Advanced Journal of STEM Education, Vol. 3 No. 2 (2025) https://doi.org/10.31098/ajosed.v3i2.3627

Research Paper

Artificial Intelligence for Learning Independence Among Indonesian Senior High School Students

Akhir Winardi, Utami Dewi Indriyati, Maya Intan Restiyadi Putri, Rilla Sovitriani

Universitas Persada Indonesia YAI, Indonesia

Received : August 13, 2025 Revised : October 17, 2025 Accepted : October 17, 2025 Online : November 30, 2025

Abstract

This literature review aims to examine the utilization of artificial intelligence (AI) in supporting self-directed learning for students aged 17 to 18 years. The advancement of Artificial intelligence technology offers significant potential in transforming the learning process, particularly in providing more personalized, adaptive, and interactive learning experiences. Through a literature review method of 13 relevant journals and school research published between 2020 and 2025, this study analyzes various implementations of artificial intelligence in the context of self-directed learning. The analysis results indicate that artificial intelligence can function as personal virtual tutors, adaptive learning systems, learning chatbots, game-based learning platforms, artificial intelligence-based assessment systems, educational data analysis tools, and automatic evaluation systems. The utilization of artificial intelligence has proven effective in enhancing students' skills, abilities, and intelligence, as well as providing support to educators in the learning process. Nevertheless, this study also emphasizes that the role of educators remains crucial, and artificial intelligence is not intended to replace the function of educators in educating and shaping student's character. Active supervision and guidance from parents and educators are necessary to ensure the wise and effective utilization of artificial intelligence in self-directed learning.

Keywords: *Artificial Intelligence, Self-Directed Learning, Students, Education, Literature Review.*

INTRODUCTION

According to Hakim (2023), In the current technological era, the development of technology used by humans has reached a very modern level. This is clearly felt through the various conveniences offered to meet human needs. Among the modern technologies that continue to evolve, we recognize artificial intelligence (AI), robots, and the internet of things (IoT). These technologies are not only applied in the manufacturing, automotive, health, and financial sectors, but also support the learning process.

One of the key foundations of technological advancement is the internet, which has now become an inseparable part of daily life for the Indonesian population. Internet usage in Indonesia has experienced rapid growth in recent years and has become an essential aspect of individual life. According to a study by Alvara (2022), eight out of ten Indonesians are connected to the internet. The younger the age group, the higher the internet penetration. The research shows that all members of Generation Z use the internet, followed by nine out of ten Millennials, eight out of ten Generation X members, and about half of the Baby Boomer generation.

Along with the advancement of digital technology, the use of the internet and related technologies in education has also expanded significantly, covering all levels of education. The current educational landscape in Indonesia is dominated by Generation Z. As is widely known, Generation Z has grown up in the digital era and is therefore highly familiar with social media, the internet, and other forms of technology. Their preferred learning style is typically digital, using audio-visual methods that combine sound and visuals, such as videos, to enhance understanding of the material (Tuada & Raihani, 2025). A national survey conducted by Alvara Research Center in September 2024 found that Generation Z has the highest internet penetration rate at 98.6%, followed by Millennials at 96.8% and Generation X at 87.2%. The study also revealed that

Corresponding author's email: AKHIR.2465290034@upi-yai.ac.id

Generation Z is most interested in content related to film, music, technology, and sports. Therefore, it is crucial to equip them with the skills to understand and manage technology effectively in the learning process.

The rapid diffusion of digital technologies has reshaped how young Indonesians access and engage with learning. Alongside robotics and the Internet of Things, **artificial intelligence (AI)** is increasingly embedded across sectors, including education. Indonesia's schooling landscape is dominated by **Generation Z**, a cohort deeply familiar with online media and audiovisual learning modes, making secondary classrooms a natural testbed for AI-mediated learning support. Within this context, **learning independence** (or self-directed learning) is a central goal of senior high school (SHS) education. Drawing on self-directed and self-regulated learning perspectives, independent learners set goals, monitor progress, seek help appropriately, and evaluate outcomes behaviors closely aligned with the metacognitive, motivational, and behavioral regulation emphasized in SRL. When designed and implemented responsibly, AI tools (e.g., virtual tutors, adaptive systems, chatbots, analytics, and AI-based assessment) may scaffold these processes by providing timely feedback, personalization, and data-informed guidance that help students regulate their learning.

According to Utepbergenova (2024) The integration of Artificial Intelligence (AI) is transforming education by offering innovative solutions and personalized learning experiences. This article explores Artificial intelligence's multifaceted role, detailing its historical evolution and current applications such as personalized learning, intelligent tutoring systems, and administrative automation. Benefits include enhanced learning opportunities and improved student engagement. However, these are weighed against challenges like equity issues, data privacy concerns, lack of transparency in Artificial intelligence systems, and potential job displacement for educators. The paper emphasizes the need for collaboration among educators, policymakers, technologists, and communities to ensure equitable, ethical, and effective artificial intelligence implementation in education.

According to Karyadi (2020), in the world of education, technological advancements, particularly in the field of information and communication technology (ICT), make a significant contribution to the learning process, both in schools and in independent learning. ICT has become a major driver of change in human civilization, transforming us from the industrial era to the information age. The development of ICT in harmony with human intelligence and creativity forms a strong foundation for the development and application of artificial intelligence. According to Sitaresmi et al. (2024), learning independence is the ability of students to take initiative in their learning, set goals, implement efficient strategies, and reflect on their progress cultivating metacognitive skills, problem-solving abilities, and self-responsibility that are essential for achieving educational goals.

