International Journal of Essential Competencies in Education
https://journal-center.litpam.com/index.php/ijece/index

Dec. 2024 Vol. 3, No. 2
e-ISSN: 2962-2131
pp. 158-183

Business Incubation Based on Technopreneurship Learning Factory: Model Design and Expert Perspectives

Indriaturrahmi [1], Saiful Prayogi [2]*, Syifa'ul Gummah [3]

[1] Department of Information Technology Education, Universitas Pendidikan Mandalika, Mataram, Indonesia.
[2] Department of Science Education, Universitas Pendidikan Mandalika, Mataram, Indonesia.
[3] Department of Physics Education, Universitas Pendidikan Mandalika, Mataram, Indonesia.

*Correspondence: saifulprayogi@undikma.ac.id

Article Info

Article History
Received: October 2024;
Revised: December 2024;
Published: December 2024

Keywords
Technopreneurship;
Business incubation;
Learning factory;
Design thinking;
Competitive advantage

Abstract

This study aims to design and validate a business incubation model based on a technopreneurship learning factory, addressing the gap between academic learning and industry demands in the context of Industry 4.0. The increasing unemployment rate among university graduates, exacerbated by a lack of practical skills and industry alignment, highlights the urgency for innovative educational approaches. The proposed model integrates theoretical knowledge with entrepreneurial simulations, fostering design thinking and competitive advantage in technopreneurship. Employing a developmental research approach, the model was evaluated through expert validation involving specialists in education, business, and technology. The validation process emphasized content and construct validity, ensuring the model's alignment with both academic and industrial requirements. The results confirmed its theoretical soundness and practical relevance, marking a significant step in revitalizing entrepreneurship education programs. This model provides a framework for universities to bridge the skills gap and enhance their role in preparing students for the modern labor market. Future research should focus on piloting the model across diverse disciplines and institutions to assess its adaptability and long-term impact. By fostering industry-academic collaboration, this study contributes to the development of a sustainable technopreneurship ecosystem, advancing innovation while addressing the challenges of traditional entrepreneurship education.

https://doi.org/10.36312/ijece.v3i2.2258

How to Cite

Indriaturrahmi, I., Prayogi, S., & Gummah, S. (2024). Business Incubation Based on Technopreneurship Learning Factory: Model Design and Expert Perspectives. *International Journal of Essential Competencies in Education*, *3*(2), 158–183. https://doi.org/10.36312/ijece.v3i2.2258

INTRODUCTION

The increasing unemployment rate among university graduates has become a major concern in many developing countries, including Indonesia. Data from Indonesia's Central Bureau of Statistics (CBS) in January 2023 revealed that the Open Unemployment Rate (OUR) based on education level stood at 36.92% of the total unemployment rate in Indonesia (Badan Pusat Statistik, 2023). University graduates, particularly those holding diplomas and bachelor's degrees, contributed to 9.39% of the OUR, a figure significantly higher than the 3.59% unemployment rate for elementary school graduates. This high rate of unemployment

among university graduates has also been reported in numerous countries worldwide (Abid et al., 2023; Dayaratna-Banda & Dharmadasa, 2022; Qiwang & Xiaorui, 2020; Yirenkyi et al., 2023). The unemployed face numerous psychological challenges, exacerbated by their difficulty in securing jobs (Okpako et al., 2021). Graduates are expected to be agents of change within society, yet they have fallen short of this expectation, as a university degree no longer guarantees the career advancement and improved quality of life that many once believed it would (Suhirman & Muliadi, 2023).

The growing unemployment issue among graduates has been linked to a significant gap between academic learning in universities and the practical skills demanded by the labor market (Aljohani et al., 2022). Previous studies explored how the weak connection between education and the skills required by industry contributes to this rising unemployment rate (Yirenkyi et al., 2023). In the era of Industry 4.0, labor market demands have shifted towards technology adoption across all aspects of life, including education (Sahidu et al., 2019; Sharma et al., 2023), network systems (Husin et al., 2023; Indriaturrahmi, 2017), and business and industrial sectors (Castagnoli et al., 2022; Indriaturrahmi & Sudiyatno, 2016). The necessity of technology-based entrepreneurship (technopreneurship) is seen as a crucial strategy for technological development (Oukil, 2011). This scenario creates an opportunity for students to embark on entrepreneurial ventures that address society's technological needs. However, a major issue arises as students struggle to translate theoretical knowledge into practical applications.

The first challenge relates to students' lack of soft skills, particularly design thinking, which is vital for innovation (Indriaturrahmi et al., 2023). Design thinking fosters students' ability to develop innovative ideas and commercialize technology (Lynch et al., 2021). The second problem is the insufficient technopreneurship training during their university education. Previous research indicates a lack of efforts by universities in developing technopreneurial skills in students (Oukil, 2011), with universities serving merely as academic service providers (Indriaturrahmi et al., 2022). Even in countries with top-tier education systems, like Finland, the entrepreneurial ecosystem at universities remains underdeveloped (Lahikainen et al., 2019). On the other hand, technopreneurship programs in universities offer students opportunities to enhance their entrepreneurial and innovative skills (Amante & Ronquillo, 2017). Nevertheless, the failure of university education in preparing students to engage in and manage technopreneurial ventures leaves them unprepared to meet modern labor market demands.

To bridge these gaps, many universities have initiated entrepreneurship programs aimed at fostering students' soft skills within an academic environment. These programs are intended to align academic learning with the practical skills required by the labor market. Ideally, these entrepreneurship programs would enable universities to play a significant role in shaping the technopreneurship ecosystem. However, most universities have failed to provide the infrastructure necessary to create this ecosystem, and entrepreneurship programs remain largely theoretical, with little impact on students' entrepreneurial spirit and interest (Setyawati et al., 2021). Adopting education systems from developed countries, the alignment of academic education with practical skills required by the labor market and modern industries is achieved through the concept of learning factories (Baena et al., 2017; Jing et al., 2023; Louw & Deacon, 2020). These learning factories are adaptable to both academic and practical skills, particularly in growing fields such as information technology.

The concept of a technopreneurship learning factory aims to revitalize university entrepreneurship programs by embedding practical and theoretical knowledge in a simulated business environment. This model allows students to apply theoretical concepts in real-world

entrepreneurial settings, fostering innovation and technology commercialization. Moreover, the technopreneurship learning factory seeks to improve students' design thinking skills, which are essential for identifying and solving complex problems in technological and business contexts. Design thinking encourages a mindset of creativity and problem-solving, helping students to approach challenges from multiple perspectives and develop innovative solutions. This skill is crucial for technopreneurs who must navigate the complexities of launching and scaling technology-based businesses (Lynch et al., 2021).

The development of a business incubation model based on a technopreneurship learning factory also aligns with the goals of fostering competitive advantages in students. Competitive advantage in technopreneurship is driven by students' ability to create and sustain innovative solutions that meet the needs of the market. By engaging in real-world business challenges through the learning factory, students enhance their entrepreneurial capabilities, improving their readiness to compete in the fast-paced, technology-driven global market (Amante & Ronquillo, 2017). Furthermore, the model aims to address the lack of technopreneurship training in university curricula by providing students with hands-on experience in running technology-based businesses. This practical experience is crucial in preparing students to meet the demands of the modern labor market, where employers increasingly seek candidates with both technical skills and entrepreneurial mindsets.

Expert validation of the technopreneurship learning factory model is a critical step in ensuring its theoretical soundness and practical relevance. Experts from the fields of education, business, and technology provide valuable insights into the model's design and implementation. Their feedback helps refine the model to ensure it meets the needs of students and aligns with industry expectations. Moreover, expert perspectives contribute to the ongoing development of the model, ensuring that it remains adaptable to evolving market conditions and technological advancements. The integration of expert feedback also ensures that the model is robust, addressing the key challenges identified in previous research, such as the disconnect between academic learning and practical skills, the lack of design thinking skills among students, and the insufficient technopreneurship training in universities (Lahikainen et al., 2019; Indriaturrahmi et al., 2022).

The urgency of developing such a model cannot be overstated. As global economies continue to shift towards technology-driven industries, the demand for technopreneurs who can innovate and lead in these fields will only increase. Without the proper training and support, university graduates will struggle to meet these demands, contributing to higher unemployment rates and limiting their potential to drive technological progress. The technopreneurship learning factory offers a solution by providing a structured environment where students can develop the skills, knowledge, and mindset necessary to succeed in the modern economy.

The development and validation of a business incubation model grounded in a technopreneurship learning factory mark a substantial advancement in tackling the challenges experienced by university graduates. This model is designed to bridge the persistent gap between theoretical academic instruction and the practical skills required by modern industries. It aims to equip students with critical competencies needed to excel as technopreneurs in increasingly dynamic and technology-driven marketplaces. By incorporating essential elements such as design thinking and competitive advantage into its framework, the model not only promotes creativity and problem-solving but also builds a solid foundation for entrepreneurship and innovation. It equips students to thrive in a dynamic global economy, fostering resilience and adaptability.

Study Objectives

The primary objective of this study is to develop a business incubation model based on a technopreneurship learning factory that enhances students' design thinking and competitive advantage in technopreneurship. This business incubation model is intended to revitalize entrepreneurship programs in universities, addressing the gap between academic learning and the practical skills required for technological entrepreneurship. By integrating academic and practical knowledge through the learning factory, the model seeks to equip students with the necessary capabilities to innovate and succeed in competitive digital and technological markets. The model will be designed and validated through expert feedback, assessing its theoretical validity in improving students' design thinking and technopreneurial competitiveness. The following objectives will guide the study:

1. To design a business incubation model based on technopreneurship learning factory that bridges the gap between theoretical academic learning and practical entrepreneurship skills.
2. To validate the model through expert evaluation, ensuring that it aligns with both academic standards and industry requirements.

Novelty of the Study

The proposed model responds to the need for innovative problem-solving in revitalizing entrepreneurship programs at universities. Current programs lack practical engagement, failing to develop critical entrepreneurial competencies in students, particularly those needed to thrive in technopreneurship. By integrating the concept of a learning factory into the business incubation process, the model creates an ecosystem that nurtures both theoretical and practical entrepreneurship skills within the academic environment. Specifically, the learning factory aims to combine the academic knowledge of students with practical, hands-on experience in a manufacturing incubation unit. This unit serves as a simulated business environment where students can apply their academic understanding of technology and entrepreneurship to real-world problems.

