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DEVELOPMENT OF TECHNOPRENEURSHIP LEARNING TOOLS IN VOCATIONAL HIGH SCHOOLS: A SYSTEMATIC REVIEW OF MODELS, COMPONENTS, AND IMPLICATIONS

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ABSTRACT
This study maps the trends in the development of technopreneurship learning tools in vocational schools through a Systematic Literature Review (SLR) of five articles published between 2021 and 2025. The analysis results show that the ADDIE and Borg & Gall models dominate due to their systematic structure. The main components of the tools focus on the integration of digital technology (AR/Chatbot), strengthening 21st-century skills (4Cs and survival skills), and technical management of entrepreneurship. The implementation of these tools has proven effective in increasing student motivation and learning outcomes, while also transforming the role of teachers into facilitators. However, a gap was found in the form of fragmented development in the independent modules. This study recommends a shift in strategy towards the formation of a comprehensive digital entrepreneurship ecosystem and a transformation of innovative mindsets to overcome the low level of digital-preneurship skills among students in the field.

INTRODUCTION

Today's business world no longer focuses on conventional buying and selling activities, but rather emphasizes the integration of digital technology throughout the entire entrepreneurial process (Wibowo, 2023; Putra et al., 2024). Entrepreneurs are now required to be able to utilize digital platforms to promote products and services, expand market

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reach, and increase business scalability. The shift towards a digital ecosystem has fundamentally changed the entrepreneurial paradigm, where the use of social media and e-commerce platforms often generates greater profits than traditional business practices (Bernardino et al., 2023).

In the era of the Fourth Industrial Revolution, entrepreneurship has evolved into a technology-based practice known as technopreneurship, which emphasizes the strategic use of technology to meet global market demands and enhance business competitiveness (Harahap et al., 2023; Luo & Zahra, 2023; Kumar et al., 2023). Through adaptation to the digital ecosystem, entrepreneurs are able to increase their scalability in running their businesses more effectively and access broader economic opportunities. Thus, technopreneurship has become an important competency for future workforce development to prepare students who are ready to utilize technology in entrepreneurship.

In the context of technopreneurship, entrepreneurship is not only defined by the use of existing technology or digital tools, but rather by the ability to independently develop an entrepreneurial ecosystem that is integrated with digital innovation (Bala & Arora, 2023). This emphasizes that mastery of technology must be accompanied by the development of an entrepreneurial mindset. However, the implementation of technology-supported entrepreneurship education has not been fully realized in the learning environment of Vocational High Schools (Hariyono, 2023).

Although curriculum changes continue to be adapted to the times to align Vocational High School education with industry demands, the challenge of fostering technopreneurship competencies among Vocational High School students remains a major issue. Low interest in entrepreneurship, combined with limited access to learning tools and media that effectively integrate digital technology into entrepreneurship learning, are problems that must be solved (Jazuli et al., 2023; Kertiasih et al., 2024). In Indonesia, based on a tracer study conducted by the Ministry of Education and Culture in 2024, only 22.28% of 2023 Vocational High School graduates chose an entrepreneurial career. This condition reflects the need for systematic efforts to strengthen technopreneurship or digital-based entrepreneurship education as a strategy to improve graduate employability and regional economic growth.

The gap between the curriculum objectives and the number of Vocational High School graduates oriented towards digital entrepreneurship is still relatively low, indicating a mismatch in the internalization of technology-based entrepreneurial values during classroom learning. The current challenges in technology-based entrepreneurship education go beyond the availability of infrastructure and are increasingly related to the capacity of teachers to design and implement pedagogical strategies that integrate technical competencies with a digital entrepreneurial mindset (Linton et al., 2021; Bachmann et al., 2024). Without structured learning tools based on sound pedagogy, technology-based entrepreneurship education risks being limited to the use of media without encouraging innovation-oriented business thinking (Hardi et al., 2022; Haryoko et al., 2022; Zhang, 2022).

In response to these challenges, learning tools are needed that systematically support technology-based entrepreneurship education and serve as operational guidelines for teachers in implementing digital entrepreneurship learning. Previous studies have developed various models, media, and modules to support technology-based entrepreneurship learning in Vocational High School. However, these studies are still fragmented and product-oriented, and there has been no systematic literature review that comprehensively synthesizes development models, core learning components, and pedagogical implications of developing technopreneurship learning tools at the vocational school level.

