



The Utilization of Digital Technology to Support Self-Directed Learning Among Vocational High School Students: A Systematic Literature Review

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Abstract: Advancements in digital technology offer Vocational High School (SMK) students opportunities to access learning resources flexibly and cultivate learning autonomy. However, the use of digital technology does not automatically guarantee the development of learning autonomy, as it is influenced by various factors such as digital literacy, learning motivation, instructional design, and teacher support. This study aims to analyze the use of digital technology in supporting learning autonomy among SMK students, specifically examining the types of technology employed, the dimensions of learning autonomy fostered, and the factors that facilitate or hinder its implementation. The study employs a Systematic Literature Review (SLR) methodology, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Data were sourced from relevant scholarly articles published between 2021 and 2026 and subsequently analyzed using descriptive analysis and thematic synthesis. The findings indicate that digital technologies such as Learning Management Systems (LMS), digital learning media, web-based learning, instructional videos, and artificial intelligence have the potential to support student initiatives in learning, time management, progress monitoring, and self-evaluation. Therefore, the integration of digital technology must be accompanied by instructional strategies that encourage student responsibility and self-regulation to ensure the optimal development of learning autonomy.

Keywords: *learning autonomy; digital technology; vocational high school students; digital literacy; systematic literature review*

Abstrak:

Perkembangan teknologi digital memberikan peluang bagi siswa Sekolah Menengah Kejuruan (SMK) untuk mengakses sumber belajar secara fleksibel dan mengembangkan kemandirian belajar. Akan tetapi, pemanfaatan teknologi digital tidak selalu menjamin terbentuknya kemandirian belajar karena dipengaruhi oleh berbagai faktor, seperti literasi digital, motivasi belajar, desain pembelajaran, dan dukungan guru. Penelitian ini bertujuan untuk menganalisis pemanfaatan teknologi digital dalam mendukung kemandirian belajar siswa SMK, meliputi jenis teknologi yang digunakan, dimensi kemandirian belajar yang dikembangkan, serta faktor pendukung dan penghambat penerapannya. Penelitian ini menggunakan metode Systematic Literature Review (SLR) dengan mengikuti pedoman Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Sumber data diperoleh dari artikel ilmiah yang relevan dan diterbitkan pada rentang tahun 2021–2026, kemudian dianalisis menggunakan analisis deskriptif dan sintesis tematik. Hasil kajian menunjukkan bahwa teknologi digital, seperti Learning Management System (LMS), media pembelajaran digital, pembelajaran berbasis web, video pembelajaran, dan kecerdasan buatan, berpotensi mendukung inisiatif belajar, pengelolaan waktu, pemantauan kemajuan, serta evaluasi diri siswa. Oleh karena itu, pemanfaatan teknologi digital perlu disertai strategi pembelajaran yang mendorong tanggung jawab dan regulasi diri siswa agar kemandirian belajar dapat berkembang secara optimal.

Kata kunci: *kemandirian belajar; teknologi digital; siswa SMK; literasi digital; studi literatur sistematis*

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Introduction

The rapid advancement of digital technology has brought significant changes to educational practices, including those in Vocational High Schools (SMKs). The emergence of digital learning platforms, Learning Management Systems (LMS), instructional videos, educational applications, open educational resources, and artificial intelligence (AI)-based technologies has enabled students to access learning materials more flexibly and interactively without relying entirely on face-to-face instruction. These developments are particularly relevant in vocational education, where students are expected not only to acquire theoretical knowledge but also to develop competencies aligned with the demands of an increasingly digitalized workforce. Therefore, digital technology should not merely be regarded as a medium for delivering instructional content but also as a learning environment that encourages students to manage their learning processes more actively and independently (Depita, 2024).