The model's novelty lies in its focus on design thinking and competitive advantage as core competencies for technopreneurs. Design thinking is critical in fostering innovative solutions to complex problems, enabling students to develop creative approaches to business and technology challenges. In addition, the model emphasizes building a competitive advantage in students, equipping them with the skills and mindset required to succeed in the fast-paced digital economy. This innovative approach has not been previously explored in university entrepreneurship programs, particularly in developing students' ability to think critically, innovate, and compete in the modern business environment.

The validation of the business incubation model by experts is a crucial step. Experts from various fields, including education, business, and technology, will provide insights into the model's design, helping to refine it to better meet the needs of both students and the industry. Their perspectives will contribute to understanding how the model can be applied in real-world settings, ensuring that it not only meets academic goals but also prepares students for the challenges of the modern labor market. By incorporating expert feedback, the study will ensure that the model is robust, adaptable, and capable of evolving alongside the rapidly changing technological landscape.

The model is expected to create a sustainable technopreneurial ecosystem within the university, where students are encouraged to innovate and apply their knowledge in practical settings. This ecosystem, supported by the incubation unit, will serve as a bridge between the university and the broader digital and industrial sectors, fostering partnerships with

businesses that require modern digital platforms and technological solutions.

By addressing the shortcomings of traditional entrepreneurship programs, this study introduces a novel and potentially transformative approach to technopreneurship education. The technopreneurship learning factory, as a core component of the business incubation model, represents a significant advancement in preparing students for the demands of the digital economy. The integration of academic and practical learning through this model promises to enhance students' entrepreneurial skills, fostering a new generation of technopreneurs who are equipped to drive technological innovation and economic growth. The long-term impact of this model, if successful, could extend beyond the university, contributing to the broader development of digital industries and creating new opportunities for graduates in the rapidly evolving global market.

LITERATURE REVIEW

Business Incubation Model in Universities

The business incubation model within universities or campuses is a program designed to support and accelerate the growth of startups and small businesses initiated by students, faculty, or members of the campus community. This program can provide various resources such as access to educational facilities, research, mentorship from experienced professionals, and networking with investors and industries. Additionally, campus incubators may offer training and workshops focused on developing business skills. The primary goal of this model is to foster innovation, create jobs, and bridge the gap between academia and industry, creating a dynamic entrepreneurial ecosystem within the academic environment.

University business incubators are crucial for fostering entrepreneurship on campus, facilitating technology transfer, and supporting the commercialization of educational or research outputs. University-affiliated incubators can offer various services to help new businesses grow and develop (Wonglimpiyarat, 2014). As universities increasingly prioritize commercialization activities alongside research and teaching, the implementation of business incubation models becomes vital to stimulating academic-based entrepreneurship (Lyken-Segosebe et al., 2020). Several studies have demonstrated the effectiveness of campus business incubators in supporting the development of new ventures with promising growth potential, nurturing startups, and promoting innovation (Barugahara et al., 2019).

One of the primary goals of university business incubators is to bridge the gap between the academic and industrial sectors by transferring knowledge and research outcomes into practical applications. These incubators can serve as platforms for technology transfer, enabling the translation of fundamental research conducted at universities into commercial products and services (Wonglimpiyarat, 2014). By establishing these incubators, higher education institutions aim to foster innovation, encourage the creation of new ventures, and provide support for entrepreneurial initiatives (Prabowo, 2022). Additionally, university incubators can establish relationships with academia, business, and government sectors, significantly impacting the growth of entrepreneurship (Dániel & Porkoláb, 2021).

The presence of university business incubators is crucial for supporting small and medium-sized enterprises (SMEs) and startups. These incubators create a conducive environment for entrepreneurs to develop their ideas, access resources such as shared facilities, counseling, training, and receive financial and technical support services (Bismala et al., 2020). Through the incubation process, university business incubators aim to generate spin-offs and startups with successful growth potential (Tritoasmoro et al., 2024). Furthermore, these incubators play a key role in job creation, promoting economic well-being, and supporting the commercialization of new ideas (Łobacz & Niedzielski, 2015).

University business incubators not only benefit startups but also the universities themselves. They serve as tools for accelerating entrepreneurship within the academic community, promoting sustainability beyond the classroom, and contributing to the development of entrepreneurial ecosystems (Hassan, 2020). By nurturing companies originating from university incubators, institutions can leverage their strengths to promote sustainable practices and support the growth of innovative ventures (Brito et al., 2018). Additionally, university-based incubators offer advantages in helping companies overcome challenges associated with new ventures, contributing to their long-term survival and success (Lasrado et al., 2016).

In conclusion, university business incubators play a vital role in fostering entrepreneurship, facilitating technology transfer, and supporting the commercialization of research outputs. These incubators act as a bridge between academia and industry, providing essential support to startups, SMEs, and entrepreneurial ventures. Through the establishment and optimization of business incubation models, universities can create a conducive environment for innovation, economic growth, and job creation within campus communities.

Entrepreneurship and Technopreneurship

Entrepreneurship involves exploring and utilizing value-added product opportunities based on economic, social, and cultural analysis (Suacamram, 2019). Developing entrepreneurship offers dual benefits to both entrepreneurs and society (Fortunato & Alter, 2017). Entrepreneurship serves as a path to self-employment, an opportunity for independent learning, and a context for leadership development and group achievement responsibility (Täks et al., 2014). It helps entrepreneurs recognize their self-worth, increases employment levels, and fosters creativity and social innovation. Therefore, entrepreneurship is considered a vital competence for students to develop in the 21st century (Obschonka et al., 2017).

Researchers have proposed an entrepreneurial competencies (EC) framework to define entrepreneurship as a transversal skill (Bacigalupo et al., 2016). This framework suggests three domains of entrepreneurship: (a) ideas and opportunities: identifying opportunities, evaluating ideas, and considering ethical and sustainable thinking; (b) resources: self-awareness, perseverance, and mobilizing others; and (c) action: planning and managing, collaborating with others, and learning through experience. Seikkula-Leino et al. (2021) studied how EC has been integrated into educational and training development across various countries, stating that entrepreneurship competencies are widely recognized as essential drivers of competence in entrepreneurship education.

Morselli and Gorenc (2022) applied EC in a case study to evaluate two entrepreneurship education classes using a problem-based learning approach for high school students. In developing entrepreneurial learning activities, emphasis on practice is highly recommended. Entrepreneurial activities should be designed with diverse features, such as promoting creativity skills essential for entrepreneurial behavior and thinking, as well as advocating for a "learning by doing" approach so that students can gain real-world business experience (Suacamram, 2019).

The concept of entrepreneurship in the field of technology is known as technopreneurship. Technopreneurship is a dynamic concept that involves blending technology and entrepreneurship to create, develop, and manage new business ventures or opportunities (Patnaik, 2023). It has become increasingly prominent, particularly as technological advancements have laid the foundation for new business models (Tajvidi & Tajvidi, 2021). Technopreneurship requires a strong willingness to master technology and a deep understanding of entrepreneurial concepts, emphasizing the synergy between

technological expertise and entrepreneurial intelligence (Putri et al., 2019). It involves leveraging technology-based ventures to drive innovation, performance, and competitiveness in business (Chinagozi et al., 2023).

At the heart of technopreneurship lies the intention to launch technology-based ventures, where individuals or organizations utilize technological innovations to establish new businesses (Salhieh & Al-Abdallat, 2021). This intention includes a combination of inherent innovation, academic self-efficacy, and a proactive approach to identifying and seizing business opportunities (Salhieh & Al-Abdallat, 2021). The commercialization research process in technopreneurship involves several stages, including business opportunity assessment, technology exploitation, and sustainable development, highlighting the comprehensive nature of technopreneurship (Phuthong, 2023). Technopreneurship education plays a crucial role in equipping individuals with the knowledge, skills, and competencies needed to create ventures through technological innovation (Ayeni & Killian, 2023). Higher education institutions, such as universities, play a pivotal role in fostering technopreneurial intentions among students by offering non-traditional curriculum approaches and enhancing technological infrastructure (Koe et al., 2020). Additionally, developing technopreneurship skills is essential for preparing individuals to thrive in the Industry 4.0 era (Raharjo et al., 2022).

The concept of technopreneurship not only involves individual ventures but also encompasses socio-technopreneurship, which focuses on social missions, technology adoption, and economic development (Pratiwi et al., 2022). By integrating social goals with technological advancements, socio-technopreneurship aims to address social issues, create jobs, and contribute to national economic growth (Pratiwi et al., 2022). Moreover, the application of technopreneurship exemplifies how technology can bridge economic interests and drive innovation in specific sectors (Nurnida & Wicaksono, 2018). Technopreneurship is closely linked to information and communication technology (ICT), where self-efficacy in ICT plays a crucial role in fostering technopreneurial interest and competence (Belmonte et al., 2022). The relationship between entrepreneurial characteristics and intention underscores the importance of traits such as creativity, innovation, and the need for achievement in driving technopreneurial efforts (Saral & Alpkan, 2017).

Technopreneurship represents a dynamic and innovative entrepreneurial approach that leverages technology to drive business creation, innovation, and sustainable development. By combining technological expertise with entrepreneurial intelligence, individuals and organizations can harness the power of innovation to build successful ventures and contribute to economic growth and societal advancement.

Learning Factory

The term learning factory (LF) or teaching factory (TEFA) refers to a system that integrates educational elements into a realistic production environment (Wagner et al., 2012), thereby applying the concept of "factory-to-classroom" (Rentzos et al., 2015). The teaching and learning process is brought closer to real manufacturing problems through a simplified shop-floor emulation (Müller et al., 2017), allowing learners to be tested under concrete industrial conditions while practicing hands-on activities (Rentzos et al., 2015). The learning factory supports experiential learning processes (Müller et al., 2017), as defined by Kolb's theory (in Monetti et al., 2023), where concrete experiences facilitate knowledge transfer. This cycle involves students (a) actively engaging in practical tasks, (b) observing, reflecting, and discussing activities with peers, (c) abstract conceptualization (analysis) and generalizing events to suggest improvements (conclusions), and (d) attempting to practice the knowledge,

ensuring that information is retained. The learning factory represents an approach adhering to experiential learning theory, where students' learning processes require laboratory experiences to enhance their understanding of theoretical concepts learned during regular classroom activities (Jasti et al., 2021).

