage in more complex problem-solving processes, evaluate alternative solutions, and create innovative ideas, which align with HOTS indicators such as analysis, synthesis, and evaluation. However, despite the numerous benefits offered by technology, there are still challenges in integrating it effectively, including inadequate infrastructure, a lack of teacher training,

and resistance to change.

Many schools, especially those in remote or underfunded areas, face challenges related to unstable internet access, outdated hardware, and limited digital resources. Therefore, to ensure effective use of technology in learning, it is essential to invest in both infrastructure and professional development for educators. In the future, emerging technologies such as augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT) are expected to play an increasingly significant role in education, creating more immersive and engaging learning experiences [10]. These technologies will allow students to interact directly with complex learning content, providing experiences that cannot be achieved through traditional teaching methods. Overall, the integration of technology in secondary education holds immense potential to enhance learning outcomes, enrich the learning process, and develop essential higher-order thinking skills to prepare students for the challenges of the modern world.

Higher Order Thinking Skills (HOTS) in Secondary School Students

Higher Order Thinking Skills (HOTS) are essential cognitive abilities that enable students to engage deeply with content and solve complex problems. These skills involve processes such as analysis, evaluation, synthesis, and creation, which go beyond basic memorization or recall of information. In secondary education, the development of HOTS is crucial as it prepares students for the complexities of the real world, where critical thinking, creativity, and problem-solving are necessary for success. Research has shown that students who develop HOTS tend to perform better academically, especially in subjects that require higher cognitive engagement, such as science, mathematics, and literature. HOTS are associated with skills that allow students to analyze information critically, evaluate alternatives, and generate innovative solutions, which are vital for success in both academic and professional environments [11].

The integration of technology in education has a significant impact on the development of HOTS. Digital tools and AI-powered platforms create interactive learning environments that challenge students to think critically, test hypotheses, and engage in problem-solving activities. These technologies help personalize the learning experience, enabling students to progress at their own pace while developing analytical and creative thinking skills. Additionally, project-based learning (PBL) and inquiry-based learning (IBL) are

instructional methods that promote HOTS [12]. Both approaches encourage students to take an active role in their learning, allowing them to work on complex problems, conduct research, and create new ideas. These methods foster skills like analysis, synthesis, and evaluation, which are central to HOTS.

Teachers play a key role in developing HOTS in secondary school students by employing teaching strategies that encourage critical thinking. Instead of simply asking students to recall facts, effective educators pose open-ended questions that require students to analyze, evaluate, and synthesize information. By incorporating collaborative learning and problem-solving activities, teachers help students develop the cognitive skills needed for higher-order thinking. However, there are challenges in developing HOTS [1], particularly due to traditional education systems that prioritize rote memorization over critical thinking. Furthermore, not all educators have the necessary training to foster HOTS in the classroom, which can limit students' opportunities to engage in higher-level cognitive processes.

As the demand for innovation and complex problem-solving grows in the modern world, the development of HOTS will become even more critical. Technology, alongside project-based and inquiry-based learning, offers opportunities to enhance these skills, but there is a need for continued investment in teacher training and curriculum development to ensure that students are equipped with the thinking skills required for success [13]. The future of HOTS development lies in creating educational environments that foster critical thinking, creativity, and problem-solving, ensuring that students are prepared for the challenges and opportunities of the 21st century.

3. Methodology

Study This uses a systematic method with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach to identify, assess, and filter study-related integration technology in learning and its impact towards higher-order thinking Skills (HOTS) in students' school medium [14]. PRISMA is A designed guideline for increasing quality reports in systematic review and meta-analysis, ensuring that all step study reported in a way that is transparent and can replicated [15].

Identification

Some keywords used to identify a study that discusses integration technology in education, in

particular in context improvement Skills Higher Order Thinking (HOTS) in student's school intermediate [16]. Keywords used cover important topics like implementation intelligence artificial intelligence (AI) in learning and the use of technology that supports a better learning process OK. Next is a list of keywords used in search literature :

Table 1. Keywords Search

Integration of technology in education
Higher-order thinking skills
AI in learning
Secondary school students
Technology-enhanced learning

In the search literature for this study, the keywords listed in Table 1 are used with implementation Boolean logic "AND" and " OR". The "OR" logic is applied to each keyword to ensure search covers variation relevant terms, such as "Integration of technology in education" OR "Higher order thinking skills" OR "AI in learning". While that, the logic "AND" is used for connecting some different keywords to obtain a study that discusses the topic in a way more specific and comprehensive, such as "AI in learning" AND "Secondary school students".