Based on this initial research gap, a systematic mapping of existing studies is needed to identify the dominant development models, instructional components, and pedagogical implications associated with technology entrepreneurship learning tools. Therefore, this study uses a Systematic Literature Review approach to critically analyze previous research and identify research gaps that can provide information for the future development of technopreneurship learning tools at the Vocational High School level (Matsumoto et al., 2021; Clarke et al., 2024). To achieve this goal, the following research questions were formulated:

RQ1: What learning tool development model is used in technopreneurship studies at the Vocational High School Level?

RQ2: What are the main components of learning tools that are the focus of the development process?

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RQ3: What pedagogical implications are reported by these studies for learning practices in Vocational High Schools?

Through the above questions, a more focused roadmap can be developed to determine future research and development of technopreneurship learning tools.

METHOD

This study uses the Systematic Literature Review (SLR) method to identify studies related to the development of technopreneurship learning tools using the PRISMA approach. There are three main stages in the PRISMA approach to extract data from previous studies, namely the identification, screening, and inclusion stages (Haddaway et al., 2022). To answer the questions formulated in the previous session, this study used the PICo (Population, Intervention, Context) framework to determine the inclusion criteria and search strategy for relevant studies in previous research (Aromataris et al., 2024).

Table 1. PICo Framework

Component	Description
Population	Vocational High School students
Intervention	Development of Technopreneurship Learning Tools (Model, Components, Implications)
Context	Vocational education at the Vocational High School level

After formulating the PICo framework as shown in Table 1, the next step is to determine the inclusion and exclusion criteria to filter relevant and quality studies. The inclusion and exclusion criteria are shown in Table 2 below:

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Time range	2021-2025	< 2021
Language	English, Indonesian	Except English and Indonesian
Document Type	Original Articles and Proceedings.	Opinion articles, book reviews, reports.
Publication Type	Open Access	Closed Access
Research Focus	Development of Technopreneurship Learning Tools	Research related to technopreneurship not development.
Subject/population	Vocational High School students	Not Vocational High School students, but college students or similar.

In the initial or identification stage, researchers conducted a search for relevant studies in English and Indonesian between 2021 and 2025 on Google Scholar, Semantic Scholar, and Dimensions databases using the following search pattern:

("technopreneurship" OR "digital entrepreneurship" OR "technology entrepreneurship") AND ("learning materials" OR "instructional design" OR "learning device" OR "teaching materials" OR "module" OR "learning package") AND ("vocational education" OR "vocational school" OR "technical school" OR "vocational high school")

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Below is a figure of the PRISMA framework for determining relevant articles for review.