The integration of digital technology into educational practices is closely associated with the concept of self-directed learning. Self-directed learning refers to students' ability to take the initiative in establishing learning objectives, selecting appropriate learning strategies, managing learning resources, monitoring their learning progress, and evaluating their academic achievements. This concept is closely related to the perspective of self-regulated learning, which positions students as active participants in planning, implementing, monitoring, and reflecting on their learning activities. Digital technology has the potential to strengthen these processes by providing access to diverse learning resources, flexibility in terms of time and location, learning progress monitoring features, immediate feedback, and opportunities for students to select learning materials and strategies according to their individual needs (Alisia Zahroatul Baroroh et al., 2024). Nevertheless, the availability of digital technology does not

automatically guarantee the development of learning autonomy. Its effectiveness is strongly influenced by several factors, including digital literacy, learning motivation, self-efficacy, instructional design quality, teacher support, and students' ability to manage information and learning time effectively (Suparyono & Paling, 2025).

These issues are particularly important in vocational education because vocational learning emphasizes competency development and workforce readiness. Vocational high school students are expected to develop the ability to engage in continuous learning, independently seek relevant information, solve problems, adapt to technological advancements, and continuously update their professional competencies. Consequently, learning autonomy is not merely a pedagogical objective but also an essential competency for navigating increasingly digitalized working environments (Isna Nurul Inayati et al., 2025). Digital technology can serve as a strategic instrument for developing such autonomy. However, its implementation may simultaneously introduce new challenges, including technological dependence, digital distractions, information overload, limited ability to evaluate the credibility of information sources, and technology use that prioritizes passive information consumption rather than meaningful and in-depth learning activities (Darmawan & Musonawawi, 2026).

Several previous studies have investigated the relationship between digital technology and learning autonomy. However, the existing literature reveals several important research gaps. First, research examining digital technology and learning autonomy remains fragmented across various technological applications, including Learning Management Systems, mobile learning, instructional videos, online learning environments, educational social media, and artificial intelligence-based technologies. Consequently, the existing findings have not yet provided a sufficiently integrated understanding of the types of digital technologies most frequently utilized to support learning autonomy among vocational high

school students (Qohhar, 2026). Second, numerous studies have primarily evaluated technological effectiveness based on academic achievement or student engagement, while specific dimensions of learning autonomy, such as learning initiative, goal setting, strategic learning management, self-regulation, time management, learning resource selection, and self-evaluation, have not consistently received sufficient attention. Third, vocational education has received relatively less research attention than general secondary education or higher education, despite its distinctive characteristics and learning requirements, particularly its emphasis on competency acquisition and preparation for employment (Munthe et al., 2026).

Another significant research gap concerns the limited systematic understanding of the mechanisms through which digital technology contributes to the development of learning autonomy among vocational high school students. Although certain technologies provide greater accessibility and flexibility, their influence on learning autonomy may operate through various mediating or supporting factors, including learning motivation, self-efficacy, digital literacy, student engagement, and pedagogical support from teachers (Arfida et al., 2025). Therefore, a comprehensive investigation is required not only to identify the types of digital technologies utilized in vocational education but also to examine their implementation patterns, educational benefits, facilitating factors, implementation barriers, and the specific dimensions of learning autonomy developed through technology-supported learning (Isna Nurul Inayati et al., 2025).

Considering these research gaps, a systematic literature review (SLR) is necessary to synthesize existing empirical evidence through a structured, transparent, and systematic approach. Unlike traditional narrative literature reviews, which are generally descriptive, a systematic literature review enables researchers to identify, select, critically evaluate, and synthesize previous research findings using explicit and reproducible procedures. This approach can provide a more comprehensive understanding of research developments concerning digital technology and learning autonomy among vocational high

school students. Furthermore, it facilitates the identification of commonly implemented technologies, dimensions of learning autonomy, factors influencing successful implementation, and research areas that remain insufficiently explored (Haikal et al., 2025).

The novelty of the present study lies in its attempt to integrate findings from previous research on various forms of digital technology with specific dimensions of learning autonomy, particularly within the context of vocational high school education (Darmawan & Musonawawi, 2026). Rather than merely identifying the types of digital technologies used in educational settings, this study systematically categorizes their potential contributions to different dimensions of learning autonomy, examines the factors that facilitate or hinder their implementation, and identifies patterns of relationships among technological characteristics, instructional strategies, and the development of students' independent learning capabilities. Accordingly, this study seeks to develop an integrated synthesis framework explaining how digital technology can support learning autonomy among vocational high school students while identifying potential directions for future empirical investigations.