Screening

Filtering is done based on criteria inclusion and exclusion that have been determined to ensure that selected studies are in accordance with the focus study [17]. Criteria cover factors like range of time publication, relevance, Topic with technology and skills think level high (HOTS), as well as the type of published publications in peer-reviewed journals or conferences [18]. The following is a table depicting the criteria for inclusion and exclusion used in the screening process study :

Eligibility

After the filtering process, the next step furthermore is to inspect the eligibility and quality studies that have been selected. At this stage, this research that is still ongoing to fulfil criteria inclusion and exclusion will be analyzed comprehensively to ensure that the data obtained is in accordance with objective research [19]. Extracted data from every study covering methodology used, type integrated technology in learning, impact technology to skills think level

high (HOTS) student's school medium, and findings main points and conclusion from every research [1]. To ensure quality and validity results obtained by researchers will do an analysis quality of every study using tool evaluation appropriate quality [4], such as Risk of Bias (RoB) or Critical Appraisal Skills Programme (CASP), in order to ensure that results study originate from studies that can reliable and valid.

Stages This started with identifying studies through various relevant databases and registers. After that, it was carried out to eliminate articles that did not fulfil the criteria for inclusion, and finally, only appropriate studies were included in the review. This diagram clearly describes the steps taken in the selection process to ensure the quality and relevance of selected studies to the objective study. The process begins with identification studies from various trusted databases, such as Scopus, Web of Science, and Education of Science, which produce a number of big articles. After that, it is done by filtering begins to deleting duplication and articles that do not fulfil criteria inclusion so that only relevant studies are considered more. Stage next is evaluation eligibility, where each remaining study is evaluated in a way deep to ensure conformity with the criteria of research. As a result, only 18 studies met the criteria. All criteria selected inclusion and eligibility for entered in review.

Analysis

After data extraction is complete and reviewed, For consistency, findings the compiled into in table summary structured [20]. Tables This contains code detailed of the 18 studies analyzed and presented in the accompanying attachments article (see Appendix). Data extraction focused on identifying aspects mainly related to the integration of AI and digital technologies in education, in particular in developing Skills in Higher Order Thinking (HOTS) among student school medium. Questions study answered systematically. Questions study First, using extracted data to identify How AI integration contributes to the development of HOTS. Questions study second researching How technology, especially AI, stimulates thinking critical, analytical and creative in-context learning. Questions study third explores how AI-powered digital learning platforms drive students [21]. In a way, they actively solve problems with complex and productive solutions. Lastly, the question study evaluates how technology changes patterns, thinking students change from consumers to passive information and become thinkers actively involved in the learning processes level. Data from 18 articles analyzed has been extracted
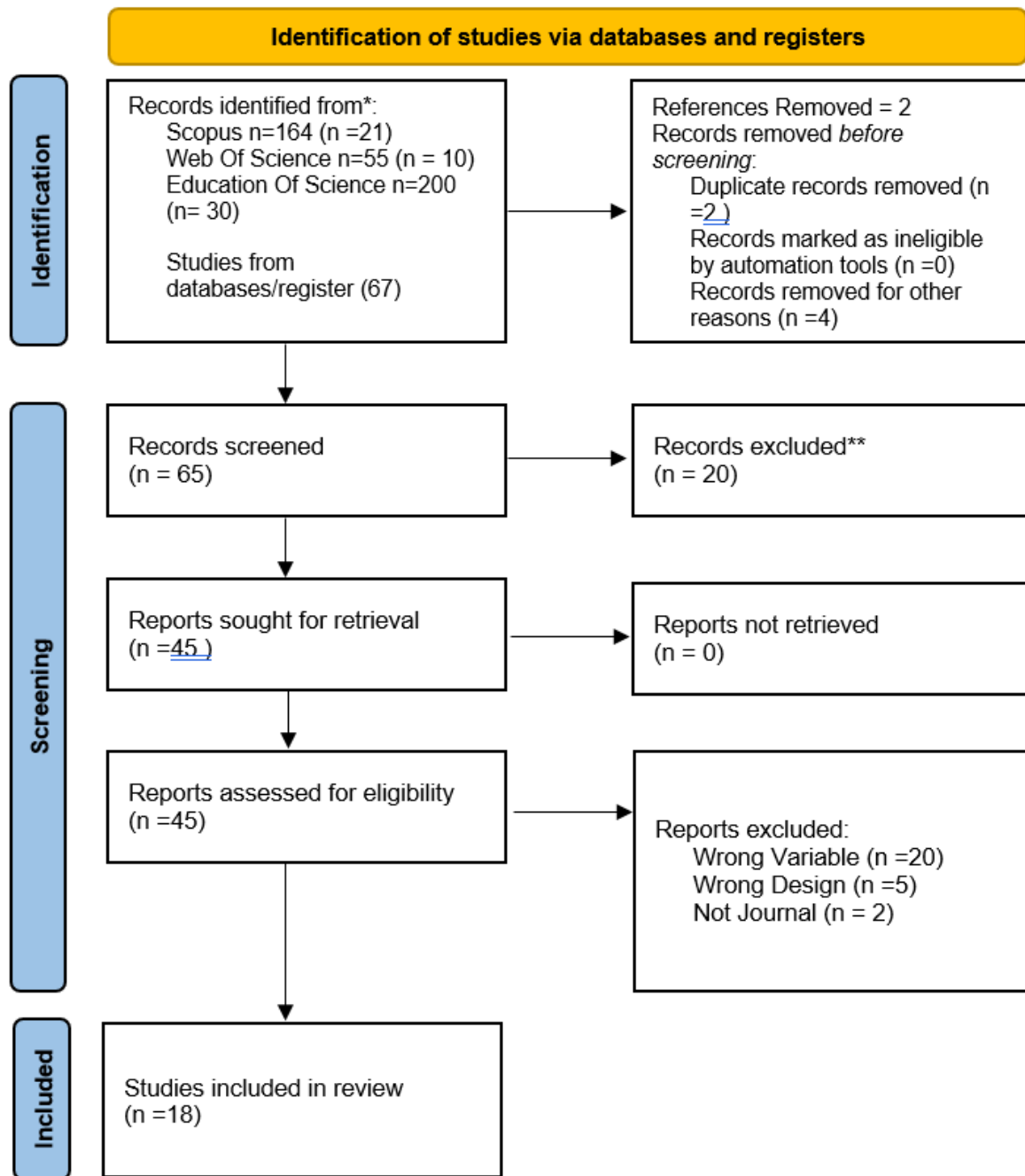
Identification of studies via databases and registers