Learning factories have garnered significant attention in both vocational and academic education, aiming to bridge the gap between theoretical knowledge and practical industry needs. This innovative approach integrates real-world production environments into the classroom, providing students with hands-on experience and practical skills (Hasanah & Malik, 2018). By bringing the factory environment into educational settings, learning factories enable students to work on, analyze, and produce quality products that meet market demands (Kusmintarti et al., 2021). This model emphasizes production-based training, aligning learning with industry standards and procedures to enhance graduates' competitiveness in the job market (Hasanah & Malik, 2018).

The learning factory model is designed to simulate industrial practices in an educational environment, offering students the opportunity to engage in authentic production/service-based learning experiences (Wahjusaputri et al., 2019). This approach facilitates two-way knowledge exchange between educational institutions and industries, ensuring that students acquire the skills and competencies required by the job market (Rahmadan et al., 2022). By immersing students in realistic work environments, the learning factory aims to improve their employability skills and readiness for the workforce (Suranto et al., 2022). Through the implementation of learning factories, educational institutions can provide students with practical experiences that reflect real-world industry demands, thereby enhancing their job readiness (Amaliah & Irfan, 2022).

One key aspect of learning factories is their focus on competency-based learning, where students actively participate in workshops, laboratories, and business partnerships to develop practical skills (Kusmintarti et al., 2021). This model emphasizes the importance of integrating educational activities, research, and innovation to create a holistic learning experience that prepares students to meet industrial demands (Heriyati et al., 2023). By applying learning factory principles, educational institutions can foster students' entrepreneurial spirit, instill industry-specific skills, and cultivate a mindset conducive to success in the business world (Hardiyanto et al., 2022). Additionally, the learning factory model is structured through a series of steps, including receiving orders, analyzing them, working on orders, quality control, and delivery, equipping students with a comprehensive understanding of the production process (Kusmintarti et al., 2021).

The concept of learning factories is not merely a theoretical framework but is actively implemented in various schools to improve students' competencies and employability (Dwijayanthi & Rijanto, 2022). This model serves as a platform for students to collaborate, innovate, and solve real-life problems, thereby deepening their understanding of industrial practices and academic knowledge (Suranto et al., 2022). Through learning factories, students can gain practical experience, develop skills, and contribute to the production of goods and services that meet market standards (Fahmi, 2019). This hands-on learning approach prepares students for the challenges of the working world by equipping them with relevant skills and experience (Komarudin et al., 2017).

The application of learning factories requires a structured approach that considers factors such as management, human resources, marketing, workshops, laboratories, and industrial partnerships (Wahjusaputri et al., 2019). By adopting the learning factory model, educational institutions can create dynamic learning environments that mirror industry standards and procedures, thereby enhancing students' readiness for the job market (Hasanah

& Malik, 2018). This approach not only benefits students by providing them with practical skills but also supports institutions in generating additional revenue through the sale of products and services produced within the learning factory (Perdana, 2019). Additionally, learning factories can contribute to institutional sustainability by enabling independent financial management and healthy business practices (Kautsar et al., 2022).

Design Thinking

The demand for skilled human resources to meet the needs in all fields of work has positioned information technology education as a platform to nurture innovative talents, particularly in creating digital innovations (Huang & Looi, 2021; Northrup et al., 2022). Producing digital innovations is not easy; it begins with how individuals can creatively design innovative works, or in other words, every innovation starts from design thinking (Smith et al., 2015). Therefore, design thinking has become an essential skill for individuals in the current era of digital transformation within the context of Industry 4.0. Several developed countries also emphasize design thinking as a core competency in information technology education curricula (Falkner et al., 2019).

Although design thinking is considered a foundation for innovation, training it in the learning process remains a challenge (Lin et al., 2024). Evidence from previous research shows that traditional teaching methods are insufficient in enhancing students' design thinking competencies (T. Li & Zhan, 2022; Prayogi et al., 2023). Specifically, in the context of information technology education, studies indicate that traditional expository teaching, which is not oriented toward design thinking, fails to improve students' design thinking skills in creating creative technology products (Ardi et al., 2024). A recent descriptive study of 30 information technology education students also revealed that their design thinking skills were categorized as poor (Indriaturrahmi et al., 2023).

Design thinking has become a crucial component in various educational contexts, particularly in technopreneurship education. Integrating design thinking into technopreneurship education can significantly enhance students' ability to innovate, solve problems, and create impactful solutions (Y. Li et al., 2019). Design thinking is not just a process but a mindset that fosters creativity, critical thinking, and user-centered problem-solving (Aflatoony et al., 2018). Its potential has been recognized to transform teaching approaches and curriculum development in entrepreneurship education, aligning with the principles of designing effective learning environments (Gong, 2020).

In the field of entrepreneurship education, design thinking is increasingly utilized to foster a culture of innovation and social impact. By integrating design thinking principles into educational programs, educators can empower students to tackle real-world challenges through creative problem-solving and collaboration (Pizarro & Graybeal, 2022). This approach not only enhances students' design thinking skills but also equips them with the tools to meaningfully contribute to social innovation initiatives (Novak & Mulvey, 2021). Moreover, design thinking has proven to be an effective framework for supporting innovation in various educational and workplace settings, emphasizing the importance of experiential learning and hands-on design activities (Razali et al., 2022).

The integration of design thinking into technopreneurship education offers unique opportunities to bridge the gap between theoretical knowledge and practical application. By engaging students in the design thinking process, educators can nurture their creativity, build essential skills, and encourage them to think innovatively (J. Li et al., 2022). This approach goes beyond traditional teaching methods by involving students in real-world challenges and encouraging them to develop viable solutions to address local, national, and global problems

(Sandars & Goh, 2020). Additionally, design thinking can play a key role in transforming entrepreneurship education curricula by incorporating its key characteristics into the course content and delivery (Gong, 2020).

In an educational context that prioritizes practical skills and hands-on experience, design thinking provides a valuable tool for fostering innovation and creativity among students, where schools can equip them with the mindset and skills necessary to thrive in technopreneurship (Selvaha, 2022). This innovative approach not only enhances students' problem-solving abilities but also encourages them to approach challenges from both logical and creative perspectives (Zi, 2022). Furthermore, design thinking has been identified as a means to promote purposeful problem-solving in technology education, emphasizing the importance of practical applications and user-centered design (Krüger, 2019).

The importance of design thinking in technopreneurship education goes beyond individual skill development and encompasses broader educational transformation. By integrating design thinking principles into curricula, educators can create more engaging and interactive learning environments that foster creativity and critical thinking (Hidayat et al., 2019). This approach not only prepares students to meet the demands of the modern business landscape but also instills a mindset of continuous innovation and adaptation (Elyta et al., 2021). Moreover, design thinking can serve as a catalyst for academic transformation by incorporating technological innovation and capacity building into the core of technopreneurship education (Mulyany et al., 2023).

METHOD

This study aimed to develop a business incubation model based on technopreneurship learning factory to enhance students' design thinking and competitive advantage in technopreneurship. The research employed a developmental approach to design and validate the model, following the methodology established for learning factory development to enhance competency (Tisch et al., 2019). This study marks a new initiative in revitalizing university entrepreneurship programs by integrating theoretical and practical knowledge within a simulated business environment. The expected outcome is a validated model that meets the program's goals, with validity criteria drawn from prior research (Huizinga et al., 2019; Nieveen et al., 2023).

Model Design

The design of the business incubation model based on technopreneurship learning factory was grounded in both theoretical and empirical studies from past research. This included a comprehensive literature review on technopreneurship, design thinking, and learning factories. The design framework was also informed by previous models of learning factory-based educational interventions and business incubation programs. The initial stage of the study involved identifying key components that align with the study objectives, particularly enhancing students' design thinking skills and competitive advantages in technopreneurship.

Based on this research, a hypothetical framework was developed that serves as the foundation of the technopreneurship learning factory. This model integrates theoretical learning from the university curriculum with practical entrepreneurial experiences within a simulated business environment. The learning factory approach enables students to engage in real-world challenges, promoting hands-on learning and the application of design thinking to solve complex problems.

The model specifically targets two core competencies: (1) design thinking, which is essential for fostering creativity and innovation, and (2) competitive advantage, which focuses on developing students' entrepreneurial mindset and equipping them with the skills needed to succeed in the competitive, technology-driven business landscape. These competencies are integrated into the business incubation process, ensuring that students gain both practical experience and entrepreneurial acumen.

Model Validation

Following the design of the hypothetical framework, the model underwent content and construct validation. Validation involved a focus group discussion (FGD) with six expert validators and practitioners from the fields of institutional development, technology, learning, and entrepreneurship education. These experts were selected based on their experience and expertise in technopreneurship, business incubation, and educational innovation. The experts provided feedback on the conceptual framework of the technopreneurship learning factory, evaluating the model's alignment with industry needs, educational goals, and its potential for enhancing students' competencies.

The validation process was divided into two stages: (1) content validation, where experts assessed the model's relevance, accuracy, and comprehensiveness in addressing the study objectives, and (2) construct validation, where the logical consistency and theoretical foundations of the model were evaluated. The FGD provided an interactive platform for experts to discuss the strengths and weaknesses of the proposed model, offering constructive criticism and suggestions for improvement.

Instruments and Data Collection

The primary instrument for collecting validation data was a validation sheet, designed to gather feedback from the expert validators. This instrument contained a series of statements aligned with the study objectives, allowing experts to rate various aspects of the model on a Likert scale. The validation sheet covered multiple dimensions of the model, including its design thinking framework, competitive advantage mechanisms, alignment with technopreneurship goals, and overall feasibility for implementation in university entrepreneurship programs. Experts were also encouraged to provide qualitative feedback in the form of open-ended comments. This feedback was vital for understanding the practical applicability of the model and identifying areas that required further refinement. The qualitative data collected from the FGD and validation sheets were analyzed descriptively to identify common themes and patterns in expert feedback.

Data Analysis

The validation data were analyzed using descriptive statistics to assess the overall validity of the technopreneurship learning factory model. Quantitative data from the validation sheets were compiled and averaged to determine the overall validity score of the model, while qualitative data were categorized and coded to identify key themes and expert recommendations. The criteria for determining the validity of the model followed the standards established in previous research (Prayogi et al., 2018), focusing on content, construct, and practical applicability. Specifically, the model was considered valid if it met the following criteria: (1) alignment with the theoretical foundations of technopreneurship and design thinking, (2) feasibility for implementation in university entrepreneurship programs, and (3) potential for enhancing students' design thinking and competitive advantage in technopreneurship.