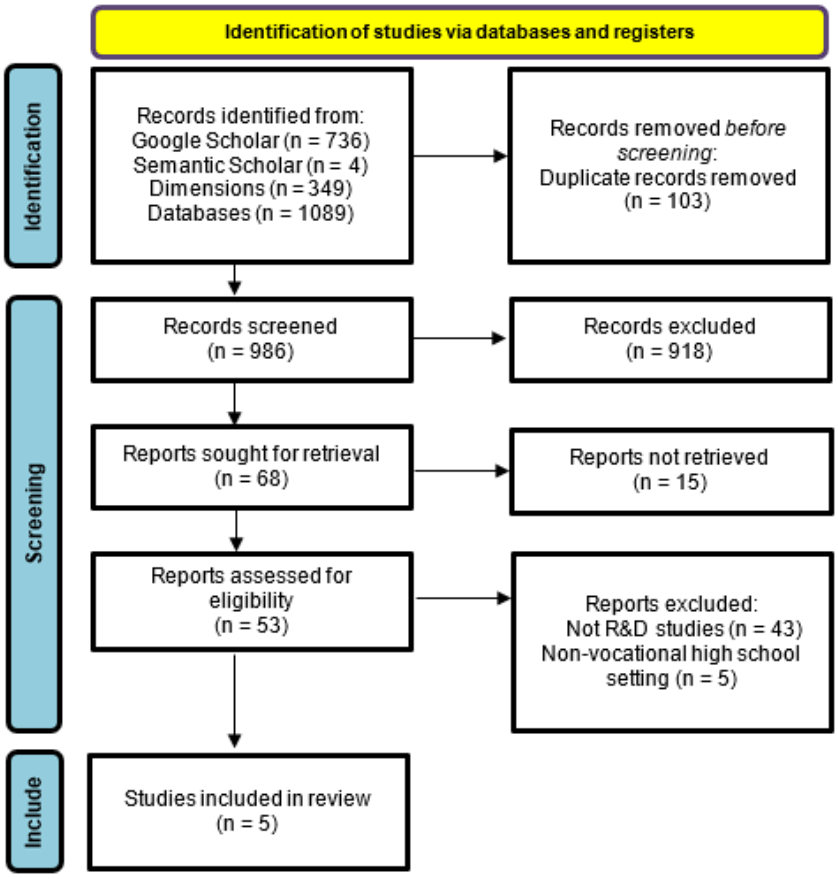

Figure 1. SLR Framework stages (Haddaway et al., 2022)

The initial search results with the above pattern yielded 736 articles from the Google Scholar database, 4 articles from Semantic Scholar, and 349 articles from Dimensions, bringing the total number of articles in this initial search to 1089. These articles were then further identified, and 103 articles were found to be duplicates and had to be removed.

The next stage was screening. At this stage, articles that passed the initial identification (986 articles) were examined based on their titles and abstracts to determine whether they were relevant to the topic of technopreneurship. The result was that 918 articles were found to be irrelevant, leaving 68 articles for further screening. Of the 68 articles, 15 articles could not be found in full text or were closed access, leaving 53 articles for the final screening phase. In the final screening phase, two additional exclusion criteria were applied, namely: (1) not R&D research and (2) research not conducted in Vocational High Schools. From this final screening, it was found that 43 articles were not R&D research, and 5 articles did not conduct research at the Vocational High School level. Thus, 5 articles remained eligible to proceed to the review process.

The final stage was inclusion. At this stage, the number of articles relevant to SLR research on the topic of developing technopreneurship learning tools at the Vocational High School level had been determined. Although the

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final selection only included five articles, this number is considered representative enough to map the trends in the development of technopreneurship learning tools in Vocational High Schools. This is because the inclusion criteria applied were very strict, namely only including research and development (R&D) published in the last five years to ensure the relevance of the technology and quality of the products produced.

The methodological quality of the five selected articles was assessed using the JBI Critical Appraisal Checklist. The assessment process was carried out by researcher accompanied by two supervisors to ensure objectivity. This instrument includes nine evaluation criteria adapted from JBI references (Barker et al., 2024). This instrument assesses the clarity of cause-and-effect relationships, participant similarity, consistency of treatment, the presence of control groups, and the implementation of pre- and post-intervention measurements. Furthermore, the appraisal evaluates the completeness of follow-up, the reliability and uniformity of outcome assessments, and the appropriateness of the statistical analysis employed in each study. JBI Critical Appraisal tools are used to ensure that articles that meet the inclusion criteria have undergone the correct scientific procedures. The article will proceed to the review process if the JBI score is in the medium to high category.

RESULTS AND DISCUSSION

Results

Based on the article selection process conducted using the PRISMA approach, there were 5 articles that met the inclusion criteria and could be used for further analysis. All articles that met the inclusion criteria were R&D research articles published between 2021 and 2025 and conducted at the Vocational High School level. The results of data extraction from articles that met the inclusion criteria are as follows:

Table 3. Data Extraction Results of Included Articles

Researcher (Year)	Product Type	R&D Model	Competency Components	Outcome
Abdurrahman & Mahmudah (2023)	Measurement Instrument for Digital Entrepreneurship	A Combination Model from Oriondo & Antonio (1984) and Mardapi & Kartowagiran (2011).	Teachpreneurship, Entrepreneur Plan, and E-digitalpreneurship Management.	Instrument is valid in terms of content and construct; student digital entrepreneurship skills remain in the low category.
Krisnawati et al. (2024)	E-LKPD for Creative Product Business Analysis	ADDIE	Character independence and business analysis (costs, profit, and BEP ratios).	Highly valid; proven effective in improving student understanding and fostering independence.
Surya & Hidayat (2024)	Chatbot-based Interactive Learning Media	Borg and Gall	Integration of 4C competencies (critical thinking, creativity, collaboration, communication).	Deemed highly valid; significantly improved learning outcomes with average scores rising from 64.76 to 91.52.
Trisetiyato et al. (2024)	Technopreneurship-based Learning Module	Borg and Gall	Product design, production processes, marketing strategies, and product promotion	Effective in improving both entrepreneurial and learning

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Researcher (Year)	Product Type	R&D Model	Competency Components	Outcome
				competencies among students.
Purnomo et al. (2025)	CLTSMK-AR Model & KLIK.AR Application	ADDIE	Survival skills including motivation, adaptability, managerial, and communication skills.	High validity and practicality; implementation significantly improved students' survival skills.

Based on Table 3 above, it is known that between 2021 and 2025, there were only publications related to the development of technopreneurship learning tools in 2023 (1 publication), 2024 (3 publications), and 2025 (1 publications). This indicates that there is still much to be explored in research and development related to the development of technopreneurship learning tools. The results of the quality assessment of the five articles above based on the JBI Critical Appraisal Tools are as follows:

Table 4. JBI Critical Appraisal Score for Included Articles

Researcher	JBI Score	Category
Abdurrahman & Mahmudah (2023)	6	Moderate
Krisnawati et al. (2024)	5	Moderate
Surya & Hidayat (2024)	6	Moderate
Trisetiyato et al. (2024)	6	Moderate
Purnomo et al. (2025)	9	High

The JBI Critical Appraisal Score provides an overview of the quality of articles that meet the inclusion criteria. From the five articles, four were classified as moderate and one was classified as high. With this in mind, all articles are worthy of further analysis in order to identify gaps in the development of technopreneurship learning tools.

Learning Tool Development Model (RQ1)

The results of data analysis from the inclusion articles extracted in Table 3 show that R&D research using the ADDIE model is still predominantly used. This is demonstrated by Krisnawati et al. (2024), who used the ADDIE model to develop E-LKPD Analysis of Creative Products, and Purnomo et al. (2025), who used the same model to develop an Augmented Reality-based Cooperative Learning model. The ADDIE development design was chosen for the development of technopreneurship learning tools because it has a logical structure, starting from needs analysis to impact evaluation, which is carried out in a measurable manner to produce tools that are valid in terms of content and construct. In addition, ADDIE includes formative and summative evaluation processes, which will help optimize product development (Nowicki et al., 2024).

Apart from the ADDIE development framework, the Borg and Gall Model is also widely used in development research. This model offers flexibility in its application because it can be modified according to the research context in Vocational High Schools (Supriyadi et al., 2022). Surya and Hidayat (2024) applied this model in their research on the development of interactive learning media based on a chatbox integrated with 4C capabilities for Retail Business material, where in this study, the Borg and Gall development was simplified into 7 stages. Meanwhile, Trisetiyato et al. (2024) also referred to the Borg and Gall model but packaged it into four main stages, including research, design, production, and product testing. The main focus of using this model is on the field trial cycle and continuous revision, which is considered very effective for the development of interactive learning media and digital technology-based practicum modules.

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On the other hand, there are several variations of models that have been specifically developed to address the needs of technopreneurship learning. Abdurrahman & Mahmudah (2023) used a combination of procedures from Oriondo & Antonio and Mardapi to develop a measurement instrument for digital entrepreneurship achievement. This model focuses on instrument design, instrument testing, and measurement. The selection of development models in this literature is highly dependent on the characteristics of the product to be developed, where the ADDIE and Borg & Gall models remain the main standards in ensuring the technical and pedagogical quality of technopreneurship learning tool development in Vocational High Schools.

Learning Tool Components (RQ2)

The development of learning tools cannot be separated from the need to facilitate the delivery of lesson material or the transfer of knowledge and skills to students (Risanti & Agustina, 2025). After extracting data from articles related to the development of technopreneurship learning tools, the components of learning tools were categorized into three main focuses, which include the integration of digital technology, the strengthening of 21st-century skills, and the mastery of technical entrepreneurship.