Based on the preceding discussion, the primary objective of this study is to systematically analyze and synthesize previous research findings concerning the utilization of digital technology in supporting self-directed learning among vocational high school students. Specifically, this study aims to: (1) identify the types and forms of digital technologies utilized in vocational high school learning environments; (2) examine the dimensions of learning autonomy developed through the integration of digital technology; (3) investigate the facilitating factors and barriers influencing the effective utilization of digital technology in promoting students' learning autonomy; and (4) identify emerging research trends and existing knowledge gaps to provide a foundation for future research agendas. Through these objectives, the study is expected to contribute to a more comprehensive understanding of technology-supported learning autonomy and provide theoretical and practical insights for

improving digital learning practices in vocational education.

Method

This study employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. These guidelines emphasize transparency and systematic procedures throughout the literature identification, screening, eligibility assessment, and selection processes. The adoption of PRISMA was intended to minimize potential researcher subjectivity during the selection of relevant scientific publications. Furthermore, the application of these guidelines enhances the transparency, traceability, and reproducibility of the literature review process, allowing other researchers to examine and replicate the procedures in future investigations.

Research Design and Setting

This study adopted a Systematic Literature Review (SLR) approach to identify, evaluate, and synthesize findings from previous studies concerning the utilization of digital technology to support learning in vocational high schools. The SLR approach was implemented in accordance with the PRISMA guidelines, which provide a systematic framework for identifying, screening, assessing the eligibility of, and including relevant scientific articles.

The literature search was conducted across several relevant academic databases, including Scopus, Web of Science, ScienceDirect, Google Scholar, and SINTA (Science and Technology Index). The search focused on scientific publications related to educational technology, vocational education, digital learning, self-directed learning, and self-regulated learning. These databases were selected to obtain relevant scholarly literature addressing the relationship between digital technology integration and the development of learning autonomy among vocational high school students.

Participants, Sample, or Data Sources

As this study employed a systematic literature review approach, it did not involve human participants as direct research respondents. Instead, the primary sources of data consisted of scientific articles examining the utilization of digital technology and the development of

learning autonomy in educational contexts, particularly vocational education at the secondary school level.

The selection of articles was based on predetermined inclusion criteria. First, the articles had to present empirical research findings or relevant scholarly reviews concerning educational technology and students' learning autonomy. Second, the research subjects or educational contexts had to involve vocational high school students or relevant vocational education settings. Third, the articles had to be published between 2021 and 2026 to capture recent developments in digital technology integration in education. Fourth, the articles had to be available in either Indonesian or English. Fifth, the articles had to be published in identifiable scientific journals to ensure the traceability of the selected publications.

In addition to the inclusion criteria, several exclusion criteria were established to maintain the relevance and quality of the reviewed literature. Articles were excluded if they did not address digital technology or learning autonomy in accordance with the research focus. Studies focusing exclusively on university students or higher education without clear relevance to vocational education were also excluded. Furthermore, articles containing insufficient methodological information or inadequate research findings for meaningful synthesis were not considered eligible.

The article selection process involved several systematic stages, beginning with the identification of potentially relevant publications, followed by duplicate removal, title and abstract screening, full-text eligibility assessment, and final inclusion of articles meeting the established criteria. These procedures were intended to ensure that the selected literature was relevant to the research objectives and suitable for systematic analysis.

Instruments and Measures

The primary research instrument was a structured data extraction sheet developed to ensure the consistent collection and organization of information from each selected article. The instrument included several components, such as article identification, research characteristics, participant information, types of digital technology utilized,

learning autonomy indicators, dimensions of learning autonomy, facilitating factors, implementation barriers, major research findings, study limitations, and identified research gaps.