Improvement and Refinement of the Model

Based on the feedback from expert validators, revisions were made to improve the conceptual framework of the model. Suggestions and inputs were accommodated to refine the model's design, ensuring that it addressed the gaps identified by the experts and aligned with the current trends in technopreneurship education. For instance, experts recommended enhancing the integration of real-world business challenges into the learning factory experience, ensuring that students gain hands-on experience in addressing practical problems. Additionally, adjustments were made to the model's design thinking component to ensure that it effectively fosters creativity and innovation among students.

The refined model was re-evaluated by the expert validators to ensure that the revisions addressed the issues raised during the initial validation phase. The final version of the technopreneurship learning factory model was then finalized for implementation, ready to be tested in future research involving university students and faculty members.

The developmental research employed a rigorous design and validation process to develop a business incubation model based on a technopreneurship learning factory. By integrating design thinking and competitive advantage into the business incubation process, the model aims to enhance students' entrepreneurial competencies and prepare them for success in the modern, technology-driven labor market. The expert validation process ensured that the model is both theoretically sound and practically relevant, addressing the challenges faced by university entrepreneurship programs and contributing to the broader goal of fostering technopreneurial innovation among students.

RESULTS AND DISCUSSION

Design of the Business Incubation Model

In the context of higher education reform, this research proposes a significant revitalization of entrepreneurship programs. Through the business incubation model based on technopreneurship learning factory, the study addresses current and future demands of increasingly connected and rapidly changing business and industrial sectors (DUDI). By integrating the technopreneurship learning factory concept into entrepreneurship programs, these initiatives become more adaptive and relevant. The policy implications of this research include a rethinking of how higher education institutions can support the development of technopreneurship among students. A summary of the state of the art and the novelty position of the research is presented in Figure 1.

As depicted in Figure 1, the business incubation model based on technopreneurship learning factory is initiated to create an entrepreneurial ecosystem within the campus through a production unit, specifically a business incubation unit. The competitive advantage in the field of information technology entrepreneurship (technopreneurship) is built from academic learning (theoretical) and practical skills (manufacturing) within the campus, which are then downstreamed (commercialized products) to society or to the business and industrial sectors (DUDI) that require digital platforms and modern digital industrial companies.

Literature from previous studies indicates that the issue of entrepreneurship education has evolved and remains debated, particularly regarding how entrepreneurship should be taught and what outcomes are expected (Ayed, 2020; Fayolle, 2013; Indriaturrahmi & Sudiyatno, 2016). Traditional teaching at universities is no longer adequate to build students' competitive advantage in entrepreneurship, particularly in the field of technopreneurship. Consequently, their competitiveness in technopreneurship has become hindered (Halim et al., 2023). Government-initiated entrepreneurship programs have had little impact on reducing the open unemployment rate among higher education graduates, improving soft skills, or

building students' technopreneurship competitive advantages. This research is at the forefront of modern higher education development, combining the latest paradigms in technopreneurship, design thinking, and learning factories.

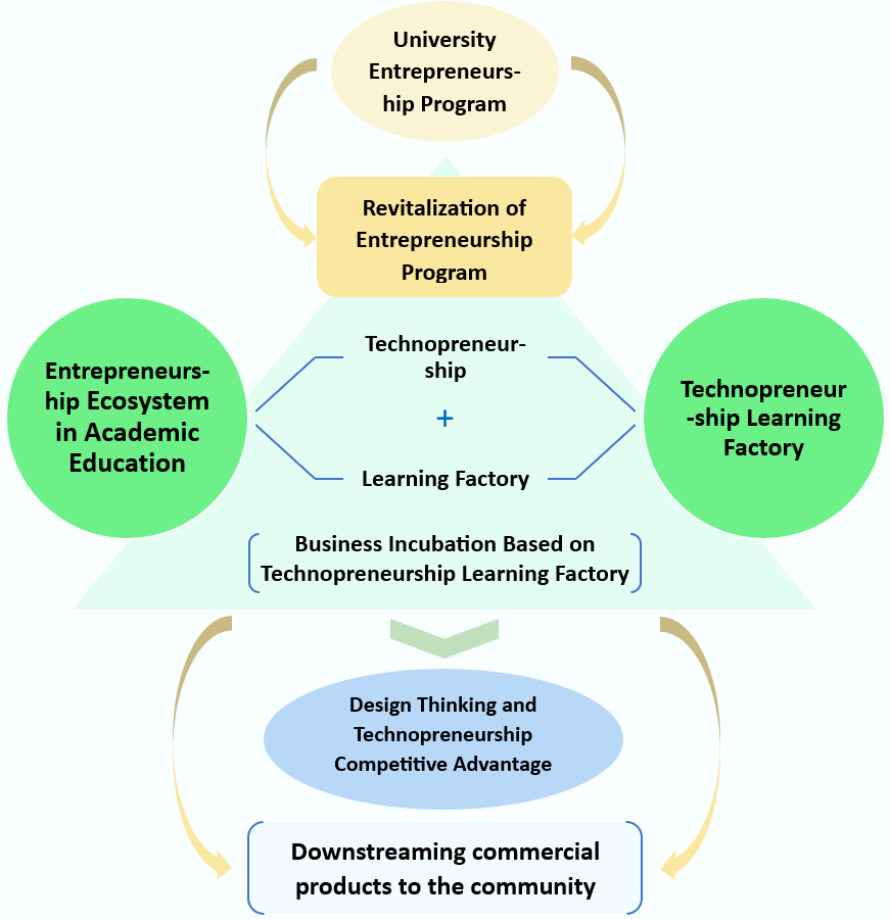

Figure 1. State of the art of the incubation model as a form of revitalization of entrepreneurship programs

The state of the art of this research leverages the concept of learning factories, which have proven effective in bridging theory and practice across various industries (Baena et al., 2017; Jing et al., 2023; Louw & Deacon, 2020). The novelty of this research lies in applying learning factories exclusively within the context of design thinking and technopreneurship competitive advantage, allowing students to gain hands-on experience in creating and managing technology businesses. This approach addresses the gap between classical learning and market needs, making this research a breakthrough in shaping future technopreneurs who meet current industry demands. Previous studies on technopreneurs have shown that individuals highly skilled in technology taught within the education sector are 34.4% more likely to escape unemployment than those without technological skills (Yirenkyi et al., 2023). Technological skills can provide a pathway for technopreneurs to reduce student unemployment following formal university education.

Design thinking is a crucial context that must be trained in the realm of technology innovation and commercialization (Indriaturrahmi et al., 2023; Lynch et al., 2021). Classical education that relies solely on technological knowledge is no longer sufficient for students' future success; they must be equipped with critical thinking skills (Passow & Passow, 2017), particularly design thinking, which is considered a fundamental mindset in entrepreneurship

education (Daniel, 2016; Huq & Gilbert, 2017; Lahn & Erikson, 2016; Nielsen & Stovang, 2015). This study introduces innovation by integrating design thinking into the technopreneurship context. By applying design thinking principles, students not only gain conceptual understanding but also a competitive edge in designing innovative solutions that meet market needs.

Phases of the Business Incubation Model

The business incubation model based on technopreneurship learning factory to enhance students' design thinking and technopreneurship competitive advantage is presented in Figure 2.

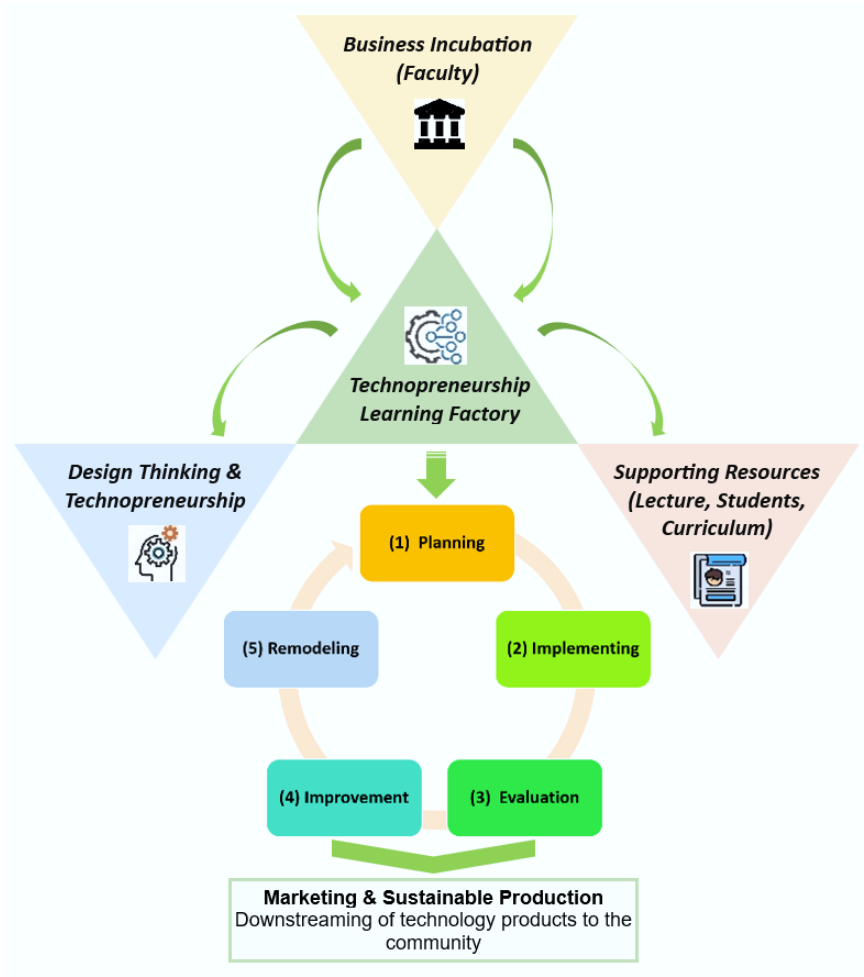

Figure 2. The business incubation model based on technopreneurship learning factory

The business incubation model based on the technopreneurship learning factory is initiated to foster an entrepreneurial ecosystem within universities through a production unit, known as the business incubation unit. The competitive advantage in technopreneurship, especially in the field of information technology, is built from both academic (theoretical) learning and practical (manufacturing) skills on campus, which are later commercialized to society and to industries that demand modern digital platforms and companies.

