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Utilization of Generative AI in High School Learning: Opportunities and Challenges Analysis

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Abstract

Study This aims to analyze opportunities and challenges in implementing generative AI technologies, such as ChatGPT and DeepSeek, in learning at the level of intermediate school in Indonesia. The approach is qualitative and descriptive based on studies, cases, and research. This is to study document policy, report education, and literature exploring readiness source power, integration processes and impacts implementation technology. The research results show that generative AI potential increases students' motivation and participation, primarily through learning media interactive and personalized material. However, there are obstacles in form gap in digital access and lack of it related to teacher training AI technology. In conclusion, the success of the implementation of generative AI relies heavily on equity digital infrastructure, training sustainable for power educators, and proper supervision of policies. Novelty from study This lies in mapping integrative opportunities and obstacles to generative AI implementation in context education middle in Indonesia. Recommendations policy covering improvement of digital access nationally, compilation guidelines on using AI in schools, and periodic evaluation of the effectiveness of AI-based learning.

Keywords: Generative AI, ChatGPT, DeepSeek, High School Learning, Education Policy

1. Introduction

Revolution technology in the digital era has changed various aspects of life, including education. One innovation in the middle developed rapidly is intelligence artificial generative AI, which is capable of creating new content in the form of text, images, audio, or video automatically based on specific input. In the world of education, technology has the potential to support better learning processes that are adaptive and creative [1], especially at the upper secondary level of schools. In Indonesia, integration technologies like ChatGPT and DeepSeek open opportunities to create environment learning based on dynamic and interactive multimedia.

Generative AI has the ability To respond to the needs of learning students by giving solutions based on personalization [2]. ChatGPT, for example, can give students relevant answers to various questions, help them understand material lessons, and even act as a virtual mentor in activity study independent [3]. On the other hand, DeepSeek, which focuses on creating multimedia content based on text and images, assists teachers in making king material engaging and interactive visual learning [4]. With the second technology, students are expected to be more active and creative in exploring lessons.

In the Indonesian context, integrating generative AI in high school education can potentially increase quality learning, especially in schools that implement multimedia-based approaches. The current curriculum emphasizes the importance of mastery of digital literacy and skills. The 21st century provides opportunities for the utilization of technology [5]. Through generative AI, students can develop critical thinking, creativity, communication, and collaboration skills that become part of objective national education.

However, the application of generative AI in high schools faces various challenges and obstacles. One of the main limitations is the digital infrastructure in several regions of Indonesia, especially in isolated areas [6]. In addition, there are still many schools that lack adequate access to devices and stable internet connectivity. This digital divide has become a significant barrier to ensuring the equal distribution of benefits from generative AI technology throughout Indonesia [7]. The gap between urban and rural areas in terms of technological access also exacerbates

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this issue. Furthermore, the lack of sufficient digital literacy among both teachers and students further hinders the effective integration of AI tools in educational settings [8]. To overcome these challenges, targeted initiatives must be implemented to enhance the digital infrastructure in underserved areas. Additionally, comprehensive training programs for educators and students are essential to ensure the effective and equitable use of generative AI in schools across Indonesia.

In addition to infrastructure challenges, teachers readiness is also a determining factor in the success of implementing generative AI. Teachers need to be trained to understand how this technology works and how to integrate it into the learning process [9]. Without adequate training, the enormous potential of generative AI cannot be maximized. Therefore, teacher training is an important part of developing technology-based education policies. From a student perspective, using generative AI, such as ChatGPT and DeepSeek, can elicit various responses. Some students may be very enthusiastic because of the easy access to information and interesting visual content. On the other hand, there is a risk of dependence on technology, which can reduce students' ability to think critically and independently if not accompanied by proper guidance. Excellent opportunities also exist to develop creative learning content that meets student needs. DeepSeek, for example, allows teachers to easily create visual illustrations that can clarify abstract concepts in subjects such as mathematics, science, and geography [10]. Meanwhile, ChatGPT can be used as an interactive discussion tool to answer students' questions in real-time, thereby increasing student engagement in the learning process [11]. At the policy level, generative AI requires synergy between the government, schools, and technology providers. Policies that support technology integration must consider aspects of equal access, student data security, and human resource development. The government also needs to ensure that every school has an equal opportunity to access this technology so that the digital divide can be minimized.