The integration of digital technology in entrepreneurship is one of the main requirements in running technopreneurship (Zein et al., 2021). Therefore, in providing entrepreneurship education to students, teachers must begin to shift from conventional methods to digital-based methods. One example is the development of interactive chatbox-based media integrated with 4C skills in Retail Business Management material by Surya and Hidayat (2024). Another example is Purnomo et al. (2025), who developed the KLIK.AR application together with Technopreneur to provide a more realistic learning experience for students in Cooperative Learning in the use of industrial technology tools, such as Mini CNC Laser. Learning activities using industrial technology train students to create creative products that have saleable value through the production process with technology (Trisetiyato et al., 2024).

The learning tools developed focus not only on technology but also on character development and 21st-century skills relevant to industry needs (Dewi & Gunadi, 2025). This focus includes the integration of 4C competencies (critical thinking, creativity, collaboration, and communication) into learning content (Surya & Hidayat, 2024). In addition, there is also an emphasis on building independent character, which includes emotional, behavioral, and value aspects, through independent project work in E-LKPD (Krisnawati et al., 2024). Several studies also focus on the development of *survival skills* such as learning motivation, adaptability, leadership, and managerial skills as the foundation of an entrepreneur's mentality (Purnomo et al., 2025).

Several studies on the development of technopreneurship learning tools maintain the depth of technical substance in management and entrepreneurship in addition to teaching soft skills. Research conducted by Abdurrahman & Mahmudah (2023) emphasizes the strengthening of digital-preneurship skills, which are technical skills that must be mastered in the 21st century. In addition, Krisnawati et al. (2024) developed E-LKPD Creative Product Analysis and Entrepreneurship so that students can learn management in running a business. Finally, Trisetiyato et al. (2024) developed a techopreneurship learning module that teaches students about target markets, product design, production processes, product finishing, marketing strategies, and product promotion enhancement.

Pedagogical Implications for Practice in Vocational High Schools (RQ3)

The technopreneurship learning tools developed in previous studies have shown significant effectiveness in improving students' competencies and learning outcomes at the Vocational High School level. The use of interactive media such as chatbots integrated with 4C skills has been statistically proven to dramatically improve student learning outcomes compared to conventional methods in business and retail management subjects (Surya & Hidayat, 2024). In addition, the cooperative learning model integrated with Augmented Reality (AR) technology achieved high effectiveness scores in improving students' survival skills, which include learning motivation, critical thinking skills, adaptability, communication, and managerial skills in the subject of Automatic Electricity (Purnomo et al., 2025). The development of E-LKPD analysis of creative products based on entrepreneurship has also proven effective in

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improving students' understanding of entrepreneurship and shaping their independent character (Krisnawati et al., 2024).

Adapting learning to the latest technology has implications for changing the role of teachers, who were initially the main source of information but have now transformed into facilitators, mentors, and pedagogical planners in the ecosystem of digital-based learning. Teachers now have a role in designing transformative learning strategies and guiding students through independent projects oriented towards the real needs of industry. Teachers' competence in selecting innovative learning models is a crucial factor in facilitating the transfer of knowledge and skills to students holistically. In addition, digital assistants help teachers provide faster feedback and conduct evaluations and monitoring of classroom activities more efficiently and measurably.

The development of technopreneurship learning tools has successfully shifted students' interests to be more oriented towards the digital business world rather than simply becoming job seekers (Dewi & Gunadi, 2025). Contextual learning experiences through 3D visualization in AR and hands-on practice using industrial technology, such as Mini CNC Laser, have been proven to foster enthusiasm, curiosity, and creativity in students in creating creative products with economic value (Trisetiyato et al., 2024; Purnomo et al., 2025). Transformative learning strategies effectively change students' paradigms from technology consumers to innovators in developing a digital entrepreneurship ecosystem or technopreneurship. Thus, strengthening students' independence in entrepreneurship, which is formed through media intervention or technopreneurship learning tools provided during school, reinforces students' tendencies and preferences for entrepreneurship after graduation.