Various business incubation models are offered in the literature, demonstrating their flexibility for implementation in universities, as highlighted in previous studies (Hassan, 2020; Nicholls-Nixon et al., 2021). The core principle of university-based business incubation models is to support and accelerate the development of startups and small businesses initiated

by students, faculty, or the campus community. Campus incubators offer training and workshops that focus on business skill development (Lahikainen et al., 2019).

The development of this business incubation model is aimed at fostering campus-based entrepreneurship, facilitating technology transfer, and supporting the commercialization of products resulting from educational programs in technology through the learning factory cycle. As illustrated in Figure 2, the business incubation prototype starts at the faculty level, analyzing available resources and is run through the technopreneurship learning factory scheme. This model operates through five life cycle phases, adapted and expanded from "The Life Cycle of Learning Factories for Competency Development" (Tisch et al., 2019) and specifically tailored to enhance students' design thinking and competitive advantage in technopreneurship. The phases are outlined as follows:

1) Planning

This phase focuses on planning all aspects required to run the technopreneurship learning factory-based incubator.

- Needs analysis: Identifying relevant market and technological needs.
- Goal setting: Establishing long-term and short-term goals for the incubator.
- Resource allocation: Identifying and allocating necessary resources, including tutors, experts, facilities, etc.
- Curriculum development: Creating a lesson plan based on collaborative project work (adjusted to relevant courses).
- Partnership building: Establishing collaborations with research institutions, industries, and other supportive partners.

2) Implementation

This phase involves up-skilling students and designing technology in the incubation process.

- Up-skilling: Enhancing students' skills and knowledge in technology, technopreneurship, technological innovation, marketing strategies, leadership, and collaboration. The goal is to ensure that participating students are equipped to innovate, manage projects effectively, and develop competitive, sustainable businesses. Up-skilling is achieved through education and training programs based on collaborative project work involving internal (faculty experts) and external (industry partners) resources.
- Designing: Designing technological products or digital platforms through collaborative project work, utilizing internal and external resources to simulate a real-world business environment.

3) Evaluation

The evaluation phase assesses the effectiveness of the program's implementation.

- Implementation evaluation: Evaluating the effectiveness of up-skilling efforts on improving students' design thinking and the success of designing competitive technology products.
- Feedback loop: Gathering feedback from students, mentors, and partners to assess successes and areas for improvement.

4) Improvement

Based on the evaluation results, this phase focuses on program improvement.

- Program enhancement: Modifying the curriculum, education, and training based on performance analysis and feedback.
- Mentor capacity: Increasing the quality and quantity of mentors and providing training to

ensure optimal support.

5) Remodeling

This phase involves reviewing and adjusting the incubation model to ensure its long-term relevance and effectiveness.

- Product adjustment: Adjusting product designs based on market needs and technological developments.
- Strategy adaptation: Adapting incubation strategies to technological trends and market demands.
- Continuous innovation: Integrating new innovations into the program and incubation methods.

Upon completing one cycle, the next step involves entering the marketing phase and ensuring sustainable production. At this stage, the technological products developed (goods or services) are not only commercialized to the public but also introduced and marketed to industries. This commercialization process involves effective marketing strategies to ensure the products are widely accepted and used. Collaboration with industries (DUDI) becomes crucial for expanding distribution networks and maximizing the commercial potential of the products. Additionally, maintaining sustainable production is essential to ensure the quality and quantity of the products remain stable and meet market demand.

In this context, technopreneurship students will learn how to face dynamic market challenges and continuously innovate to maintain their products' competitive edge. Thus, the business incubation model based on a technopreneurship learning factory focuses not only on product development but also on applying sustainable business strategies to create added value and a competitive advantage for young technopreneurs from the student community.

Expert Perspectives on the Business Incubation Model

The results of validity tests of the model are presented and discussed in the context of relevant literature. The data from the validation of the business incubation model based on technopreneurship learning factory are shown in Table 1.

Table 1. The results of validity tests

Aspect of validity	Mean	SD	Criteria
Content validity – Needs	4.333	0.300	Very valid
Content validity – State of the Art	4.610	0.251	Very valid
Construct validity	4.332	0.470	Very valid
Average	4.425	0.340	Very valid

The data in Table 1 indicate that the business incubation model based on technopreneurship learning factory has a very high level of validity based on three key aspects measured: content validity and construct validity. For content validity, specifically related to needs, the average score obtained was 4.333 with a standard deviation of 0.300, categorized as "Very Valid." This suggests that the model has been well-adapted to meet relevant needs. Additionally, content validity assessing the state of the art achieved an average score of 4.610 with a standard deviation of 0.251, also categorized as "Very Valid," confirming that the model aligns with the latest developments in the field. Regarding construct validity, the average score was 4.332 with a standard deviation of 0.470, also falling within the "Very Valid" category. Overall, the model's average validity score was 4.425 with a standard deviation of 0.340, indicating that the model is considered highly valid from the various perspectives tested.

This research successfully achieved its main objective: to develop and validate business incubation model based on technopreneurship learning factory aimed at enhancing students' design thinking skills and technopreneurial competitive advantage. The results of the validity, practicality, and effectiveness tests indicate that this model can make a significant contribution in addressing challenges faced by higher education, especially regarding the gap between academic learning and the practical skills required by modern industries (Aljohani et al., 2022; Yirenkyi et al., 2023). Additionally, the model provides a solution to the challenges posed by a lack of soft skills, particularly design thinking, which often hinders innovation and students' competitiveness in the field of technopreneurship (Indriaturrahmi et al., 2023; Oukil, 2011). Hence, this research confirms that revitalizing entrepreneurship programs through this incubation model is essential.

The validity of the business incubation model based on a technopreneurship learning factory demonstrated excellent results. The strong content validity reinforces that the model was designed based on real-world needs, both from the perspectives of students and industries (Husin et al., 2023; Suacamram, 2019). These findings align with literature that states that an effective learning model must be relevant to industry developments, particularly in the era of the Fourth Industrial Revolution (Roblek et al., 2016). The high construct validity further shows that the model's components were systematically organized and aligned with the underlying theories of technopreneurship and learning factories (Baena et al., 2017; Tisch et al., 2019). This means that the model is grounded not only in intuition but also in a solid theoretical framework.

CONCLUSION

The development and validation of the business incubation model based on technopreneurship learning factory presented in this study offer significant progress in addressing the challenges faced by higher education. By integrating academic learning with practical entrepreneurial experiences, the model successfully bridges the gap between theoretical knowledge and the practical skills demanded by the modern labor market. The emphasis on design thinking and competitive advantage enhances students' ability to innovate and compete in the fast-paced, technology-driven business environment. Validation results confirm the model's effectiveness, with high scores in both content and construct validity, demonstrating that it aligns with industry needs and academic standards.

This model provides a solution to the prevalent issues in traditional entrepreneurship education, which often fails to equip students with the necessary soft skills and practical experiences required for technopreneurship. The technopreneurship learning factory approach fosters hands-on learning, promoting innovation, technology commercialization, and industry readiness. The findings underscore the importance of adapting educational programs to meet the demands of Industry 4.0, ensuring that students not only gain knowledge but also develop the entrepreneurial mindset and skills required to thrive in the modern economy. This model holds the potential to transform entrepreneurship education and better prepare students for future challenges.

LIMITATION

One limitation of this study is that the business incubation model based on technopreneurship learning factory was validated primarily through expert feedback rather than comprehensive, real-world testing involving students and industry partners. While the expert validation ensured the model's theoretical soundness, its practical application and long-term effectiveness in diverse university settings were not fully explored. Additionally,

the study focused on a specific context within information technology education, which may limit the generalizability of the model to other academic disciplines or industries. Future research should involve pilot implementations across various universities and sectors to assess the model's adaptability, scalability, and impact on students' entrepreneurial success and market readiness.

RECOMMENDATION

It is recommended that future research and implementation of the business incubation model based on technopreneurship learning factory include extensive pilot programs across multiple universities and industries to assess its practical effectiveness and adaptability in real-world settings. Institutions should consider integrating the model into their entrepreneurship curricula to provide students with hands-on experience in design thinking and business development. Collaborations with industry partners are essential to ensure the model aligns with evolving market needs and technological advancements. Additionally, continuous feedback from students, educators, and industry professionals should be incorporated to refine and enhance the model's relevance, scalability, and long-term impact on students' entrepreneurial skills and career readiness.

Author Contributions

The authors have sufficiently contributed to the study, and have read and agreed to the published version of the manuscript.

Funding

This research was funded by the Ministry of Education, Culture, Research, and Technology (Kemdikbudristek) Republic of Indonesia under Decree No. 0459/E5/PG.02.00/2024 and Agreement/Contract Numbers between LLDIKTI-VIII and DRTPM Kemdikbudristek: 110/E5/PG.02.00.PL/2024; LLDIKTI-VIII and LPPM Undikma: 2927/LL8/AL.04/2024; and LPPM Undikma and the researchers: 048/L1/PP/UNDIKMA/2024.

Acknowledgement

We would like to express our sincere gratitude to the Ministry of Education, Culture, Research, and Technology (Kemdikbudristek) Republic of Indonesia for their financial support, as well as to the research institutions and industry partners involved in this project. Special thanks are extended to the experts who provided valuable feedback during the validation process, and to Universitas Pendidikan Mandalika for facilitating this research.

Declaration of Interest

The authors declare no conflict of interest.