This study aims to analyze the opportunities and challenges of implementing generative AI (ChatGPT and DeepSeek) in high schools in Indonesia through a descriptive analysis approach. By understanding the potential benefits and constraints, the results are expected to be a reference for policymakers and education practitioners in integrating generative technology effectively and sustainably. This study is expected to formulate various implementation strategies to maximize the benefits of generative AI in improving the quality of education in high schools. It will also provide recommendations on steps that the government, schools, and teachers should take to overcome various obstacles that arise during the implementation process.

2. Research Methods

Study This uses a qualitative approach. Qualitative research is done to explain an issue, phenomenon, or case in a way that is descriptive through written data analysis [12]. This aims to study the utilization of Generative AI in intermediate and above-average schools in Indonesia, focusing on opportunities and challenges in implementing ChatGPT and DeepSeek technology. Research data This is obtained from secondary data sources that have been available in the form of official documents from educational institutions and agencies, government, and international, as well as articles, journals, and results studies relevant to using digital technology in the learning process. This data is analyzed in a descriptive way based on textual content or content analysis.

The case study was chosen because it offers a comprehensive perspective on the opportunities and challenges of implementing generative AI in the education sector, particularly in high school environments. This approach allows the researcher to deeply analyze the complexities of introducing AI technologies in a classroom setting and understand their potential impact on both teaching and learning processes. By focusing on this specific educational level, the case study helps to uncover the unique needs, obstacles, and opportunities that arise when integrating generative AI into the curriculum. The analysis aims to build a clear understanding of how policy decisions and the effective implementation of AI technology can shape the future of education. It explores various aspects such as resource allocation, teacher training, curriculum adaptation, and student engagement. Ultimately, this study serves as a foundation for developing strategies that can be used to map the successful integration of generative AI into high school education, ensuring its benefits are fully realized.

This study uses framework analysis focusing on three indicators: input, process, and output [13]. The third indicator used for the answer question study is as follows:

- (a) Input: Is adequate input available for implementing generative AI policies in high schools?
- (b) Process: Is the policy, the explained steps straightforward, and the operational implementation?
- (c) Output: Has the policy reached the expected results?

This study describes opportunities and challenges faced in the implementation of generative AI. It provides relevant recommendations for taker policies, educators, and institutions' education to optimize generative AI utilization in learning at the high school level in Indonesia.

3. Results and Discussions

The results of this study examine the implementation of generative AI in high schools in Indonesia through an analysis of three main aspects, namely input, process, and output. These three aspects are interrelated in determining the effectiveness of implementing technologies such as ChatGPT and DeepSeek in supporting learning activities. This analysis is based on a review of literature, education policies, and reports from related institutions that provide an overview of the opportunities and obstacles schools face in adopting these generative technologies.

The implementation of generative AI in high schools provides an excellent opportunity to increase student engagement in learning, primarily through the personalization of materials and enrichment of visual content. ChatGPT allows students to get direct answers to their questions, while DeepSeek facilitates teachers in creating more engaging and interactive learning media. However, although the potential of this technology is vast, its implementation is not free from various challenges, such as limited digital infrastructure and teachers' readiness.

This analysis will be divided into three main parts, namely input, which discusses the readiness of resources and infrastructure; the process, which highlights the implementation steps in schools; and output, which evaluates the results of the application of generative AI technology on the quality of student learning. Each section will provide a comprehensive overview of the factors influencing the success and obstacles of implementing generative AI in high schools.