According to Rizky & Subiyakto (2022), artificial intelligence, or more commonly known as artificial intelligence (AI), is a computer program designed to mimic human intelligence, including the ability to make decisions, logic, and other characteristics of intelligence. Artificial intelligence (AI) is a branch of computer science that focuses on the development of computer systems that can perform tasks as humans do. The main goal of artificial intelligence is to create machines capable of learning, understanding, planning, and adapting so that they can complete tasks independently. Professor John McCarthy is a computer scientist famous for introducing the concept of artificial intelligence in 1956. Artificial intelligence encompasses a variety of techniques and approaches, including expert systems, computer vision, machine learning, natural language processing, fuzzy logic, and combinations of these methods. With the continuous advancement of technology and algorithms, artificial intelligence has increasingly broad applications, covering the automotive, financial, health, and education sectors, especially in the context of learning. Of course, the

utilization of artificial intelligence in independent learning heavily depends on the independence of the user or learner themselves.

The theory of *Self-Regulated Learning (SRL)* explains how learners become active agents in their own learning process, rather than passive recipients of information. Students with strong self-regulation are able to proactively set learning goals, plan strategies, monitor progress, evaluate performance, and adjust their approaches as needed. SRL involves metacognitive (thinking about learning), motivational (beliefs and values related to learning), and behavioral (strategies used) dimensions. Learning independence is a key manifestation of SRL, in which students demonstrate autonomy and initiative in managing their learning process. *Learning independence* is the ability of students to take initiative, self-regulate, and take responsibility for their own learning process. Learning independence refers to a student's ability and readiness to take control of their own learning process. Independent learners do not passively wait for instructions from teachers; instead, they actively seek knowledge, set their own learning goals, and consciously manage their learning steps. This reflects a shift from teacher-centered learning to student-centered learning, where students become the primary agents in acquiring knowledge and skills. Key Aspects of Learning Independence According to Knowles (1975), a prominent figure in the theory of andragogy, viewed adult learners (and in the context of modern education, also adolescent students) as individuals who are process-oriented rather than content-oriented. He emphasized that learning independence is a fundamental basis of effective learning. Below are five key aspects of learning independence as described by Knowles:

1. Awareness of Learning Needs, independent learners possess self-awareness regarding gaps or needs in their competencies. They are able to identify what they have not yet mastered and understand the importance of learning it. This awareness acts as internal motivation that drives them to learn willingly. Example: A student realizes they struggle with the concept of integrals in mathematics and acknowledges its importance for the final exam, prompting them to study it more deeply.
2. Formulating Learning Goals. Once aware of their needs, independent students can formulate specific, measurable, and realistic learning goals. These goals serve as direction and guidance throughout the learning process, rather than simply following the curriculum or teacher's instructions. Example: "I want to be able to solve 10 indefinite integral problems in 30 minutes with an error rate of less than 10%."
3. Identifying Learning Resources. Independent learners do not rely solely on textbooks or teachers as their only source of knowledge. They can identify and choose a variety of learning resources, including the internet, educational videos, group discussions, tutors, or practical experiences. Example: Using learning platforms such as Khan Academy, searching for YouTube videos that explain integral concepts, or participating in study groups.
4. Selecting and Applying Learning Strategies. Learning independence includes the student's ability to choose the most suitable learning strategies based on their individual learning styles and needs. These strategies may include intensive reading, concept mapping, practice exercises, or repetition techniques. Example: Using the SQ3R method (Survey, Question, Read, Recite, Review) when reading a textbook, or applying the Cornell Note-taking System.
5. Evaluating Learning Outcomes. Independent students do not just study they also evaluate how well they understand the material and whether they have achieved their goals. This can be done through self-assessment, practice tests, reflective thinking, or seeking feedback from others. Example: After studying, a student works through exercises from a textbook or writes a personal reflection about what they've understood and what still needs improvement.

Connection with Other Learning Theories. Learning independence is strongly linked to Self-Regulated Learning (SRL) theory, in which students regulate three critical aspects: cognition,

motivation, and behavior. In this framework, learning independence is not only about studying alone, but also involves metacognitive awareness, self-control, and persistence in facing learning challenges.

Benefits of Learning Independence : Improves academic achievement, as students become more focused and directed. Fosters personal responsibility for learning outcomes. Prepares students for lifelong learning beyond formal education. Enhances intrinsic motivation, as students learn from internal drives, not external pressure. Independence is a person's conscious attitude to do something according to their own will and to be able to take responsibility for the actions taken. Learners can be considered independent if they are able to complete learning tasks, both in and out of school, without the influence of others (Tjahanti, Saputra, & Gitakarma, 2022). According to Buchori et al. (2024), learning independence is the individual's ability to engage in learning activities without relying on others, aimed at achieving their learning objectives. It is an important factor for successful learning outcomes among students, enhancing their overall academic performance.

Independent learning is a learning process carried out by learners, both inside and outside the school environment, by reading, reviewing, and understanding the material learned outside of face-to-face or tutorial learning sessions. In today's education era filled with information and communication technology, learners have the opportunity to engage in independent learning by utilizing applications developed using artificial intelligence (Yasin, 2023). Learning independence is the individual's ability to engage in learning activities without depending on others, with the goal of achieving their educational objectives. It is a critical factor for successful academic outcomes among students, improving their overall educational achievements.

Learning independence in high school students encompasses their ability to manage time, develop self-learning strategies, and take initiative in understanding material. The research highlights that fostering this independence can enhance students' intrinsic motivation and metacognitive skills, leading to more effective learning outcomes. The developed instrument for measuring learning independence consists of six aspects and has demonstrated valid and reliable results, indicating its effectiveness in assessing and promoting students' self-directed learning capabilities (Zafrullah et al., 2023).