REFERENCES

Abid, M., Benmeriem, M., Gheraia, Z., Sekrafi, H., Abdelli, H., & Meddah, A. (2023). Asymmetric effects of economy on unemployment in Algeria: Evidence from a nonlinear ARDL approach. *Cogent Economics & Finance*, *11*(1), 2192454. https://doi.org/10.1080/23322039.2023.2192454

Aflatoony, L., Wakkary, R., & Neustaedter, C. (2018). Becoming a Design Thinker: Assessing the Learning Process of Students in a Secondary Level Design Thinking Course. *International Journal of Art & Design Education*, *37*(3), 438–453. https://doi.org/10.1111/jade.12139

Aljohani, N. R., Aslam, A., Khadidos, A. O., & Hassan, S.-U. (2022). Bridging the skill gap between the acquired university curriculum and the requirements of the job market: A

data-driven analysis of scientific literature. *Journal of Innovation & Knowledge*, *7*(3), 100190. https://doi.org/10.1016/j.jik.2022.100190

Amaliah, R., & Irfan, D. (2022). The Effect of the Teaching Factory Learning Model on The Work Readiness of Class XII Students of SMKN 1 Sinunukan. *Aksara: Jurnal Ilmu Pendidikan Nonformal*, *8*(3), 1759. https://doi.org/10.37905/aksara.8.3.1759-1768.2022

Amante, A. D., & Ronquillo, T. A. (2017). Technopreneurship as an outcomes-based education tool applied in some engineering and computing science programme. *Australasian Journal of Engineering Education*, *22*(1), 32–38. https://doi.org/10.1080/22054952.2017.1348186

Ardi, R. F. P., Bilad, M. R., Mustofa, H. A., & Maulachela, A. B. (2024). Analysis of Students' Design Thinking in Creating 3D Creative Works Utilizing Mobile Technology within the Framework of Local Wisdom. *International Journal of Ethnoscience and Technology in Education*, *1*(1), 15–27. https://doi.org/10.33394/ijete.v1i1.10879

Ayed, T. L. (2020). Extending the debate over entrepreneurial education effectiveness: The case of a Saudi university. *Education and Training*, *62*(7/8), 805–823. https://doi.org/10.1108/ET-12-2019-0273

Ayeni, D. O., & Killian, O. T. P. (2023). Technopreneurship Education, Occupational Counselling, and Sustainable Development in Nigeria. *British Journal of Multidisciplinary and Advanced Studies*, *4*(4), 34–43. https://doi.org/10.37745/bjmas.2022.0255

Bacigalupo, M., Kampylis, P., Punie, Y., & Van den Brande, G. (2016). *EntreComp: The entrepreneurship competence framework.* Publications Office of the European Union. https://data.europa.eu/doi/10.2791/593884

Badan Pusat Statistik. (2023). *Tingkat Pengangguran Terbuka Berdasarkan Tingkat Pendidikan*. https://www.bps.go.id/id/statistics-table/2/MTE3OSMy/tingkat-pengangguran-terbuka-berdasarkan-tingkat-pendidikan.html

Baena, F., Guarin, A., Mora, J., Sauza, J., & Retat, S. (2017). Learning Factory: The Path to Industry 4.0. *Procedia Manufacturing*, *9*, 73–80. https://doi.org/10.1016/j.promfg.2017.04.022

Barugahara, F., Maumbe, B., & Nzaro, R. (2019). Developing a Business Incubator Model for an Entrepreneurial University: The Case of Bindura University of Science Education. *Journal of Small Business and Entrepreneurship Development*, *7*(2). https://doi.org/10.15640/jsbed.v7n2a7

Belmonte, Z. J., Decapia, R. Jr., Tu, K. E., Lavado, M. J., Junio, M. N., & Lira, P. E. V. (2022). Impact of Information and Communications Technology on Technopreneurial Intention among Engineering Students. *International Journal of Information and Education Technology*, *12*(8), 756–761. https://doi.org/10.18178/ijiet.2022.12.8.1681

Bismala, L., Andriany, D., & Siregar, G. (2020). Development Strategy Analysis of Technology Business Incubator in Small Medium Enterprises Accompaniment. *Journal of Critical Reviews*, *7*(01). https://doi.org/10.31838/jcr.07.01.39

Brito, M. D., Brunstein, J., & Amaro, R. A. (2018). Education for Sustainability Beyond the Classroom: Companies Born in University Incubators. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3203802

Castagnoli, R., Büchi, G., Coeurderoy, R., & Cugno, M. (2022). Evolution of industry 4.0 and international business: A systematic literature review and a research agenda. *European Management Journal*, *40*(4), 572–589. https://doi.org/10.1016/j.emj.2021.09.002

Chinagozi, O. G., Joe, O. N., & Olawale, S. R. (2023). Technopreneurship and Business Performance of Ride-Hailing Firms in Lagos State. *International Journal of Research and Innovation in Social Science*, *VII*(IV), 1367–1383. https://doi.org/10.47772/IJRISS.2023.7514

Daniel, A. D. (2016). Fostering an entrepreneurial mindset by using a design thinking approach in entrepreneurship education. *Industry and Higher Education*, *30*(3), 215–223. https://doi.org/10.1177/0950422216653195

Dániel, Z. A., & Porkoláb, P. F. (2021). Success Factors for University Incubators—A Benchmarking Model for Better Performance. *Köz-Gazdaság*, *16*(3), 219–243. https://doi.org/10.14267/RETP2021.03.15

Dayaratna-Banda, O. G., & Dharmadasa, P. D. C. S. (2022). An Economics Analysis of Employability and Unemployment of Humanities and Social Sciences Graduates in Sri Lanka. *South Asian Survey*, *29*(2), 155–180. https://doi.org/10.1177/09715231221124714

Dwijayanthi, K. D., & Rijanto, T. (2022). Implementation of Teaching Factory (TEFA) in Vocational School to Improve Student Work Readiness. *Journal of Vocational Education Studies*, *5*(1), 61–71. https://doi.org/10.12928/joves.v5i1.5922

Elyta, E., Martoyo, M. & Herlan. (2021). Formulation Model of Power Based Technopreneurship in the Digital Technology Era. *International Journal on Advanced Science, Engineering and Information Technology*, *11*(6), 2344. https://doi.org/10.18517/ijaseit.11.6.10968

Fahmi, K. N. (2019). Pengembangan Modul Kimia Berbasis Teaching Factory pada materi Redoks Terintegrasi Kompetensi Keahlian Teknik Fabrikasi Logam dan Manufaktur. *Journal of Educational Chemistry (JEC)*, *1*(2), 107. https://doi.org/10.21580/jec.2019.1.2.4433

Falkner, K., Sentance, S., Vivian, R., Barksdale, S., Busuttil, L., Cole, E., Liebe, C., Maiorana, F., McGill, M. M., & Quille, K. (2019). An International Comparison of K-12 Computer Science Education Intended and Enacted Curricula. *Proceedings of the 19th Koli Calling International Conference on Computing Education Research*, 1–10. https://doi.org/10.1145/3364510.3364517

Fayolle, A. (2013). Personal views on the future of entrepreneurship education. *Entrepreneurship & Regional Development*, *25*(7–8), 692–701. https://doi.org/10.1080/08985626.2013.821318

Fortunato, M. W.-P., & Alter, T. (2017). Community entrepreneurship development: An introduction. In M. W.-P. Fortunato & T. R. Alter (Eds.), *Entrepreneurship, Community, and Community Development* (1st ed., pp. 1–12). Routledge. https://doi.org/10.4324/9781315112893-1

Gong, C. (2020). Design Thinking Transforms Teaching Approaches and Curriculum Development for Entrepreneurship Education. *Proceedings of the International Conference on Modern Educational Technology and Innovation and Entrepreneurship (ICMETIE 2020)*. International Conference on Modern Educational Technology and Innovation and Entrepreneurship (ICMETIE 2020), Sanya, China. https://doi.org/10.2991/assehr.k.200306.100

Halim, H. A., Ahmad, N. H., & Waqas, A. (2023). Young technopreneur ventures' agility and competitiveness in Malaysia: Role of inhibitors. *Journal of Science and Technology Policy Management*. https://doi.org/10.1108/JSTPM-10-2022-0172

Hardiyanto, W., Hatimah, I., Wahyudin, U., Saepudin, A., & Nurajizah. (2022). Strategies to improve entrepreneurship skills of youth considering the business and industry effects. *Economic Annals-XXI*, *197*(5–6), 17–23. https://doi.org/10.21003/ea.V197-03

Hasanah, H., & Malik, Muh. (2018). Teaching Factory-Based for Entrepreneurship Learning Model in Vocational High Schools. *Proceedings of the International Conference on Indonesian Technical Vocational Education and Association (APTEKINDO 2018)*. International Conference on Indonesian Technical Vocational Education and

Association (APTEKINDO 2018), Surabaya, Indonesia. https://doi.org/10.2991/aptekindo-18.2018.46

Hassan, N. A. (2020). University business incubators as a tool for accelerating entrepreneurship: Theoretical perspective. *Review of Economics and Political Science*. https://doi.org/10.1108/REPS-10-2019-0142

Heriyati, P., Yunus, U., Ariestyani, A., & Ubaidillah, U. (2023). Teaching Factory as a Competency-Based Learning Program for Vocational High School. *Proceedings of the 5th International Conference on Vocational Education and Technology, IConVET 2022, 6 October 2022, Singaraja, Bali, Indonesia*. Proceedings of the 5th International Conference on Vocational Education and Technology, IConVET 2022, 6 October 2022, Singaraja, Bali, Indonesia, Singaraja, Indonesia. https://doi.org/10.4108/eai.6-10-2022.2327336

Hidayat, H., Tamin, B. Y., Herawati, S., Khairul, K., & Syahmaidi, E. (2019). The contribution of technopreneurship scientific learning and learning readiness towards the entrepreneurship learning outcomes in higher vocational education. *Jurnal Pendidikan Vokasi*, *9*(1), 21–32. https://doi.org/10.21831/jpv.v9i1.20466

Huang, W., & Looi, C.-K. (2021). A critical review of literature on "unplugged" pedagogies in K-12 computer science and computational thinking education. *Computer Science Education*, *31*(1), 83–111. https://doi.org/10.1080/08993408.2020.1789411

Huizinga, T., Nieveen, N., & Handelzalts, A. (2019). Implementation Activities in Design Teams: Opportunities to Demonstrate and Acquire Design Expertise. In J. Pieters, J. Voogt, & N. Pareja Roblin (Eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning* (pp. 175–190). Springer International Publishing. https://doi.org/10.1007/978-3-030-20062-6_10

Huq, A., & Gilbert, D. (2017). All the world's a stage: Transforming entrepreneurship education through design thinking. *Education and Training*, *59*(2), 155–170. https://doi.org/10.1108/ET-12-2015-0111

Husin, M. H., Ibrahim, N. F., Abdullah, N. A., Syed-Mohamad, S. M., Samsudin, N. H., & Tan, L. (2023). The Impact of Industrial Revolution 4.0 and the Future of the Workforce: A Study on Malaysian IT Professionals. *Social Science Computer Review*, *41*(5), 1671–1690. https://doi.org/10.1177/08944393221117268