3.1. Input: Infrastructure Readiness, Resources, and Policy Support

Input readiness is a critical factor in determining the success of implementing generative AI technologies, such as ChatGPT and DeepSeek, in high schools. Input encompasses all the necessary resources required to support the educational process, including infrastructure, technological devices, educators, and supporting policies. In Indonesia, the government's Merdeka Belajar program offers a significant opportunity for high schools to integrate new technologies into their educational frameworks [14], [15]. This program aims to provide schools with the tools, training, and policies necessary to enhance the quality of education. By focusing on digitalization, the government is helping schools bridge the gap in terms of resources and knowledge, facilitating the use of AI-based tools that can improve student engagement and learning outcomes. The success of such initiatives depends on the readiness of schools to invest in necessary technology and the willingness of educators to adopt and adapt to these changes. Therefore, preparing teachers with digital competencies and ensuring adequate infrastructure will be crucial in achieving successful AI adoption in high schools.

Schools in urban areas generally have better access to essential devices such as computers and stable internet [16]. This infrastructure advantage facilitates the seamless implementation of generative AI-based technologies in the learning process. In many leading schools, computer laboratories have been optimized to support digital-based learning, providing students with the necessary tools to explore AI-driven educational tools and resources [17]. The availability of these resources enhances the ability of both teachers and students to engage with advanced learning platforms, fostering an environment where digital literacy and technological skills can be effectively developed [18]. This urban advantage creates a more conducive atmosphere for AI integration in education.

However, the digital divide remains a significant challenge, especially in rural and remote areas [19], [20]. Many regional schools face substantial limitations in terms of access to devices and reliable internet connectivity [21]. This lack of essential infrastructure can prevent schools from fully leveraging the benefits of generative AI technology, hindering equal opportunities for all students. Without the proper resources, the potential for AI to enhance learning experiences remains untapped in these underserved areas. To address this issue, the government has launched the School Digitalization program, which aims to provide device assistance to schools in need [22]. This initiative seeks to bridge the gap by ensuring that all schools, regardless of their location, have access to the necessary technologies into the learning process. Teachers must possess strong digital competence to effectively use AI tools like ChatGPT and DeepSeek in their classrooms [23]. Therefore, teacher training programs focused on equipping educators with the necessary skills to navigate advanced technologies should be prioritized. These programs will ensure that teachers are not only familiar with these tools but can also incorporate them seamlessly into their teaching strategies, ultimately enhancing the learning experience for students.

With supporting policies such as the Regulation of the Minister of Education No. 24 of 2020, supporting the strengthening of the use of educational technology, the opportunities for implementing generative AI are increasingly wide open. However, this effort must be accompanied by equal access and improving the quality of human resources so that there is no gap between schools.

3.2. Process: Integration of Generative AI Technology into Learning Activities

The implementation process refers to the concrete steps taken to integrate generative AI technology into learning activities in high schools. A practical technology implementation method must include the planning, implementation, and evaluation stages [24]. During the planning stage, a thorough needs assessment is conducted to understand the school's requirements, the technological tools available, and the digital literacy levels of both teachers and students. In the implementation stage, the AI tools are integrated into the curriculum, and teachers are trained to effectively use these technologies to enhance the learning experience [25]. Students, in turn, are guided in how to interact with and utilize AI for their assignments and projects. The evaluation stage is crucial to assess the effectiveness of AI integration, with feedback from teachers, students, and school management. This phase helps to identify areas for improvement and ensure continuous adaptation of AI tools to meet the evolving needs of the school environment. Active involvement of all stakeholders ensures the success and sustainability of AI adoption.

A case study of five schools in Banyumas Regency, Central Java Province, shows that several high schools have started using ChatGPT as a tool for interactive learning. Teachers at the school utilize ChatGPT's capabilities to answer students' questions in real-time. Thus, students can get additional explanations outside of formal class hours, improving their understanding of the material.