Identification

Records identified from*:
  Scopus n=164 (n =21)
  Web Of Science n=55 (n = 10)
  Education Of Science n=200
  (n= 30)

  Studies from
  databases/register (67)

→

References Removed = 2
Records removed *before
screening*:
  Duplicate records removed (n
  =2)
  Records marked as ineligible
  by automation tools (n =0)
  Records removed for other
  reasons (n =4)

Screening

Records screened
(n = 65)

→

Records excluded**
(n = 20)

Reports sought for retrieval
(n =45)

→

Reports not retrieved
(n = 0)

Reports assessed for eligibility
(n =45)

→

Reports excluded:
  Wrong Variable (n =20)
  Wrong Design (n =5)
  Not Journal (n = 2)

Included

Studies included in review
(n =18)

***Figure 1.** Prisma Flowchart*

in a systematic way to identify How integration technology, in particular intelligence artificial intelligence (AI), contributes to the development of skills at the high level (HOTS) in learning. Extraction results This is summarized in the table (see Appendix A) and includes objective research, methods, main findings, and the relation with HOTS development through the use of technology:

- **Critical Thinking**
  Nine articles discuss critical thinking. Critical thinking includes the ability to

evaluate information objectively and logically, question assumptions, and compile an argument or valid conclusion [22]. Many articles highlight the role of AI in stimulating critical thinking and assessing information.

- **Analytical Thinking**
  Nine uplifting articles are included. Analytical thinking involves breaking information into small parts for analysis. AI technology is used to help students structure

complex information and identify connections between drafts.

- **Creative Thinking**

  A total of 8 articles high light the skills of creative thinking. Creative thinking is the ability to generate ideas or solutions that are new and original. Studies show that AI, especially generative AI like ChatGPT, facilitates the exploration of innovative ideas and supports the divergent thinking process.

- **Problem-Solving**

  There were 10 articles that emphasized the importance of skills. Problem-solving is the process of finding a solution for a problem that is not own answer directly. Many articles show that AI supports the breakdown of complex problems through simulation, learning based on projects, and feeds that come back direct.

- **Evaluation and Judgment**

  6 articles examine its skills. Evaluation and judgment include the ability to make evaluations based on certain criteria. AI is used in context evaluation, which is automatic, reflection-independent reflection, and databased decision-making.

- **Reflection**

  Four articles discuss skills reflection. Reflection is a process of thinking. Return to experience or results Study To increase understanding. Some articles note that technology helps students evaluate the thinking process they use.

- **Synthesis and Creation**

  Seven articles discuss the ability to synthesize and create. Synthesis and creation involve merging information from various sources to produce something new. AI is often used as a tool to help create content, including writing, presentations, and multimedia projects.