Rather than employing direct psychometric measurements, this study examined learning autonomy through the categorization and synthesis of findings reported in the selected articles. To enhance analytical consistency, learning autonomy was classified into several indicators frequently discussed in the literature, including learning initiative, goal setting, learning planning, strategy selection, time management, learning progress monitoring, self-regulation, self-evaluation, and reflective learning.

Digital technologies were categorized according to their characteristics and instructional functions. These categories included Learning Management Systems (LMS), mobile learning applications, instructional videos, educational applications, collaborative learning platforms, digital learning resources, simulation technologies, and artificial intelligence-based learning tools. This classification provided a systematic foundation for examining how different technological applications may contribute to specific dimensions of learning autonomy among vocational high school students.

Procedure and Research Ethics

The research procedure consisted of several systematic stages designed to ensure transparency and consistency throughout the literature review process.

The first stage involved identifying the research problem and formulating research questions based on the central focus of the study, namely the utilization of digital technology to support self-directed learning among vocational high school students.

The second stage involved developing a literature search strategy using relevant keywords associated with digital technology, vocational education, learning autonomy, self-directed learning, and self-regulated learning.

The third stage consisted of identifying and collecting scientific articles from the selected academic databases according to the

predetermined search strategy and publication criteria.

The fourth stage involved screening the retrieved articles based on the established inclusion and exclusion criteria. During this stage, article titles and abstracts were examined to determine their preliminary relevance to the research objectives.

The fifth stage involved conducting a full-text eligibility assessment to evaluate whether the selected articles adequately addressed the research focus. Articles meeting the established eligibility criteria were included in the final collection of studies for further analysis.

The sixth stage involved extracting relevant information from the selected articles using the structured data extraction instrument. This process ensured that essential information was collected consistently across the reviewed publications.

The final stage involved data synthesis, during which research findings were categorized, compared, and interpreted according to the types of digital technology utilized, dimensions of learning autonomy, facilitating factors, implementation barriers, and emerging research trends.

In addition to these procedures, the methodological quality of the selected articles was considered during the review process. Quality assessment focused on the relevance of each study to the research objectives, the appropriateness of the research design, sample characteristics, clarity of research instruments or data collection procedures, suitability of analytical methods, and consistency between the reported findings and conclusions.

Regarding research ethics, this study relied on previously published scientific literature and did not involve direct interaction with human participants. Therefore, the review process focused on maintaining academic integrity through accurate representation of the original research findings, appropriate acknowledgment of information sources, and transparent reporting of the literature selection and synthesis procedures.

Data Analysis

The collected data were analyzed using descriptive analysis and thematic synthesis. Descriptive analysis was employed to map the

distribution and characteristics of the selected articles based on publication year, research design, types of digital technology utilized, and research subjects. This analysis provided an overview of research trends and the characteristics of existing studies examining digital technology integration and learning autonomy in vocational education.

Thematic synthesis was employed to identify recurring patterns and themes concerning the contributions of digital technology to the development of learning autonomy among vocational high school students. This approach enabled the researchers to organize and interpret findings from different studies according to their conceptual similarities, educational implications, and relevance to the research objectives.

The synthesis process classified the research findings into seven major thematic categories: (1) learning accessibility and flexibility, (2) learning initiative and learner control, (3) learning planning and time management, (4) learning progress monitoring and self-regulation, (5) learning evaluation and reflection, (6) teacher roles and pedagogical support, and (7) barriers to digital technology utilization.

These thematic categories served as an analytical framework for examining the potential relationships between technological characteristics, instructional practices, and the development of self-directed learning among vocational high school students. Through this framework, the study sought to identify how different digital technologies may facilitate students' ability to plan, manage, monitor, and evaluate their learning activities.

Furthermore, the results of the descriptive analysis and thematic synthesis were integrated to develop a research map illustrating existing research developments, frequently investigated themes, and areas requiring further empirical investigation. This research map was intended to provide a comprehensive overview of the current literature and identify potential directions for future studies concerning the effective integration of digital technology to

strengthen learning autonomy in vocational education.

Results and Discussion

Results

This study selected scientific literature relevant to the utilization of digital technology and learning autonomy among vocational high school students. The selected studies were systematically reviewed, and essential information was extracted to identify research characteristics, technological applications, and major findings.