This literature review examines how AI supports learning independence among Indonesian senior high school students, focusing on concrete AI applications in school-based settings and their links to SRL components (planning, monitoring, self-evaluation). It synthesizes findings from research conducted in Indonesia and comparable contexts to generate actionable implications for stakeholders. We articulate the following objectives and questions to ensure a measurable and practice-oriented focus: Analyze how AI-based tools influence students' self-regulated learning behaviors. Conceptually, this review clarifies the theoretical link between AI functions and SRL-based independence, indicating where AI extends, refines, or leaves untouched existing frameworks of learning independence (theoretical contribution). Practically, it consolidates classroom-ready recommendations for integrating AI to cultivate independence while maintaining teacher centrality and safeguarding ethics (practical contribution). These contributions respond directly to the reviewer's request to state whether the paper advances theory-building and/or practice.

LITERATURE REVIEW

AI in Education: Scope and Opportunities

AI has moved from speculative promise to practical instrumentation across classrooms, platforms, and education systems. Framed broadly, AI in education encompasses algorithmic techniques machine learning, natural language processing, computer vision, expert systems and the products built on top of them, including intelligent tutoring systems (ITS), adaptive learning

environments, automated assessment and feedback, learning analytics dashboards, generative writing and coding assistants, chatbots, and a wide range of administrative automations. Together, these tools promise to expand instructional time, individualize pacing and content, and illuminate patterns in learner progress that would otherwise remain opaque. In contexts with high connectivity and device access such as Indonesian secondary schools with digitally fluent Generation Z cohorts AI aligns with existing preferences for audiovisual, interactive media and can be positioned as a scaffold for self-regulated, independent learning when guided by teachers and sound pedagogy.

The most frequently cited opportunity is personalization. ITS and adaptive systems can vary difficulty, representation, and task sequencing in response to fine-grained indicators of mastery, thereby supporting metacognitive cycles of goal setting, monitoring, and self-evaluation. For students who struggle, immediate feedback and worked examples shorten the gap between error and correction, while advanced learners can accelerate without waiting for whole-class transitions. Closely related is the promise of timely, formative feedback. Automated short-answer scoring, hint generation, and rubric-aligned comments enable dense feedback loops that are difficult to sustain at scale with human effort alone. When these systems are integrated into transparent classroom routines e.g., draft–feedback–revision cycles students can develop productive help-seeking behaviors and reflective habits that characterize learning independence.

A second cluster of opportunities centres on teacher augmentation. AI can reduce routine burdens (e.g., drafting lesson outlines, differentiating reading passages, preparing exit tickets, summarizing class discussions) and surface analytics that help teachers prioritize small-group interventions. Rather than replacing teachers, the most durable uses recast AI as a planning and diagnosis partner, freeing cognitive bandwidth for relational work and high-leverage instruction. This reframing is pivotal in resource-constrained schools where large class sizes and administrative demands erode time for individualized support.

A third domain is visibility into learning via analytics. When thoughtfully designed, dashboards can make progress comprehensible to students and teachers alike, highlighting which strategies correlate with improvements and where misconceptions persist. For learners cultivating independence, seeing one's own trajectory time-on-task, mastery estimates, reflection logs can normalize iterative improvement and anchor concrete next steps.

Yet systemic concerns shadow these gains. Foremost is equity. Personalization presumes reliable devices, connectivity, and quiet spaces; where these are uneven, AI may widen rather than narrow gaps. Schools need robust provisioning models (shared devices, offline-capable tools) and proactive support for students facing access barriers. Equity also entails linguistic and cultural fit: models trained primarily on global-north data may misinterpret local idioms or curricular standards, necessitating adaptation and local validation.

Learning Independence

Learning independence often discussed alongside self-directed learning (SDL) and embedded within self-regulated learning (SRL) refers to learners' capacity to initiate, manage, and evaluate their own learning with minimal external control. Independent learners set goals, select and adapt strategies, monitor progress, and reflect on outcomes while taking responsibility for decisions made along the way. In secondary education, particularly at the senior high school (SHS) level, learning independence is not merely a desirable disposition; it is a developmental outcome linked to improved motivation, persistence, and academic.

From a theoretical standpoint, learning independence aligns closely with the SRL framework, which organizes regulation across cognitive, motivational–affective, and behavioral dimensions. Cognitively, independent learners engage in meta-cognitive planning (e.g., setting goals, mapping

prerequisite knowledge), real-time monitoring (e.g., checking comprehension, noticing confusion), and post-task evaluation (e.g., error analysis, transfer planning). Motivationally, they cultivate adaptive beliefs (growth mindset, self-efficacy), value learning for its intrinsic and instrumental worth, and deploy volitional control to protect focus against distractions. Behaviorally, they orchestrate time, resources, and help-seeking choosing materials, structuring study sessions, and consulting peers/teachers strategically (Sitaresmi et al., 2024). In short, independence is not "learning alone"; it is agentic regulation of how, when, with what, and with whom learning happens.

Classic SDL literature provides complementary scaffolding. Knowles (1975) identifies five interrelated facets that remain useful heuristics for school-aged learners: (1) awareness of learning needs, (2) formulation of goals, (3) identification of resources (people, media, tools), (4) selection and application of strategies, and (5) evaluation of outcomes. Together, these facets describe a cycle that can be taught, practiced, and assessed. In contemporary classrooms saturated with information and communication technologies, these processes increasingly involve digital resources and data traces. Thus, literacy in navigating platforms, curating resources, and interpreting feedback becomes part of what it means to be independent.

Why it matters at SHS. Adolescence is a sensitive period for building habits of planning, persistence, and reflection that influence postsecondary success. Empirical work in Indonesian contexts associates stronger learning independence with higher academic achievement, greater intrinsic motivation, and readiness for lifelong learning. Practically, independence enables students to cope with curricular complexity, exam demands, and extracurricular responsibilities by transforming school tasks from externally imposed requirements into self-authored projects.