Indriaturrahmi, I. (2017). Analisis Perbandingan Routing Protokol OSPFv3 dengan RIPng pada Jaringan IPv6. *Jurnal Teknologi Pendidikan : Jurnal Penelitian dan Pengembangan Pembelajaran*, *2*(1), 8–13. https://doi.org/10.33394/jtp.v2i1.615

Indriaturrahmi, I., Faesal, A., Febriana, A., & Satria, M. C. (2022). Penggunaan Metode AHP dalam pemilihan Jenis Promosi Kampus Berdasarkan Lokasi Sekolah. *Journal of Computer System and Informatics (JoSYC)*, *4*(1), Article 1. https://doi.org/10.47065/josyc.v4i1.2568

Indriaturrahmi, I., Prayogi, S., Asy'ari, M., & Samsuri, T. (2023). Analysis of Students' Design Thinking in Information Technology Innovation. *Lensa: Jurnal Kependidikan Fisika*, *11*(2), 89–96. https://doi.org/10.33394/j-lkf.v11i2.10493

Indriaturrahmi, I., & Sudiyatno, S. (2016). The Role of Business and Industry in The Implementation of Vocational High School (VHS) Based on Local Wisdom in the City of Mataram. *Jurnal Pendidikan Vokasi*, *6*(2), Article 2. https://doi.org/10.21831/jpv.v6i2.6277

Jasti, N. V., Kota, S., & Venkataraman, P. (2021). Development of a lean manufacturing simulation laboratory for continuing education students. *Journal of Adult and Continuing Education*, *27*(2), 292–323. https://doi.org/10.1177/1477971420962519

Jing, Z., Turi, J. A., Lu, S., & Rosak-Szyrocka, J. (2023). Sustainability through Factory-Based Learning in Higher Education. *Sustainability*, *15*(6), 5376. https://doi.org/10.3390/su15065376

Kautsar, A., Wiyono, G., Mulia, M., Iqbal, M., & Al-Fairusy, M. (2022). Teaching Factory Model Development in Vocational High Schools. *AL-ISHLAH: Jurnal Pendidikan*, *14*(4), 6347–6360. https://doi.org/10.35445/alishlah.v14i4.2461

Koe, W.-L., Alias, N. E., Marmaya, N. H., Majid, I. A., Mohamad, M., & Mohamad, M. (2020). Likelihood in Choosing Technopreneurship as Career among Undergraduate Students. *International Journal of Academic Research in Business and Social Sciences*, *10*(5), Pages 686-696. https://doi.org/10.6007/IJARBSS/v10-i5/7241

Komarudin, K., Sutadji, E., & Suhartadi, S. (2017). Contribution of Teaching Factory Learning Strategy Implementation, Mastery of Basic Knowledge, and Self Efficacy to the Vocational Competence and Its Impact to Student Work Readiness in Malang Vocational Education of Motorcycle Engineering. *Proceedings of the 1st International Conference on Vocational Education And Training (ICOVET 2017)*. 1st International Conference on Vocational Education And Training (ICOVET 2017), Malang, Indonesia. https://doi.org/10.2991/icovet-17.2017.36

Krüger, M. (2019). Design Thinking for German Vocational Schools? Discovering of an Innovative Approach by Testing in Teacher Education. *Open Education Studies*, *1*(1), 209–219. https://doi.org/10.1515/edu-2019-0015

Kusmintarti, A., Ismanu, S., & Anshori, Moh. A. (2021). *Design of Entrepreneurship Learning Model with Teaching Factory Method to Improve Student's Competencies:* 2nd Annual Management, Business and Economic Conference (AMBEC 2020), Batu, East Java, Indonesia. https://doi.org/10.2991/aebmr.k.210717.041

Lahikainen, K., Kolhinen, J., Ruskovaara, E., & Pihkala, T. (2019). Challenges to the development of an entrepreneurial university ecosystem: The case of a Finnish university campus. *Industry and Higher Education*, *33*(2), 96–107. https://doi.org/10.1177/0950422218815806

Lahn, L. C., & Erikson, T. (2016). Entrepreneurship education by design. *Education and Training*, *58*(7/8), 684–699. https://doi.org/10.1108/ET-03-2016-0051

Lasrado, V., Sivo, S., Ford, C., O'Neal, T., & Garibay, I. (2016). Do graduated university incubator firms benefit from their relationship with university incubators? *The Journal of Technology Transfer*, *41*(2), 205–219. https://doi.org/10.1007/s10961-015-9412-0

Li, J., Luo, H., Zhao, L., Zhu, M., Ma, L., & Liao, X. (2022). Promoting STEAM Education in Primary School through Cooperative Teaching: A Design-Based Research Study. *Sustainability*, *14*(16), 10333. https://doi.org/10.3390/su141610333

Li, T., & Zhan, Z. (2022). A Systematic Review on Design Thinking Integrated Learning in K-12 Education. *Applied Sciences*, *12*(16), 8077. https://doi.org/10.3390/app12168077

Li, Y., Schoenfeld, A. H., diSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2019). Design and Design Thinking in STEM Education. *Journal for STEM Education Research*, *2*(2), 93–104. https://doi.org/10.1007/s41979-019-00020-z

Lin, L., Dong, Y., Chen, X., Shadiev, R., Ma, Y., & Zhang, H. (2024). Exploring the impact of design thinking in information technology education: An empirical investigation. *Thinking Skills and Creativity*, *51*, 101450. https://doi.org/10.1016/j.tsc.2023.101450

Łobacz, K., & Niedzielski, P. (2015). The Interests of Main Stakeholders in The Commercialisation Process of Business Ventures Within University Business Incubators. *Optimum. Studia Ekonomiczne*, *5(77)*, 53–76. https://doi.org/10.15290/ose.2015.05.77.04

Louw, L., & Deacon, Q. (2020). Teaching Industrie 4.0 technologies in a learning factory through problem-based learning: Case study of a semi-automated robotic cell design. *Procedia Manufacturing*, *45*, 265–270. https://doi.org/10.1016/j.promfg.2020.04.105

Lyken-Segosebe, D., Mogotsi, T., Kenewang, S., & Montshiwa, B. (2020). Stimulating Academic Entrepreneurship through Technology Business Incubation: Lessons for the Incoming Sponsoring University. *International Journal of Higher Education*, *9*(5), 1. https://doi.org/10.5430/ijhe.v9n5p1

Lynch, M., Kamovich, U., Longva, K. K., & Steinert, M. (2021). Combining technology and entrepreneurial education through design thinking: Students' reflections on the learning process. *Technological Forecasting and Social Change*, *164*, 119689. https://doi.org/10.1016/j.techfore.2019.06.015

Monetti, F. M., Boffa, E., De Giorgio, A., & Maffei, A. (2023). The Impact of Learning Factories on Teaching Lean Principles in an Assembly Environment. In K.-Y. Kim, L. Monplaisir, & J. Rickli (Eds.), *Flexible Automation and Intelligent Manufacturing: The Human-Data-Technology Nexus* (pp. 271–283). Springer International Publishing. https://doi.org/10.1007/978-3-031-18326-3_27

Morselli, D., & Gorenc, J. (2022). Using the EntreComp framework to evaluate two entrepreneurship education courses based on the Korda Method. *The International Journal of Management Education*, *20*(1), 100591. https://doi.org/10.1016/j.ijme.2021.100591

Müller, B. C., Menn, J. P., & Seliger, G. (2017). Procedure for Experiential Learning to Conduct Material Flow Simulation Projects, Enabled by Learning Factories. *Procedia Manufacturing*, *9*, 283–290. https://doi.org/10.1016/j.promfg.2017.04.047

Mulyany, R., Muhammad, S., Geumpana, T. A., Halim, H., Muslim, M., Miksalmina, M., & Pertiwi, C. D. (2023). A Potential Framework For an Impactful Technopreneurship Education. *Indonesian Journal of Business and Entrepreneurship*. https://doi.org/10.17358/ijbe.9.2.208

Nicholls-Nixon, C. L., Valliere, D., Gedeon, S. A., & Wise, S. (2021). Entrepreneurial ecosystems and the lifecycle of university business incubators: An integrative case study. *International Entrepreneurship and Management Journal*, *17*(2), 809–837. https://doi.org/10.1007/s11365-019-00622-4

Nielsen, S. L., & Stovang, P. (2015). DesUni: University entrepreneurship education through design thinking. *Education and Training*, *57*(8/9), 977–991. https://doi.org/10.1108/ET-09-2014-0121

Nieveen, N. M., Van Den Akker, J. J. H., & Voogt, J. M. (2023). Curriculum design. In *International Encyclopedia of Education(Fourth Edition)* (pp. 198–205). Elsevier. https://doi.org/10.1016/B978-0-12-818630-5.03032-3

Northrup, A. K., Burrows Borowczak, A. C., & Slater, T. F. (2022). K-12 Teachers' Perceptions and Experiences in Starting to Teach Computer Science. *Education Sciences*, *12*(11), 742. https://doi.org/10.3390/educsci12110742

Novak, E., & Mulvey, B. K. (2021). Enhancing design thinking in instructional technology students. *Journal of Computer Assisted Learning*, *37*(1), 80–90. https://doi.org/10.1111/jcal.12470

Nurnida, I., & Wicaksono, E. K. (2018). Analysis Of Technopreneurship Applications In Alternative Energy Company: Study On Cv. Wahana Putera Ideas, Bandung. *Proceedings of the 4th Bandung Creative Movement International Conference on Creative Industries 2017 (4th BCM 2017)*. 4th Bandung Creative Movement International Conference on Creative Industries 2017 (4th BCM 2017), Bandung, Indonesia. https://doi.org/10.2991/bcm-17.2018.27

Obschonka, M., Hakkarainen, K., Lonka, K., & Salmela-Aro, K. (2017). Entrepreneurship as a twenty-first century skill: Entrepreneurial alertness and intention in the transition to adulthood. *Small Business Economics*, *48*(3), 487–501. https://doi.org/10.1007/s11187-016-9798-6

Okpako, E. K., Lawrence, K. C., & Falaye, A. O. (2021). The state of psychological wellbeing of unemployed distinction graduates and the factors contributory to their wellbeing. *International Journal of Adolescence and Youth*, *26*(1), 376–390. https://doi.org/10.1080/02673843.2021.1963294