Table 1. Article Identification and Selection Process

Selection Stage	Process	Number of Articles
Identification	Articles identified	110
Screening	Duplicate articles removed	86
Screening	Articles screened based on titles and abstracts	70
Screening	Articles excluded based on titles and abstracts	50
Eligibility	Full-text articles assessed	35
Eligibility	Articles excluded after full-text assessment	20
Inclusion	Articles meeting the criteria and included in the synthesis	12

Note: The figures above are translated directly from the original manuscript. The selection counts require verification because they do not

yet form a mathematically consistent PRISMA flow.

The literature selection process was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. According to the research records, 110 articles were initially identified through searches across selected academic databases. The selection process involved duplicate removal, title and abstract screening, full-text eligibility assessment, and final article inclusion. The research records reported 86 duplicate articles, 70 articles at the title and abstract screening stage, 50 articles excluded during screening, 35 articles assessed for full-text eligibility, and 20 articles excluded following full-text assessment. Ultimately, 12 articles were reported as meeting the inclusion criteria and were incorporated into the final synthesis. However, the numerical records of the selection stages require further verification because the reported figures do not form a fully consistent PRISMA sequence.

The selected publications addressed various aspects of digital technology integration in vocational education, particularly its relationship with learning effectiveness, student motivation, academic achievement, and learning autonomy. The findings were synthesized to identify common research patterns, technological applications, educational benefits, and limitations associated with the implementation of digital learning technologies.

2. Characteristics of the Reviewed Studies

The 12 reviewed studies examined different forms of digital technology and their educational applications. These included digital literacy, blended learning, artificial intelligence, digital instructional media, Learning Management Systems, online learning platforms, web-based instruction, and Canva-based learning applications. The studies employed different research approaches, including empirical investigations and literature reviews, reflecting the diversity of methodological perspectives within technology-supported vocational education research.

Sari et al. (2025) investigated the relationships among digital literacy, learning independence, learning motivation, self-efficacy, and learning effectiveness. Their findings indicated that

digital literacy, learning independence, and motivation significantly influenced learning effectiveness. Similarly, Aritantia et al. (2021) examined blended learning in vocational education and identified its potential contribution to improving learning motivation and academic achievement.

Haikal et al. (2025) specifically explored the effectiveness of Learning Management Systems in supporting learning autonomy and academic achievement. Meanwhile, Zalsyabila and Aisyah (2025) examined digital instructional media and highlighted their contributions to student motivation and the development of effective learning environments. Other studies focused primarily on technological effectiveness, creativity, and learning outcomes rather than directly measuring students' self-directed learning capabilities.

These findings indicate that digital technology has become an important component of vocational education. Nevertheless, the reviewed studies differed in their research objectives and outcome measurements, making it necessary to distinguish evidence concerning learning autonomy from findings related to general academic performance.

3. Utilization of Digital Technology in Vocational Education

The literature synthesis identified several digital technologies utilized to support vocational high school learning activities. Learning Management Systems were among the technologies discussed because they provide structured environments for organizing instructional materials, managing assignments, and facilitating learning activities. Haikal et al. (2025) highlighted the contribution of LMS platforms to learning autonomy and academic performance, suggesting their relevance to more independent learning experiences.

Blended learning was another important instructional approach identified in the literature. Aritantia et al. (2021) reported that combining conventional classroom instruction with digital learning activities contributed to improved motivation and academic achievement. This approach provides opportunities for students to engage with

instructional materials through different learning environments.

Artificial intelligence-based instruction was examined by Juliantika et al. (2026) and Hudaya et al. (2026). Their studies highlighted the potential of AI-supported learning to improve creativity and academic outcomes. However, the reviewed findings did not provide sufficient evidence to conclude that artificial intelligence directly improved students' ability to independently plan, monitor, and evaluate their learning.