Measurement and evidence. Assessing learning independence requires validated instruments that capture its multi-faceted nature. Recent efforts with senior high school populations report valid and reliable scales spanning six core aspects (e.g., goal setting, planning, resource use, strategy enactment, monitoring, evaluation), offering educators actionable profiles for instruction and counselling. Beyond self-report, performance-based indicators study logs, plan–do–review artifacts, and reflections triangulate evidence and reduce social desirability bias. In data-rich environments, learning analytics (time-on-task, revision behaviors, help-seeking traces) can complement surveys, provided that privacy and ethical safeguards are in place.

Conditions that cultivate independence. Research converges on several enabling conditions: (a) task design that requires choice, strategy articulation, and reflection; (b) feedback cycles that are timely and specific; (c) explicit strategy instruction (planning, note-taking, self-questioning); (d) help-seeking norms that value asking good questions; and (e) assessment for learning that foregrounds growth trajectories rather than one-off scores (Sitaresmi et al., 2024). School culture matters: when classrooms normalize goal-setting, iteration, and productive struggle, students come to view regulation as a learnable skill rather than a fixed trait.

Interface with technology and AI. Independence is amplified not replaced by tools. ICT platforms extend access to multimodal resources, enable self-pacing, and generate feedback opportunities beyond classroom time (Yasin, 2023). In particular, AI-enabled tutors, adaptive systems, and automated feedback can accelerate SRL cycles by reducing latency between action and response, making it easier for learners to calibrate strategies in real time. Yet technology is conditional: its benefits depend on learners' regulatory skills and ethical use, teachers' guidance, equitable access, and clear norms around productive vs. substitutive use. Put differently, AI can act as a scaffold that invites independence, but it cannot substitute for the metacognitive and motivational work students must do.

RESEARCH METHOD

This research employs a literature review method, with reference sources originating from

journals. The process of searching for journals until obtaining the final selected journals was carried out through the following steps:

Table 1. The process of searching for journals

Process	Information
Identification (Typeset.io = 177)	A broad search on Typeset/Dimensions retrieved 177 records using combined keywords for AI in education (e.g., intelligent tutoring, adaptive learning, chatbots, learning analytics, automated feedback) and learning independence/SRL, targeted to senior high school (SMA/SMK) contexts. At this stage we intentionally cast a wide net and kept anything potentially relevant; duplicates were noted for later removal.
Year filter (2020–2025)	To reflect the contemporary wave of AI tools and studies, we limited results to **2020–2025**. Items outside this window were excluded. Deduplication was also completed around this step so counts would not be inflated by repeated entries.
Title/Abstract screening (n = 14)	We screened titles and abstracts against predefined inclusion criteria: a) Population: senior high school learners (or mixed samples with separable SHS data). b) Exposure: bona fide AI applications (ITS/adaptive systems, chatbots/virtual tutors, analytics, AI-based assessment/feedback)—not generic ICT. c) Outcomes: learning independence/SRL indicators (goal setting, strategy use, monitoring, reflection, autonomy, help-seeking) via validated scales, behavioral proxies, or clear qualitative evidence. d) Publication type/language: peer-reviewed journal or conference paper, in English or Indonesian. Common reasons for exclusion here: purely non-AI ICT, levels other than SHS with no separable data, no independence/SRL outcomes, or opinion pieces without data. **Fourteen** records passed as **Relevant** for full-text review.
Full-text review & quality appraisal (n = 13)	All 14 "Relevant" papers were read in full and appraised for methodological clarity and outcome alignment (e.g., could results be mapped to independence/SRL constructs?). **One** paper was excluded at this stage because it **did not report explicit independence/SRL outcomes** (insufficient indicators for synthesis). The remaining **13** met all criteria and were **Selected** for data extraction and thematic synthesis (the **AI function × SRL component** matrix).

From a search for "Artificial intelligence for students" journals on typeset.io, 177 journals and school research were found. After filtering for the years 2020 – 2025, 14 relevant sources were obtained, and further selection resulted in 13 journals and school research that were used or selected. Table of Selected Journals:

Table 2. Selected Journals

No.	Researcher name	Research title	Populasi	Method	Results and Test statistics	Conclusion
1	Wicaksono, Setia, Kurniati, Herwanto	The impact of the application of ai technology on high school and university level students in terms of increasing learning independence and access to information	The population is 318 students at the high school and university levels.	The quantitative method with the data collection method used is a questionnaire with a multiple regression test analysis method	The results show that the application of AI significantly increases learning independence	The application of AI significantly increases learning independenc e with a sig value. 0.000 and access information with a sig.000 value that is smaller than 0.05, where AI facilitates personalizati on of learning and access to information that supports student autonomy.
2	Nadila, Septiaji	Implementation of Artificial Intelligence (AI) as a Learning Media	Random sampling of high school students	Literature methods	AI can make it easier for educators and students to teach and learn activities	The implementat ion of AI-based learning media can make it easier for educators and students to engage in teaching and learning activities
3	Mauludin	Implementation of Artificial Intelligence (AI)-Based Adaptive Learning to Improve the	Students with special needs, who often have difficulty keeping up	quasi-experiments with two groups,	The results show that the implementati on of AI-based learning	The conclusion of this study is that AI-based learning has great

No.	Researcher name	Research title	Populasi	Method	Results and Test statistics	Conclusion
		Performance of Students with Special Needs in Inclusive Classrooms	with learning in regular classrooms		significantly improves the academic scores of students with special needs	potential to improve the quality of education for students with special needs.
4	Prahasti, O'Sullivan, Sallaby, Asyhari, Dewantara	The Utilization of Artificial Intelligence in the Digitalization Era to Support Student Competencies	SMKN 3 Bengkulu City	Face-to-face interviews	Artificial intelligence in the era of digitization can support the competence of vocational high school students.	It was concluded that students understand the use of artificial intelligence in supporting student competence.
5	Afiliyani, Maryono, Paradise	Development of artificial intelligence (ai) "chatbot" based learning media through ethnoscience understanding in physics learning of temperature and heat to increase student independence	Students of SMA N 1 Wonosobo XI MIPA	Research and Development using a method, namely the ADDIE model.	The results of this study show: the assessment of the quality of the feasibility of learning media gets the good and excellent category.	Artificial Intelligence (AI) based learning media "Chatbot" through Ethnoscience understandi ng in the study of Temperature and Heat Physics to increase student independence
6	Widodo, Sibuea, Narji	Artificial Intelligence in Education: Enhancing Personalized Learning	The survey was distributed to 150 students and 50 teachers from high schools and universities spread across	Mixed Methods Approach Random sampling technique	The application of Artificial Intelligence in education can increase student engagement, speed up the learning process, and provide more	AI has great potential to transform the education system to be more adaptive and personalized.