Oukil, M.-S. (2011). A development perspective of technology-based entrepreneurship in the Middle East and North Africa. *Annals of Innovation & Entrepreneurship*, *2*(1), 6000. https://doi.org/10.3402/aie.v2i1.7986

Passow, H. J., & Passow, C. H. (2017). What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review. *Journal of Engineering Education*, *106*(3), 475–526. https://doi.org/10.1002/jee.20171

Patnaik, S. (2023). The Technopreneurial Hub: An Innovative Entrepreneurial Approach to Minimise Clothing and Textile Waste. *European Conference on Innovation and Entrepreneurship*, *18*(2), 951–960. https://doi.org/10.34190/ecie.18.2.1672

Perdana, N. S. (2019). Evaluasi Pelaksanaan Pembelajaran Model Teaching Factory dalam Upaya Peningkatan Mutu Lulusan. *Jurnal Serunai Administrasi Pendidikan*, *7*(1). https://doi.org/10.37755/jsap.v7i1.116

Phuthong, T. (2023). Defining Technopreneurs' Commercialization Research Process in the Emerging Thai Economy: Research for Constructing Grounded Theory. *TEM Journal*, 1142–1155. https://doi.org/10.18421/TEM122-60

Pizarro, N., & Graybeal, G. M. (2022). Learning Design Thinking: A Social Innovation Jam. *Entrepreneurship Education and Pedagogy*, *5*(2), 208–224. https://doi.org/10.1177/25151274211014082

Prabowo, P. (2022). Digital Marketing Learning Needs for Business Incubator Participants. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 754–758. https://doi.org/10.46254/SA03.20220186

Pratiwi, C. P., Sasongko, A. H., Aguzman, G., Wibawa, R. C., & Pambudy, R. (2022). Characteristics and Challenge Faced By Socio-Technopreneur in Indonesia. *Business Review and Case Studies*. https://doi.org/10.17358/brcs.3.1.13

Prayogi, S., Ardi, R. F. P., Yazidi, R. E., Tseng, K.-C., & Mustofa, H. A. (2023). The Analysis of Students' Design Thinking in Inquiry-Based Learning in Routine University Science Courses. *International Journal of Essential Competencies in Education*, *2*(1), Article 1. https://doi.org/10.36312/ijece.v2i1.1338

Prayogi, S., Yuanita, L., & Wasis. (2018). Critical Inquiry Based Learning: A Model of Learning to Promote Critical Thinking Among Prospective Teachers of Physic. *Journal of Turkish Science Education*, *15*(1), Article 1.

Putri, M. K., Anggadwita, G., & Wicaksono, M. B. (2019). Identification of the Influence of Academic's Personal Characteristics and Academic's Perceived Support on University Students' Intention to Become Technopreneur. *JURNAL APLIKASI MANAJEMEN*, *17*(2), 366–379. https://doi.org/10.21776/ub.jam.2019.017.02.20

Qiwang, Z., & Xiaorui, W. (2020). Factors Influencing Employment Rate and Mobility of Science and Engineering and Economics and Management Graduates in Northeast China: An Examination. *SAGE Open*, *10*(2), 215824402093193. https://doi.org/10.1177/2158244020931935

Raharjo, H., Sofyan, H., Sukardi, T., & Siswanto, I. (2022). Validation of Technopreneurship Skill Questionnaire: Vocational Students' Perspective in the COVID-19 Pandemic. In J. Priyana & N. K. Sari (Eds.), *Proceedings of the 9th International Conference on Education Research, and Innovation (ICERI 2021)* (pp. 22–32). Atlantis Press SARL. https://doi.org/10.2991/978-2-494069-67-1_4

Rahmadan, R., Kristiawan, M., & Sasongko, R. N. (2022). Teaching Factory Management for Dressing, Catering, Beauty and SPA Program. *AL-ISHLAH: Jurnal Pendidikan*, *14*(4), 6575–6586. https://doi.org/10.35445/alishlah.v14i4.2317

Razali, N. H., Ali, N. N. N., Safiyuddin, S. K., & Khalid, F. (2022). Design Thinking Approaches in Education and Their Challenges: A Systematic Literature Review. *Creative Education*, *13*(07), 2289–2299. https://doi.org/10.4236/ce.2022.137145

Rentzos, L., Mavrikios, D., & Chryssolouris, G. (2015). A Two-way Knowledge Interaction in Manufacturing Education: The Teaching Factory. *Procedia CIRP*, *32*, 31–35. https://doi.org/10.1016/j.procir.2015.02.082

Roblek, V., Meško, M., & Krapež, A. (2016). A Complex View of Industry 4.0. *SAGE Open*, *6*(2), 215824401665398. https://doi.org/10.1177/2158244016653987

Sahidu, H., Gunawan, G., Herayanti, L., Indriaturrahmi, I., Astutik, F., & Bon, A. T. (2019). *The Development of E-Assessment with Learning Management System*. *9*(3). https://index.ieomsociety.org/index.cfm/article/view/ID/5971

Salhieh, S. M., & Al-Abdallat, Y. (2021). Technopreneurial Intentions: The Effect of Innate Innovativeness and Academic Self-Efficacy. *Sustainability*, *14*(1), 238. https://doi.org/10.3390/su14010238

Sandars, J., & Goh, P.-S. (2020). Design Thinking in Medical Education: The Key Features and Practical Application. *Journal of Medical Education and Curricular Development*, *7*, 238212052092651. https://doi.org/10.1177/2382120520926518

Saral, H. C., & Alpkan, L. (2017). *The Relationship Between Entrepreneurial Characteristics And Entrepreneurial Intention*. 363–371. https://doi.org/10.15405/epsbs.2017.12.02.31

Seikkula-Leino, J., Salomaa, M., Jónsdóttir, S. R., McCallum, E., & Israel, H. (2021). EU Policies Driving Entrepreneurial Competences—Reflections from the Case of EntreComp. *Sustainability*, *13*(15), 8178. https://doi.org/10.3390/su13158178

Selvaha, L. (2022). Design Thinking: Logic or Creativity. *Human, Technologies and Quality of Education, 2022*, 871–880. https://doi.org/10.22364/htqe.2022.62

Setyawati, Y., Sugiharto, F. B., Rosyanafi, R. J., Cahyanto, B., Rini, T. A., & Yusuf, A. (2021). Pengaruh MBKM Kewirausahaan Terhadap Minat Berwirausaha Mahasiswa. *MOTORIC*, *5*(2), Article 2.

Sharma, Y., Suri, A., Sijariya, R., & Jindal, L. (2023). Role of education 4.0 in innovative curriculum practices and digital literacy– A bibliometric approach. *E-Learning and Digital Media*, 20427530231221073. https://doi.org/10.1177/20427530231221073

Smith, R. C., Iversen, O. S., & Hjorth, M. (2015). Design thinking for digital fabrication in education. *International Journal of Child-Computer Interaction*, *5*, 20–28. https://doi.org/10.1016/j.ijcci.2015.10.002

Suacamram, M. (2019). Developing Creativity and Entrepreneurship of Undergraduate Students through a Field Trip Overseas. *International Journal of Instruction*, *12*(1), 591–606. https://doi.org/10.29333/iji.2019.12138a

Suhirman, S., & Muliadi, A. (2023). Biology Students' Perceptions Towards Entrepreneurship Learning: A Comparative Study Based on Gender and Semester. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1332–1340. https://doi.org/10.29303/jppipa.v9i3.3364

Suranto, Rohmah, W., Nuryana, I., Sutama, Narimo, S., & Amanda, B. (2022). Using Teaching Factory Model for Improving Student Employability Skills in Vocational High School. In N. Ishartono & Y. Sidiq (Eds.), *Proceedings of the 7th Progressive and Fun Education International Conference (PROFUNEDU 2022)* (pp. 103–111). Atlantis Press SARL. https://doi.org/10.2991/978-2-494069-71-8_13

Tajvidi, R., & Tajvidi, M. (2021). The growth of cyber entrepreneurship in the food industry: Virtual community engagement in the COVID-19 era. *British Food Journal*, *123*(10), 3309–3325. https://doi.org/10.1108/BFJ-06-2020-0559

Täks, M., Tynjälä, P., Toding, M., Kukemelk, H., & Venesaar, U. (2014). Engineering Students' Experiences in Studying Entrepreneurship: Students' Experiences in Studying Entrepreneurship. *Journal of Engineering Education*, *103*(4), 573–598. https://doi.org/10.1002/jee.20056

Tisch, M., Abele, E., & Metternich, J. (2019). The Life Cycle of Learning Factories for Competency Development. In E. Abele, J. Metternich, & M. Tisch, *Learning Factories* (pp. 127–198). Springer International Publishing. https://doi.org/10.1007/978-3-319-92261-4_6

Tritoasmoro, I. I., Ciptomulyono, U., Dhewanto, W., & Taufik, T. A. (2024). Determinant factors of lean start-up-based incubation metrics on post-incubation start-up viability: Case-based study. *Journal of Science and Technology Policy Management*, *15*(1), 178–199. https://doi.org/10.1108/JSTPM-12-2021-0187

Wagner, U., AlGeddawy, T., ElMaraghy, H., & MŸller, E. (2012). The State-of-the-Art and Prospects of Learning Factories. *Procedia CIRP*, *3*, 109–114. https://doi.org/10.1016/j.procir.2012.07.020

Wahjusaputri, S., Fitriani, S., & Syarif, S. (2019). Canvas Model Business as an Innovation of Teaching Factory Learning in the Fashion Department of 27 Public Vocational High School, Jakarta. *Dinamika Pendidikan*, *14*(2), 142–154. https://doi.org/10.15294/dp.v14i2.21167

Wonglimpiyarat, J. (2014). Technology Transfer and Entrepreneurial Development through University Business Incubation Process in Thailand. *World Technopolis Review*, *3*(2), 78–88. https://doi.org/10.7165/WTR2014.3.2.78

Yirenkyi, E. G., Debrah, G., Adanu, K., & Atitsogbui, E. (2023). Education, skills, and duration of unemployment in Ghana. *Cogent Economics & Finance*, *11*(2), 2258680. https://doi.org/10.1080/23322039.2023.2258680

Zi, M. (2022). Sensory Design and Design Thinking for Design Educating. *International Journal of Higher Education Pedagogies*, *2*(3), 1–13. https://doi.org/10.33422/ijhep.v2i3.28