Other technologies included Edmodo, web-based instructional platforms, and Canva-based learning media. These applications were associated with improvements in learning processes, motivation, and academic performance. Overall, the reviewed studies demonstrated the diversity of digital technologies being implemented in vocational education.

4. Digital Technology and Students' Learning Outcomes

The reviewed literature revealed that digital technology was frequently associated with positive educational outcomes, particularly learning motivation, academic achievement, creativity, and student engagement. Several studies reported improvements following the implementation of digital instructional approaches.

Rahmadani et al. (2026) investigated web-based learning among vocational students majoring in motorcycle technology. Their findings demonstrated statistically significant differences between experimental and control groups in learning interest and academic achievement. The experimental group obtained a mean learning interest score of 52.27, compared with 46.40 in the control group, with a significance value of 0.024. Furthermore, the experimental group achieved a post-test mean score of 86.67, whereas the control group obtained 65.67. The reported significance value for learning outcomes was 0.000, indicating a statistically significant difference.

Similarly, Hudaya et al. (2026) reported significant differences in academic achievement between students receiving artificial intelligence-based instruction and those participating in conventional learning. Pramana and Sirait (2026) also identified the

contribution of Canva-based instructional media and learning motivation to students' achievement in digital marketing subjects.

Although these findings demonstrate the educational potential of digital technologies, improvements in academic performance should not automatically be interpreted as evidence of increased learning autonomy. Learning outcomes and self-directed learning represent related but conceptually distinct educational constructs.

5. Dimensions of Self-Directed Learning

The conceptual synthesis identified several dimensions through which digital technology may contribute to students' learning autonomy. These dimensions included learning initiative, goal setting, learning planning, time management, learning resource selection, progress monitoring, self-regulation, and self-evaluation.

Digital learning environments may encourage students to independently access instructional materials and select resources according to their learning needs. Similarly, technology-supported learning activities may provide opportunities for students to establish learning objectives, organize assignments, and manage their learning schedules.

Learning Management Systems and other online platforms may also facilitate progress monitoring by providing access to assignments, learning activities, and feedback. These features are conceptually relevant to self-regulated learning because they can support students in monitoring their performance and identifying areas requiring improvement.

However, the reviewed literature did not consistently provide direct empirical measurements of these dimensions. Therefore, the identified relationships should be understood primarily as a conceptual framework for examining the potential contribution of digital technology to self-directed learning rather than as confirmed effects across all selected studies.

6. Facilitating Factors and Implementation Challenges

The synthesis identified several factors potentially influencing the effectiveness of digital technology in supporting learning autonomy. These included digital literacy,

learning motivation, self-efficacy, instructional design, teacher support, and access to technological infrastructure.

Digital literacy emerged as an important consideration because students require appropriate competencies to access, evaluate, and utilize digital learning resources effectively. Learning motivation and self-efficacy were also relevant to understanding students' willingness to participate actively in technology-supported learning activities.

Nevertheless, digital technology integration presents several challenges. These include unequal access to digital devices, limited internet connectivity, differences in students' technological competencies, distractions from non-educational applications, information overload, and excessive dependence on technological assistance.

These challenges indicate that technological availability alone cannot guarantee meaningful learning autonomy. Appropriate instructional strategies and teacher guidance remain important for supporting students in developing responsible and independent learning practices.

7. Research Trends and Identified Gaps

The reviewed literature demonstrated considerable research interest in the relationship between digital technology and educational effectiveness. Most of the selected studies emphasized improvements in academic achievement, learning motivation, creativity, or instructional quality. Comparatively fewer studies directly investigated the specific dimensions of self-directed learning among vocational high school students.

This finding highlights an important research gap concerning the measurement of learning autonomy. Although digital technologies may create favorable conditions for independent learning, additional empirical investigations are needed to determine whether students actually develop stronger abilities to establish learning goals, manage learning strategies, monitor progress, and evaluate their performance.

The synthesis also identified the need for more comprehensive research examining the relationships among technological characteristics, pedagogical strategies, and students' learning autonomy. Future studies should employ validated instruments and

appropriate research designs to investigate these relationships directly.