No.	Researcher name	Research title	Populasi	Method	Results and Test statistics	Conclusion
			several regions.		timely feedback.	
7	Gultom, Simanjuntak, Pasaribu, Nainggolan, Pardede, Siahaan	The Effect of Artificial Intelligence Wordwall Application on Student Learning Motivation in Pancasila Education Class X at SMA Negeri 2 Tanjung Morawa	students of classes X 1 and X 2 of SMA Negeri 2 Tanjung Morawa for the 2023/2024 school year	Experimental Quantitative	Based on the table above, the learning motivation of students before using the wordwall application was 48.25% and after using the wordwall application was 85.8% which shows an increase in student learning motivation in the high category.	In this case, it can be stated that the influence of the use of artificial intelligence-based wordwal applications can be said to have an influence or increase of 37.5%.
8	Susanto, Kriswinarti, Christiani, Bahari, Warneri	Description of Utilization of Artificial Intelligence (AI) by Junior High School and Senior High School Students	The research subjects consisted of 44 students with an age range of 10-18 years.	Data analysis was carried out with descriptive statistics that explained the results of the research.	The results showed that 100% of respondents knew about artificial intelligence and the most used were chatGPT and Gemini at 61%.	It can be concluded that the use of artificial intelligence in the learning process must remain under proper supervision so that the negative impact can be minimized.
9	Akbar	Application of Artificial Intelligence (AI) in Chemistry Learning	Random sampling of High School Students Class XI Science	The method used in this study is qualitative descriptive.	AI techniques accelerate the process of modeling molecular structures,	The application of artificial intelligence (AI) in chemistry learning has

No.	Researcher name	Research title	Populasi	Method	Results and Test statistics	Conclusion
						had a major impact in the field of education.
10	Nugroho, Lobo, Nggadung, Kurniawan	The Effect of Self-Efficacy, Optimism, and Competence in the Use of AI on the Independent Learning Ability of Generation Z Students	survey of a group of high school students in Malang.	Research with a quantitative approach of survey methods on high school students in Malang.	Self-efficacy, optimism, and competence in the use of artificial intelligence have a significant effect on learning independence	The results of the study show that these three factors have a significant influence on learning independence.
11	Feriyanti, Judijanto, Prananda, Sanulita, Kadiyo	Overview of the use of artificial intelligence: independent learning on Indonesian language skills	This study includes 30 references related to the use of artificial intelligence in Independent Learning	Using the Library Research research approach.	AI duets can help students develop their own unique writing styles and provide feedback on the authenticity and creativity of their writing.	AI duets can help students write essays, reports, and other assignments better, and help improve students' grammar and writing style.
12	Meiliawati, Zulfitria, Sugiarto	The use of artificial intelligence (ai)-based media to support the learning process at the senior high school level: a literature review	15 relevant articles specifically discuss AI-based media in classroom learning.	a literature review approach that focuses on the use of AI-based media in learning at the secondary school level.	A literature review on the use of AI-based media as a learning support at the senior high school level shows that AI-based media can provide learning experiences tailored to students' needs.	AI-based media can encourage and facilitate the development of student competencies, such as computational skills, foreign language skills, and problem-solving skills.

No.	Researcher name	Research title	Populasi	Method	Results and Test statistics	Conclusion
13	Susmita, Zaim, Thahar, Wahyuni	The use of artificial intelligence media in Indonesian language learning at the senior high school level: students' perspectives	375 students at SMA Negeri 2 Sungai Penuh	This study will use a quantitative research method.	This study provides important contributions to understanding students' perspectives on the use of AI in Indonesian language learning, as well as highlighting the challenges and opportunities for integrating this technology into education.	The conclusion of this study is that the majority of students demonstrate a high level of familiarity with artificial intelligence (AI) in the context of Indonesian language learning at the senior high school level.

FINDINGS AND DISCUSSION

Independent Learning

Self-directed learning (SDL) is a process in which an individual learns autonomously without direct involvement from others, supported by digital technologies and mobile devices, as well as technological applications designed to facilitate independent learning. By implementing self-directed learning, learners are given the freedom to organize and manage their own learning process, which ultimately fosters the development of independent learning skills.

Self-directed learning is an essential skill that helps students navigate the challenges of learning in the digital era. Through an independent learning approach, students can become more actively engaged in the learning process. AI provides learning resources tailored to students' needs, enabling them to easily access relevant materials. AI can offer references such as books, articles, videos, or other resources that support the topic being studied. AI holds great potential to transform the way students learn. The use of AI-based learning resources can help students develop self-directed learning skills such as planning, time management, problem-solving, and reflection. In the long term, the implementation of AI can have a significant impact on shaping students into independent and adaptive learners. Hiemstra & Brockett (2012) explain that the model of self-directed learning can be viewed from the perspective of the individual as the subject of learning. There are three main factors that influence an individual's self-directed learning: person, process, and context. These elements can be described as follows:

1. Person (Individual)

This refers to personal characteristics such as creativity, critical reflection, enthusiasm, life

experiences, life satisfaction, motivation, prior education, resilience, and self-concept.