Teachers also use DeepSeek to produce visual content such as diagrams, graphs, and interactive illustrations. This visual content has proven effective in explaining complex concepts, such as in mathematics and geography lessons [26]. According to [27], visual media can increase students' absorption of material because it is easier to understand than textual explanations alone.

However, observations from several schools also show obstacles in the implementation process. Some teachers, especially those unfamiliar with AI-based software, find it difficult to understand how generative AI technology works. In addition, not all schools have technical staff who can assist teachers in using this technology effectively.

The implementation process also faces administrative obstacles, such as the lack of technical guidance and specific regulations related to the use of generative AI in education. Therefore, clear national guidelines are needed so that all schools have the same standards for implementing this technology. Periodic evaluation of the implementation process must also be carried out to ensure that learning objectives can be achieved optimally. At the higher education level, the Ministry of Higher Education, Science and Technology has published a Guide to the Use of Generative Artificial Intelligence in Learning in Higher Education. This guidebook is designed to help lecturers, students, and the entire academic community understand and implement the ethics of using Generative AI in higher education learning, including guidelines for ensuring that the learning process in higher education takes into account various ethical aspects, such as integrity, data security, and privacy, transparency, and inclusiveness [28].

To clarify the implementation process of generative AI in high schools, the flowchart in Figure 1 shows the stages involving resource preparation, teacher training, technology integration into the curriculum, and evaluation of results. This flow illustrates how the implementation process is designed and implemented in various schools.



Figure 1. Flowchart of Generative AI Technology Implementation

3.3. Output: Impact of Generative AI Implementation on Learning Quality

Output refers to the results or impacts of implementing generative AI technology in high schools, reflecting the tangible benefits brought by the integration of such technologies into the educational environment. The success of the implementation can be measured through various indicators, such as improvements in student learning outcomes, enhanced digital skills, and the overall effectiveness of the learning process [29]. For example, AI-based tools like ChatGPT and DeepSeek have shown promising initial results in schools that have adopted them. These tools have helped increase student participation in learning activities by offering personalized learning experiences, instant feedback, and interactive problem-solving opportunities. Furthermore, the use of AI fosters critical thinking, creativity, and collaboration among students, as they engage with digital content and tools [30], [31]. By enabling students to explore new ways of learning, generative AI enhances their digital literacy and prepares them for a technology-driven future. Overall, these tools contribute to a more engaging and efficient learning environment.

Figure 2 shows Geography material generated by AI, illustrating key elements of an Erupting Volcano, such as Earth Plates, Lava Flows, and Subduction Zones. This AI-generated visualization serves as an effective teaching tool by providing students with a dynamic and interactive representation of complex geological processes. By using multimedia elements like visual graphics, animations, and simulations, generative AI helps to simplify abstract concepts, making them easier for students to understand. The ability to present these concepts in a more engaging and visually appealing way can enhance student comprehension and retention. Moreover, AI-generated visuals encourage active learning, allowing students to interact with the material and explore various scenarios in real-time. This study highlights the potential of AI-based visualizations in enriching traditional learning methods, offering an innovative approach to education that combines technology with traditional teaching strategies, ultimately enhancing the overall learning experience in schools.



Figure 2. Visualization Results of Generative AI Case Study

The survey results conducted in the case study of the five schools showed that students involved in AI-based learning reported increased learning motivation. They felt more interested because the methods used were more varied and interactive. ChatGPT, for example, allows students to explore various answers without fear of being wrong, thus encouraging their courage to ask questions and think critically.

DeepSeek significantly enriches visual learning materials. Teachers report that students find it easier to understand abstract concepts such as mathematical calculations and natural phenomena after being given visual illustrations generated by AI. This technology also encourages students' creativity in creating technology-based multimedia projects. Student motivation and participation are important indicators in assessing the effectiveness of learning. The implementation of generative AI, such as ChatGPT and DeepSeek, in a case study of five schools, with objects of two classes each at grade 11 or as many as 300 students in Banyumas Regency, shows significant changes in both aspects. Figure 3, the following graph presents the results of a survey of student motivation and participation before and after the implementation of AI in high schools.