Overall, the findings suggest that digital technologies offer meaningful opportunities to support flexible, interactive, and student-centered learning environments in vocational education. However, the development of self-directed learning depends not only on technological integration but also on instructional practices, learner characteristics, and the availability of adequate educational support. These findings provide a foundation for developing a more comprehensive understanding of technology-supported learning autonomy among vocational high school students.

Discussion

The findings of the reviewed literature indicate that digital technology has been widely utilized in vocational high school education to support instructional processes, enhance learning motivation, and facilitate more interactive learning experiences (Sari et al., 2025). Nevertheless, the contribution of digital technology to learning autonomy should be interpreted critically, as improvements in academic achievement do not necessarily indicate that students have developed the ability to independently regulate and manage their learning processes.

A conceptual synthesis of the reviewed literature suggests that the potential contributions of digital technology to learning autonomy can be examined through several dimensions, including learning initiative, learning planning, time management, learning resource selection, learning progress monitoring, and self-evaluation (Haikal et al., 2025). These dimensions serve as an analytical framework for understanding the potential role of digital technology in promoting independent learning. However, they should not be interpreted as dimensions that have necessarily been directly measured or empirically confirmed in all the reviewed studies.

The literature also highlights the importance of learning motivation, digital literacy, instructional media effectiveness, and technology integration in improving students' learning outcomes (Purniasih & Agustiana, 2024). These factors are relevant to understanding the conditions under which

digital technology may support learning autonomy. Nevertheless, a clear distinction must be maintained between findings directly reported in the reviewed studies and conceptual interpretations developed through the present synthesis.

Although digital technology provides numerous educational opportunities, its implementation also presents several challenges. From a conceptual perspective, these challenges include unequal access to digital devices and internet connectivity, variations in students' digital competencies, distractions caused by non-educational applications, information overload, and excessive dependence on technological assistance (Inayati et al., 2025). These challenges deserve particular attention because access to digital technology does not automatically ensure that students possess the competencies required to use it effectively and independently.

The primary contribution of this study lies in integrating discussions of digital technology utilization and learning autonomy within vocational high school education. Given the diversity of digital learning media and instructional platforms, future investigations should move beyond the measurement of academic achievement and focus more specifically on students' learning initiative, self-regulation, and control over their learning processes.

Conceptually, this study proposes a framework connecting three major components: the characteristics of digital technology, pedagogical strategies, and the dimensions of students' learning autonomy. From a practical perspective, vocational high schools and teachers should integrate digital technology with instructional activities that require students to demonstrate initiative and responsibility for their learning. Such activities may include independent learning projects, digital reflective journals, and the establishment of individual learning goals. Through these approaches, digital technology can function not only as a medium for delivering instructional content but also as a supportive environment for

developing students' self-directed learning competencies.

Conclusion

This study aimed to analyze the utilization of digital technology in supporting self-directed learning among vocational high school students through a systematic literature review. Based on the reviewed literature, the digital technologies examined included Learning Management Systems (LMS), digital learning media, web-based learning platforms, instructional videos, and artificial intelligence-based technologies. These technologies have the potential to support learning accessibility and flexibility, student initiative, time management, learning progress monitoring, and self-evaluation. However, their availability and implementation do not automatically lead to the development of learning autonomy, as their effectiveness is influenced by several factors, including digital literacy, learning motivation, instructional design, teacher support, and the availability of technological infrastructure.

The main contribution of this study is the development of a conceptual synthesis framework connecting the characteristics of digital technology, pedagogical strategies, and dimensions of learning autonomy within vocational education. The practical implications emphasize the importance of integrating digital technology into learning activities that extend beyond instructional content delivery and academic achievement improvement. Teachers should provide opportunities for students to independently plan, manage, monitor, and evaluate their learning processes. Future research should employ transparent literature selection procedures and empirically investigate the effects of different digital technologies on specific dimensions of learning autonomy among vocational high school students. Consequently, conclusions regarding the effectiveness of digital technology should be supported by empirical evidence that directly measures learning autonomy rather than relying exclusively on academic achievement indicators.

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