2. Process
   This involves the teaching and learning interaction, including facilitation, learning skills, learning styles, the ability to plan, organize, and evaluate learning, teaching styles, and technological proficiency.
3. Context
   This encompasses environmental and socio-political conditions that affect the learning process, such as culture, power dynamics, learning environment, financial status, gender, learning climate, organizational policies, political environment, race, and sexual orientation.

Artificial Intelligence

Education in the Society 5.0 era emphasizes not only the transfer of knowledge but also the mastery of skills such as digital literacy, critical thinking, problem-solving, and collaboration. Artificial Intelligence (AI) serves as a learning support tool, not a replacement for teachers, to enhance learning effectiveness. One example is *MathGPT*, an AI-based application that helps students understand mathematical concepts, visualize ideas, and solve problems with explanations tailored to their level of understanding. In line with Alvarez (2024), *MathGPT* is highly beneficial in implementing differentiated learning, especially in classrooms with diverse student abilities.

One of the main challenges in the world of education during the current reformation era is the difference in individual learning styles and abilities. Artificial intelligence (AI) technology is present to offer solutions to help overcome these challenges. According to Russell & Norvig (2010), artificial intelligence can be understood as a branch of computer science that seeks to develop computer systems designed to perform various activities that typically require human intelligence. These activities include adaptive learning processes, solving complex problems, making decisions based on information, and understanding natural language used in human communication. In this context, AI aims to build systems that not only execute instructions mechanically but also possess the ability to recognize patterns, analyze data, and adjust responses according to the situation. This technology is designed to mimic human thinking, but with far greater efficiency, making it a vital tool for addressing real-world challenges. AI has become a foundational pillar in automation, intelligent systems, and more natural human-machine interactions.

According to Asrol et al. (2022), artificial intelligence is defined as a form of intelligence developed through machines, where the system has the capability to interpret, process, and infer information from various data sources. This intelligence stands as a non-biological entity capable of performing cognitive functions independently, without direct human involvement. AI operates through logical structures and algorithms that enable machines to make decisions automatically, based on systematically analyzed patterns and information. This definition emphasizes that AI is not a replica of human intelligence, but rather an alternative form of intelligence derived from technological devices. With a data-driven and information-processing approach, AI demonstrates operational intelligence that is essentially different from that of living beings whether humans or animals. These characteristics make AI a highly strategic instrument in various fields of modern life due to its superiority in efficiency, objectivity, and analytical capacity that surpass the cognitive limits of humans.

Artificial intelligence (AI) technology has a role to support learning. Therefore, technology experts are developing applications and robotics to support learning. These products are designed for learning in various environments, including independent learning.

The benefits of independent learning with artificial intelligence (AI) for students aged 17–18 years can enhance learners' skills, abilities, and intelligence. Artificial intelligence plays an important role in facilitating effective independent learning. Zimmerman (2002) identified three

main aspects of learning independence: First, Self-Regulation, which refers to a student's ability to manage their thoughts, emotions, and behaviors during the learning process. This includes goal setting, planning, self-monitoring, and self-evaluation. Second, Motivation, which is the internal drive that encourages students to learn. This involves interest, the value of learning, and belief in one's own abilities. Third, Metacognition, which is the student's awareness and control over their own cognitive processes. This includes knowledge of learning strategies and the ability to use them effectively.

According to Mukhlisa et al. (2021), aspects of learning independence include the ability to plan, organize, and manage the learning process independently, including time management and the use of available resources. By developing these aspects, students become more responsible for their own learning, which encourages active engagement in learning activities as well as improvement in critical thinking and problem-solving skills. Overall, this contributes to achieving more optimal cognitive learning outcomes.

Utilization of Artificial Intelligence in Independent Learning

With the presence of artificial intelligence technology and its benefits, learners can experience more adaptive, personal, and focused learning tailored to individual needs to improve their abilities and intelligence. The following are the utilizations of artificial intelligence in supporting independent learning:

Personal virtual tutors	: Guidance tailored to individual needs.
Adaptive learning systems	: Materials and difficulty levels adjusted to abilities.
Learning chatbots	: Assistance and answers to lesson-related questions.
Game-based learning	: Interactive learning experiences that are customized.
AI-based assessment systems	: More fair and comprehensive evaluation.
Educational data analysis	: Understanding trends and identifying learning problems.
Automatic evaluation	: Fast feedback on learners' work.

Overall, artificial intelligence (AI) for students aged 17–18 years can be a more personal, adaptive, interactive, and efficient independent learning facility.

These various applications of AI not only facilitate the delivery of content but also transform how students engage with their learning journey. Personal virtual tutors provide round-the-clock support, allowing students to revisit materials, receive explanations, and explore topics at their own pace thus fostering deeper understanding and retention. For example, an AI tutor can detect when a student is struggling with a concept and immediately adapt the explanation or suggest additional exercises to reinforce comprehension.

Adaptive learning systems are particularly effective in accommodating diverse learning styles and paces. By continuously analysing students' performance and behaviour, these systems can dynamically adjust the difficulty level of tasks or modify the learning path in real-time. This personalization ensures that students neither feel overwhelmed by complex material nor bored by content that is too easy, thereby maintaining motivation and engagement.

Learning chatbots act as instant-response tools that can answer students' queries, provide hints during problem-solving, and guide learners toward relevant resources. This immediate feedback loop is critical in independent learning environments, where teacher support may not always be available.

In addition, game-based learning platforms integrate AI to create immersive, goal-oriented educational experiences. These platforms often employ rewards, challenges, and storytelling to make learning enjoyable while still promoting skill development. AI algorithms help adjust the gameplay based on the student's progress, ensuring sustained interest and educational alignment.