- **Decision Making**

  Found 2 articles discussing making a decision. Decision-making is the ability to choose the solutions best from various alternatives. The technology used for support taking decision data-driven and modelling scenarios.

Limitations

Studies This instead of without limitations. First, the analysis is limited to 18 articles, which may not fully represent the landscape of further research about AI integration and development skills level high (HOTS) in education [23]. The studies chosen also vary in matter context, level of education, and methodology, which can cause heterogeneity in interpretation. Furthermore, the main thing is in the literature that has been reviewed by peers, who have the potential to ignore outlook relevant from literature grey, ongoing research, or studies that are not published.

Second, although the coding process is systematic, there is still the possibility of subjective interpretation during data extraction and classification of the HOTS category [6]. Some studies do not explicitly label or define skills based on the specifics discussed, so inferred coding based on thematic analysis is needed.

Lastly, the rapid development of emerging AI technology, especially Generative AI, presents a target that continues to grow changed. Thus, the findings from the review This Possible become worn because of the emergence of tools, pedagogical approaches, and new research. Future research must Continue to monitor and evaluate the connection dynamic between AI and practice education in various backgrounds and populations.

4. Results and Discussion

A total of 18 studies were entered in the review and detailed in Appendix A. Studies the obtained from three source main: Scopus, Web of Science, and Education of Science, with an initial total of 419 records before being filtered. After the filtering process, the beginning involved deletion duplication and articles that were not relevant, 65 notes were selected for review. A total of 45 reports were Then evaluated for eligibility, and 27 of them were issued Because they used variables that were not appropriate (n = 20), designed research that was not relevant (n = 5), or none did no article journal (n = 2). Selection Process This produced 18 studies that met the criteria criteria inclusion and were analyzed in a way deep.

All studies analyzed published between 2020 to 2024 focusing on integration technology, especially Artificial Intelligence (AI) and Generative AI (GenAI) in context learning. Studies This represents context education intermediate and also high, and serves diverse approaches methodological start from survey quantitative, interview qualitative, up to method mixed. Studies explore the contribution of technology to the development of higher-order thinking Skills (HOTS), such as thinking critically, analytically, creatively, problem-solving problems, and reflection.

Q1: Technology integration, especially artificial intelligence (AI), in learning, can increase Skills of higher-order Thinking (HOTS) in students' school medium.

Analysis results against 18 articles show that integration technology, in particular intelligence artificial intelligence (AI), is consistently associated with improvement skills level high (HOTS) in students' intermediate school. Findings in studies This indicates that technology is not only used as a tool to help instruction but rather functions as a facilitator of cognitive strengthening ability to think critically, analytically, and creatively [24]. Some articles, such as those written by [25] and [26], argued that implementation technology in smart classroom form, devices learning AI-based, and digital simulations are capable of creating experiencing interactive and challenging learning environments. Kind of This allows students for involved more in breakdown problems, making decisions, and reflecting on the thinking process they are Alone.

Besides that, the findings from the articles by [27] and [28]emphasized that technology gives room for students to evaluate information in an independent way, process content in a way critically, and produce ideas or solutions new . These processes, in harmony with indicator main HOTS, such as analysis, synthesis, and evaluation, emerged as results direct from the utilization of technology AI based on learning. Many studies take note that AI integration drives students For No Again not only to become recipient information but also to creator's knowledge through involvement in active, explorative, and reflective material lessons.

Q2: Technology, especially AI, can stimulate students to think more critically, creatively, and analytically in context learning at the school medium level.

Results of the study against 18 articles show that technology, in particular intelligence artificial intelligence (AI), has a significant role in stimulating students to think more critically, creatively, and analytically in context learning at the level of school intermediate [29]. Studies underline that AI is not only a tool to help technical but also a cognitive medium that is capable of pushing the involvement of intellectual students in the learning process. For example, [26] and [30] revealed that the use of AI-based platforms such as ChatGPT helps students develop critical thinking through the process of testing ideas, comparing information, and reflecting on learned content. AI also provides an environment that encourages exploration and creation of ideas, which is based on thinking creatively.

Next, articles like [26] and [24]showed that students exposed to the system learning tend to

show improvement in thinking analytically, especially in describing complex problems, connecting drafting cross topics, and evaluating various alternative solutions. AI plays a role in providing fast and specific feedback, which allows students to revise their understanding sustainably and develop ideas independently [21]. Even in context assignments, technology pushes students To compile logical arguments, develop creative approaches, and think in a way systematic to problems faced.