Discussion

Comparison of Studies

An analysis of the five included articles shows a diversity of approaches in the development of technopreneurship learning tools at the vocational school level. Krisnawati et al. (2024) and Purnomo et al. (2025) used the ADDIE development model because of its logical structure, starting from needs analysis to impact evaluation. In contrast to the two researchers mentioned earlier, Surya & Hidayat (2024) and Trisetiyato et al. (2024) preferred to use the Borg and Gall model, which offers flexibility in the field testing cycle and continuous revision. Meanwhile, Abdurrahman & Mahmudah (2023) took a different path by combining the procedures of Oriondo & Antonio (1984) and Mardapi & Kertowagiran (2011) to focus development on the validity of learning outcome measurement instruments. In terms of product components, there are also differences in focus; Surya & Hidayat (2024) integrate 4C competencies through chatbot media, while Purnomo et al. (2025) emphasize strengthening survival skills such as motivation and adaptability using Augmented Reality technology. Further comparison shows that Krisnawati et al. (2024) focus on managerial aspects through cost and profit analysis, while Trisetiyato et al. (2024) prioritize marketing strategies and real production processes using industrial tools. Although the approaches and models used vary, all researchers agree that technological intervention in learning devices can significantly improve students' understanding, motivation, and independent character.

Research Gap

Although various learning tools have been proven effective in improving learning outcomes, this review found several research gaps that need to be addressed. The majority of current research still tends to be fragmented and oriented towards the development of media or modules for specific subject matter, but has not touched on the development of tools that can train students to build a digital entrepreneurship ecosystem independently. In addition, a gap was found between the technical quality of the tools and the actual competencies of students. Although Abdurrahman & Mahmudah (2023) have developed a valid measurement instrument, field data shows that the level of digital-preneurship skills of Vocational High School students in general is still in the low category. Another gap is seen in the focus of development, which is still dominated by the operational mastery of certain industrial tools to produce physical products, compared to the transformation of mindsets to innovate in competitive digital-based

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business models. This indicates that the essence of creative innovation to realize business ideas has not been fully integrated holistically into the existing learning tools.

Novelty

The novelty of this systematic review lies in the identification of the urgent need to shift from the development of fragmented learning tools to the formation of a comprehensive digital technopreneurship ecosystem in Vocational High Schools. This study confirms that learning effectiveness does not only depend on the availability of infrastructure, but also on transformative learning strategies that can change the paradigm of students from mere consumers of technology to digital innovators. This novelty offers a new roadmap for future research development that not only focuses on the technical aspects of using industrial tools or digital applications, but also integrates the strengthening of survival skills and innovative mindsets as the mental foundation of entrepreneurship. Through mapping the studies of the past five years, this review provides strategic direction for educators to transform into facilitators in a digital learning ecosystem designed to strengthen students' entrepreneurial preferences after graduating from school.

CONCLUSION

The results of a Systematic Literature Review related to the development of technopreneurship learning tools at the Vocational High School level in R&D research conducted over the past five years show that the development of learning tools is dominated by the ADDIE and Borg & Gall models. In several previous studies on the development of technopreneurship learning tools, the focus of development was not only on the integration of technology in learning, but also on teaching the soft skills needed in the era of the 4.0 industrial revolution , as well as contextual digital-based entrepreneurial management and technical skills. Although the implementation of these tools has proven effective in improving student learning outcomes, motivation, and independence, as well as transforming the role of teachers into facilitators, there are still significant research gaps because current development tends to be limited to independent modules and has not touched on the formation of a comprehensive digital entrepreneurial ecosystem to address the low level of students' digitalpreneurship skills in the field.

Future research should be directed toward developing learning tools that are integrated into a comprehensive digital technopreneurship ecosystem, in order to avoid fragmented development of specific modules or media. The focus of future research should emphasize the transformation of innovative mindsets and the design of competitive digital business models, going beyond mere technical mastery of industrial tools. In addition, more in-depth studies are needed to find effective pedagogical strategies to bridge the gap between the technical quality of learning tools and the real improvement of students' digital-preneurship skills in the field. Finally, future research can explore the strategic role of teachers in transforming themselves into facilitators who are able to holistically align students' technical competencies with the needs of the global digital market.

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