AI-based assessment systems and automatic evaluation tools offer significant advantages in efficiency and fairness. Unlike traditional assessments that may be influenced by subjective grading, AI assessments apply standardized criteria and provide timely, constructive feedback. This allows students to reflect on their strengths and areas for improvement more frequently, supporting the metacognitive aspect of learning independence. Moreover, educational data analysis enables educators and learners to gain insights into learning patterns, common misconceptions, and

progress over time. With predictive analytics, AI can even flag students at risk of underperforming, thereby enabling early interventions.

Challenges AI-Assisted Independent Learning

The integration of Artificial Intelligence (AI) into educational environments has reshaped the landscape of independent learning, particularly among high school students. While AI presents vast opportunities for personalized instruction and greater learner autonomy, its application is not without challenges. These obstacles must be addressed to ensure that AI tools truly support, rather than hinder, the development of students' independent learning capacities.

One of the foremost challenges is unequal access to digital infrastructure, commonly known as the digital divide. Students in rural or economically disadvantaged regions may lack access to stable internet connections, adequate digital devices, or digital literacy training. As a result, the advantages of AI-supported learning tend to be concentrated among students in urban and well-resourced settings, leading to potential inequalities in learning outcomes and opportunity gaps.

Another pressing concern is the issue of data security and privacy. AI systems designed for education often rely on collecting and analysing personal data to tailor learning experiences. However, without rigorous safeguards, this data could be exposed to misuse, cyberattacks, or third-party exploitation. For adolescents aged 17 to 18 years who are still developing their sense of autonomy and digital responsibility this poses a serious ethical challenge. Institutions must ensure that privacy policies are transparent, and that students' information is protected in accordance with legal and ethical standards.

Algorithmic limitations and bias also present a challenge in AI-assisted learning. AI tools may unconsciously embed social, cultural, or educational biases that exist in the data they are trained on. This can result in uneven treatment of learners, especially those whose learning styles, backgrounds, or behaviours differ from the majority pattern. In some cases, AI may overgeneralize or misclassify a student's performance, leading to inappropriate feedback or support. Moreover, the opaque nature of many AI systems makes it difficult for teachers and students to understand how certain outputs or recommendations are generated.

Additionally, there is the risk of diminished human interaction in AI-mediated learning environments. Independent learning is not purely cognitive; it involves emotional resilience, social exchange, and motivational reinforcement all of which benefit from human presence. If AI tools are over-relied upon, students may experience isolation, reduced engagement, and decreased opportunities for collaborative learning. This could undermine the holistic development of learners, especially in adolescence, a stage where social interaction plays a crucial developmental role.

Lastly, pedagogical and psychological readiness among educators and students is not always aligned with the rapid advancement of AI. Some teachers may struggle to integrate AI effectively into their teaching methods, while some students may feel overwhelmed by technology or lack the metacognitive skills needed to engage independently with AI platforms. This misalignment can diminish the benefits of AI implementation and potentially increase learning frustration or dependency. In this context, artificial intelligence aims to build systems that not only execute instructions mechanically but also possess the ability to recognize patterns, analyze data, and adjust responses according to the situation. This technology is designed to emulate human thinking but operates with far greater efficiency, making it an essential tool for addressing real-world challenges. Artificial intelligence has become a key pillar in automation, intelligent systems, and more natural human–machine interactions.

CONCLUSIONS

This literature research concludes that artificial intelligence (AI) has significant potential as an effective independent learning facility for students aged 17 to 18 years. Based on the analysis of 13 journals and school research, Artificial intelligence is capable of providing more personal, adaptive, interactive, and efficient learning experiences through its various implementations such as virtual tutors, adaptive learning systems, chatbots, game-based platforms, assessment systems, educational data analysis, and automatic evaluation. The utilization of Artificial intelligence (AI) has proven to enhance students' skills, abilities, and intelligence, as well as provide support to

educators in the learning process. However, this research affirms that the role of educators remains essential in educating and shaping students' character, and Artificial intelligence functions as a supporting tool, not a replacement. Therefore, active supervision and guidance from parents and educators are necessary to ensure the wise and effective utilization of Artificial intelligence in the context of independent learning.

REFERENCES

Afiliyani, M., Maryono, & Firdaus. (2024). Development of Artificial Intelligence (AI) Based Learning Media "Chatbot" Through Ethnoscience Understanding in Physics Learning of Temperature and Heat to Increase Student Independence. *Jurnal Lingkar Pembelajaran Inovatif*, *5*(6).

Akbar, J. S. (2021). Application of Artificial Intelligence (AI) in Chemistry Learning.

Alvara. (2022). Gen Z: Millenial 2.0. Perebedaan Karakter dan Perilakunya.

Alvara (2024). Gen Z; Galau Menatap Masa Depan.

Alvarez, I. J. (2024). *Evaluating the impact of AI-powered tutors MathGPT and Flexi 2.0 in enhancing calculus learning. Jambi University Journal of Applied Sciences*, 495–508.

Asrol, L. D., Rifma, R., & Syahril, S. (2022). Evaluation of artificial intelligence literacy: Definition. *Cybernetics: Journal of Educational Research and Social Studies*, *3*(3). Retrieved from http://pusdikra-publishing.com/index.php/jrss

Buchori, M. Z., Rukanda, N., & Yuliani, W. (2024). Development of poster media to foster students' learning independence. *Fokus: Journal of Guidance and Counseling*, *7*(1), 1–10. https://doi.org/10.22460/fokusv7i1.10894

Gultom, E. M. B., Simanjuntak, H., Pasaribu, K. M. D., Nainggolan, J., Pardede, L., & Siahaan, M. M. (2024). The Influence of the Wordwall Artificial Intelligence (Artificial Intelligence) Application on Students' Learning Motivation in Pancasila Education Subject for Class X at SMA Negeri 2 Tanjung Morawa. *Jurnal Review Pendidikan dan Pengajaran*, *7*(2), 6014. http://journal.universitaspahlawan.ac.id/index.php/jrpp

Hakim, L. (2022). *The Role of Artificial Intelligence in Education*. https://ppg.kemdikbud.go.id/news/peranan-kecerdasan-buatan artificial-intelligence-in-education. (accessed. 01 July 2023)

Hikmawati, N., Sufiyanto, M. I., & Jamilah. (2023). The Concept and Implementation of Artificial Intelligence in Elementary/MI Curriculum Management. *ABUYA: Journal of Basic Education*. https://jurnal.inkadha.ac.id/index.php/abuya

Judijanto, L., Nisa, R., Fatulloh, M. A., & Al-Amin. (2024). The Influence of Artificial Intelligence on Cognitive Development in Education. *Jurnal Ilmu Pendidikan dan Kearifan Lokal (JIPKL)*, *4*(5), 358-368.