Comparison of Student Motivation and Participation Before and After Al Use

Figure 3. Comparison Graph of Student Motivation and Participation in the Use of AI

The graph's results show that generative AI technology increases student motivation and participation in teaching and learning activities. Students who were initially passive became more enthusiastic about asking questions and discussing during the learning process. Teachers also reported that the classroom atmosphere became more dynamic after integrating technology.

However, there is concern that students become too dependent on technology to complete academic tasks. According to [32], excessive use of technology without proper guidance can reduce students' critical thinking skills. Therefore, teachers need to supervise students to ensure that technology is only used as a tool, not a substitute for the process.

Overall, the output of implementing generative AI shows great potential to improve the quality of education in high schools. However, long-term evaluation is needed to assess the extent to which these results can be maintained and developed in the future. Continuous policy support and intensive training will be key to ensuring the success of implementing this technology across schools in Indonesia.

As part of the research results, Table 1 compares findings on each aspect analyzed, from school readiness in providing infrastructure to the results of implementing generative AI technology on student learning outcomes.

Table 1 Comparison of Findings

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Analysis Aspects	Key Findings
Input	Most urban schools have adequate infrastructure, but rural schools still experience a digital divide.
Process	Teachers have started to use ChatGPT for interactive learning, but not evenly across all schools.
Output	Increased student motivation and participation in schools that have adopted generative AI.

Considering the analysis of input, process, and output in the implementation of generative AI in high schools, this technology offers excellent opportunities to improve the quality of education in Indonesia. AI technologies like ChatGPT and DeepSeek can provide a more interactive, personalized, and multimedia-based learning approach. AI's ability to answer students' questions in real-time, provide additional explanations, and generate visual content that supports understanding abstract concepts makes it a potential tool to improve student learning outcomes. However, the success of its implementation depends not only on the potential of the technology but also on the readiness of resources and policy support.

4. Conclusion and Policy Recommendations

The implementation of generative AI technology at the high school level, such as ChatGPT and DeepSeek, has shown great potential in improving the quality of education in Indonesia. This technology offers a more adaptive, personal, and creative learning approach to help students understand complex concepts through visual media and text-based interactions. However, the success of implementing this technology depends on the readiness of schools to provide adequate infrastructure, the competence of educators, and supportive and sustainable education policies. The conclusion of this study confirms that although there are great opportunities, obstacles must be overcome. One of the main challenges is the digital divide, especially in rural and remote areas that still have minimal access to digital devices and the Internet. Without equal access, all students will not feel the benefits of generative AI technology equally. Therefore, strengthening digital infrastructure must be the focus of national education policy so that there is no inequality in the learning process. In addition, the competence of educators is a key element that needs to be strengthened. Teachers must be given comprehensive training, not only in terms of the technical use of AI but also in pedagogical aspects. They must be able to integrate this technology with appropriate learning methods so that students do not only rely on AI but also develop critical thinking and problem-solving skills. Government policies must emphasize ongoing training as an integral part of digital literacy programs in schools. The government needs to formulate precise monitoring and evaluation policies to maximize the benefits of generative AI. This supervision aims to ensure that AI technology aligns with learning objectives and does not cause students to become dependent on technology. Periodic evaluations are needed to assess the effectiveness of AI implementation in various educational contexts and provide recommendations for improvement based on the results of these evaluations. Overall, educational policies related to generative AI must prioritize inclusivity and equity. The government, schools, teachers, and technology providers must work together to overcome existing challenges and optimally utilize opportunities. Thus, the implementation of generative AI technology in high schools can be a driver of educational transformation that is not only based on technology but also prioritizes holistic and future-oriented educational values.

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