Q3: Digital learning platforms supported by AI technology can encourage students to be more active in solving complex problems, evaluating alternatives, and creating innovative solutions.

The findings of the 18 articles analyzed indicate that the digital learning platform supported by AI technology consistently pushes students for more active in solving complex, evaluating alternatives, and creating innovative solutions. Studies as done by [22], [31]and [32]showed that the presence of AI in learning platforms Not only facilitates access to information but also directs students to develop a systematic approach to finishing tasks that are of a nature open and problematic. AI enables personalization learning with serve challenge adaptive and feed come back automatically customized with the needs of each student so that push exploration alternatives and improvements quality the resulting solution.

Besides that, articles such as [33] and [12] emphasize that AI technology strengthens the involvement of students in the process of making decisions through simulation database databases, scenario breakdown problems and the use of tool help analysis. In context, students Not only finish questions routinely but are involved in the evaluation process [31], the choices available and make decisions based on information that has been they analysis in a way deep. This shows that AI is not only a provider answer but also a partner supportive thinking development of original and contextual solutions.

Findings strengthen that AI-based digital platforms create room for dynamic and solution-oriented learning problems [34]. This environment, in a way, actively stimulates students' ability to evaluate complexity, consider various alternatives, and design solutions relevant to innovative learning in the 21st century. AI has proven to become more important in transforming learning from a reproductive nature towards a productive and creative nature.

Q4: The use of technology in learning can change the pattern of thinking. Students tend to depend on convenience to access information that pushes them to focus more on the thinking process and development skills. Think level tall.

Analysis of 18 articles shows that the use of technology in learning, especially that which is based on intelligence artificial intelligence (AI), contributes to changing patterns. Students, from the beginning, tend to be passive and dependent on convenient access to information and become more active and reflective in the process of thinking. A study done by [9] and [11] revealed that AI integration in activity Study pushes students not just to look for answers instantly but to trace the thought process in a way deeper. In environment learning based on technology, students are faced with challenges that require understanding conceptual, logical reasoning, and strategic planning, so they get involved cognitively.

Furthermore, research by [8] and [35] emphasized that technology allows the occurrence of a learning process that emphasizes reflection, evaluation, and reconstruction of understanding. Features like bait coming back automatically, monitoring progress learning, and digital scaffolding provide students with a chance to evaluate results, work themselves alone, understand mistakes, and improve learning strategies. This is to form habits and learn more autonomous and responsible answers to the thinking process, not just results-oriented.

It can be concluded that the use of technology in learning plays a role in forming a more process-oriented student mindset, not only product-oriented [13]. Technology helps facilitate the shift from learning that is of a nature consumptive to constructive learning, where students are pushed to think critically, investigate information in-depth, and develop skills that are level-high and sustainable.

5. Conclusions

Study This discloses that integration technology, in particular intelligence artificial intelligence (AI), has a significant impact on improving skills at think level high (HOTS) in students' school medium. Although technology is Already Lots applied in the world of education, in-depth research about its influence on HOTS development is still limited. Based on an analysis of 18 relevant articles, it was found that AI-based technology AI based not only makes it easier to access information but also functions as a trigger for students for more active in thinking critically, creatively, and analytically. The use of tool learning AI-based learning, such as smart classrooms, adaptive platforms, and digital simulations, enables students for involved more in in breaking complex problems and evaluating various alternative solutions. This process strengthens the ability to think in a better way structured and in-depth, which is the core of HOTS. In addition, the use of technology also works to change patterns think students, from dependence on convenient access to information, become better at understanding the thinking process That is Alone.

However, even though findings show the potential big AI to improve HOTS, there are still a number of gaps in the necessary literature. Therefore, a recommendation from the study covers the need to study more continuation deep for to impact term long from use AI technology in various context Education. Research more carry on can explore How technology can integrated in a more comprehensive way into curriculum education intermediate. For more, delve deeper into its influence on HOTS development. In addition, to support the successful of AI integration, it is also important to give adequate training for educators so that they can optimize potential technology in teaching. Improvement in accessibility technology also becomes step important to ensure that all students, without exception, can feel the benefit from learning AI-based. With these steps, it is expected that the use of technology will Keep growing and have a positive impact on skills at think high level in students' schools medium.

ensuring the text was polished and professional. Lastly, our appreciation goes to GitHub Copilot, whose code completion and suggestions helped us maintain coherence and consistency throughout the article, especially when drafting technical sections. The seamless integration of Copilot allowed us to focus on the content while enhancing the technical accuracy of our work. These tools significantly contributed to the efficiency and effectiveness of our writing process, and we are grateful for their assistance in the creation of this article.

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