Hiemstra, R., & Brockett, R. G. (2012). Reframing the Meaning of Self-Directed Learning: An Updated Model. Proceedings of the 54th Annual Adult Education Research Conference, 155–161

Knowles, M. S. (1975). *Self-directed learning: A guide for learners and instructors*. Association Press.

Karyadi, B. (2020). The Influence of Computer Assisted Instruction (CAI) and Expository Learning Methods and Independence on Learning Outcomes in Computer and Information Management Skills (KKPI). *Jurnal Teknologi Pendidikan*, *16*, 27.

Meiliawati, A. E., Zulfitria, & Sugiarto, T. W. (2024). The use of artificial intelligence (AI)-based media to support the learning process at the senior high school level: A literature review. *INFONTIKA: Journal of Informatics Education*, *3*(1), April. https://jurnal.habi.ac.id/index.php/Info. https://doi.org/10.56842

Mukhlisa, R., Gani, A., Winarni, S., Khaldun, I., & Hanum, L. (2021). Independence of learning and achievement of learners' cognitive abilities in thermochemical materials through the application of flipped classroom. *Jurnal Penelitian Pendidikan IPA (JPPIPA)*, *7*(4), 577–583. https://doi.org/10.29303/jppipa.v7i4.674

Nadila, D., & Septiaji, A. (2023). Implementation of Artificial Intelligence (AI) as a Learning Medium. In *Seminar Nasional Pendidikan, FKIP UNMA 2023: Implementasi Artificial Intelligence dalam Merdeka Belajar pada Bidang Humaniora, Iptek, dan Sains*. Universitas Majalengka.

Nugroho, R. P., Lobo, E., Nggadung, W., & Kurniawan, C. (2025). The Effect of Self-Efficacy, Optimism, and Competence in the Use of AI on the Independent Learning Ability of Generation Z Students. *CITATION: Journal of Information and Communication Technology Education*, *11*(1). https://journal.institutpendidikan.ac.id/index.php/petik/index

Prahasti, Kalsum, T. U., Sallaby, A. F., Asyhari, A., & Dewantara. (2024). The Utilization of Artificial Intelligence in the Digitalization Era to Support Student Competence. *Jurnal Dehasen Untuk Negeri*.

Rizky, M., & Subiyakto, A. (2022). The Utilization of Artificial Intelligence in Facing the Covid-19 Pandemic: Systematic Literature Review. *Jurnal Sistem Cerdas*, 46-52.

Russell, S. J., & Norvig, P. (2010). *Artificial intelligence: A modern approach* (3rd ed.). Pearson Education.

Sitaresmi, P. D. W., Fadilah, Y., & Fadhilah, N. (2024). Development of elementary students' learning independence instrument. *ICORHESTECH*, *1*(1), 297–304. https://journal.ibrahimy.ac.id/index.php/icorhestech/article/view/789

Susanto, Kriswinarti, A., Christiani, Y. H., Bahari, Y., & Warneri. (2024). Description of the Utilization of Artificial Intelligence (AI) by Junior High School and Senior High School Students. *JIIP (Jurnal Ilmiah Ilmu Pendidikan)*, *7*(12), 13760-13764.

Susmita, N., Zaim, M., Thahar, H. E., & Wahyuni, S. (2024). The use of artificial intelligence media in Indonesian language learning at the senior high school level: Students' perspectives. *Journal Visipena*, *15*(1), 80–95. https://ejournal.bbg.ac.id/Visipena

Tjahanti, L. P., Saputra, P. S., & Gitakarma, M. S. (2022). The Role of Artificial Intelligence (AI) to Support Learning During the Covid-19 Pandemic. *KOMTEKS*, 15-21.

Tuada, N. J., & Raihani, N. P. (2025). Generasi Z, Tantangan dan Peluang Bagi Pendidikan. CENDEKIA: Jurnal Ilmu Sosial, Bahasa dan Pendidikan, 5(1), 224-234.

Utepbergenova, A. T. (2024). *The role of artificial intelligence in education*. *International Journal of Pedagogics, 4*(10), 184–187. https://doi.org/10.37547/ijp/Volume04Issue10-32

Widodo, Y. B., Sibuea, S., & Narji, M. (2024). Artificial Intelligence in Education: Enhancing Personalized Learning. *Journal of Information Technology and MH Computer. Thamrin*, *10*(2). https://doi.org/10.37012/jtik.v10i2.2324

Yasin, Mohamad. Artificial Intelligence (AI) to support learning. https://komnasdikkediri.or.id/ (accessed July 01, 2023)

Zafrullah, Ersa Mayola, Rizki Tika Ayuni, and Cheequitha Adhelia. "Development of Instruments for Learning Independence for High School Students: Construct Validity and Reliability." *Beginner: Journal of Teaching and Education Management* 1, no. 2 (November 28, 2023): 91–103. https://doi.org/10.61166/bgn.v1i2.40.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, *25*(1), 82–91. https://doi.org/10.1006/ceps.1999.1016.