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Article

Development of an instructional system design as a guideline for Nursepreneur mastery learning policy: Elevating healthcare through design thinking and InnoTVET approach

Nongluck Manowaluilou

Kasetsart University, Bangkok 10900, Thailand; fedunlm@ku.ac.th

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Abstract: This research presents an innovative perspective on vocational education by merging the Instructional System Design (ISD) model with Innovation in Thailand Vocational Education and Training (InnoTVET) principles. Targeted at nursing students, the course aims to cultivate entrepreneurial skills while connecting vocational training with healthcare policy development. It aligns with global movements in Education for Sustainable Development (ESD), addressing the increasing demand for nurse entrepreneurs who can devise creative healthcare solutions within established policy frameworks. By employing mastery learning techniques alongside design thinking, the course effectively bridges theoretical concepts with practical applications. The mixed-methods study underlines relevant contribution in students' entrepreneurial mindsets. Results from *t*-tests reveal the students' ability to identify opportunities, engage in innovative thinking, and work within policy frameworks. Findings are supported by qualitative data, which demonstrate enhanced confidence, improved problem-solving capacities, and a deeper understanding of healthcare market dynamics. Although expert evaluation of student projects is scheduled for future iterations, the initial outcomes reinforce the course's success. The course is structured into seven modules spanning 45 hours, featuring active learning components, five business-oriented assignments, and a final innovation project that integrates the curriculum's core elements. This design ensures students develop both practical expertise and interdisciplinary insights critical to healthcare innovation. The integration of InnoTVET and ISD principles in nursing education sets a precedent for vocational education reform. This example of a successful nursepreneurship initiative provides a scalable model for enhancing vocational programs in diverse fields, fostering innovation and sustainability.

Keywords: design thinking; healthcare; innoTVET; instructional system design; nursepreneur

1. Introduction

The rapidly evolving healthcare industry requires professionals with clinical expertise and entrepreneurial skills to navigate and contribute to its dynamic landscape. This study focuses on integrating English for Business and Entrepreneurship for Nursing Students into the first-year nursing curriculum, using the Instructional Systems Design (ISD) model. The course is designed to help students bridge general education knowledge with practical applications, fostering essential skills for the modern healthcare environment.

The increasing demand for nurse entrepreneurs has been risen due to the changes in careers and future demands of entrepreneurial mindset. Thus, this study emphasizes the needs for nursing students to learn entrepreneurial principles, in which the skills are essential for understanding the healthcare business, including creating innovative

products, navigating regulations, and effectively marketing and selling their ideas. The course is designed for nursing students in order to prepare them to be more than just ordinary nurses but to empower them to pioneer as healthcare innovators with entrepreneurial consideration.

Moreover, the course prepares students on business communication and entrepreneurship, providing students with learning tools designed to determinate opportunities, create healthcare solutions, and encourage them to present innovative healthcare products. By instilling these competencies early, the program empowers nursing students to become proactive leaders capable of addressing healthcare challenges and driving change.

More importantly, the InnoTVET (Innovation in Thailand Vocational Education and Training) is the innovative approach to be applied in all areas of education, initiating with vocational education in mind, but extend beyond curricula, and within healthcare education could eventually equip workforce ready to innovate and thrive in a rapidly changing industry.

1.1. Integrating vocational education and nursing innovation

Integrating vocational education, digital information systems, and entrepreneurship vigorously shapes future learners in all education sectors to meet the demands of the modern workforce. This study bridges these key areas to design a comprehensive course that equips students with entrepreneurial skills supported by digital tools, tailored from vocational contexts to nursing areas. This approach aligns with current educational trends and fosters innovation and problem-solving, essential for today's rapidly transforming enterprises (Beaird et al., 2018; Liu, 2023).

Vocational education has traditionally emphasized hands-on skills and practical knowledge. However, the growing complexity of industries requires an entrepreneurial mindset, allowing learners to adapt and create new opportunities. Integrating entrepreneurship into vocational education empowers students to think critically, innovate within their field, and even create their business ventures (Boore and Porter, 2011; Gilmartin, 2013). This is particularly relevant in Thailand, where vocational education is upbeating and a sector where the needs of a dynamic global market meet the workforce development system (Manowaluilou et al., 2022).

Digital information systems play a crucial role in enhancing nursing learning experiences. Using digital tools, such as learning management systems and data-driven platforms, allows for more personalized, flexible learning environments. These systems facilitate continuous feedback and enable students to develop entrepreneurial skills through interactive modules, real-world case studies, and simulations (Altman et al., 2018). Combining digital learning tools with vocational education enhances students' ability to apply entrepreneurial concepts in practical settings, fostering technical proficiency and business acumen (Abookire et al., 2020).

Incorporating entrepreneurship in healthcare education is a relatively novel concept but has vast potential. The International Council of Nurses defines a nurse entrepreneur as a "proprietor of a business that offers nursing services of a direct care, educational, research, administrative, or consultative nature" (Sanders and Kingma, 2012). Hewison and Badger (2006) describe nurse entrepreneurs as individuals

operating within government-run health services to develop and deliver innovative nursing services. This entrepreneurial role in healthcare necessitates proactive approaches and specialized skill sets (Phillips and Garman, 2000).

Creative thinking and empathy are highlighted as crucial for nursing students, helping them address the diverse needs of patients in a dynamic healthcare environment (Ferreira et al., 2015). However, entrepreneurship is often overlooked in the healthcare sector due to the challenges posed by organizational structures and culture (Phillips and Garman, 2006). This research addresses these challenges by proposing a course integrating entrepreneurship with nursing education. It equips future healthcare professionals with essential business and digital skills to enhance their innovation capacity.

This unique course design combines vocational education, digital information, and entrepreneurship, providing students with the practical skills needed in their chosen fields and equipping them with entrepreneurial and digital fluency. By leveraging these interdisciplinary areas, we can create a more versatile and adaptive workforce capable of driving innovation and growth in various industries, including healthcare (Cusson et al., 2020; Vannucci and Weinstein, 2017).

1.2. Innovative pathways in nursepreneurship in vocational education and healthcare

Nurse entrepreneurs encounter unique challenges in healthcare, including the need for strategic marketing, effective networking, and accessing mentorship to foster entrepreneurial growth (Vannucci and Weinstein, 2017). These challenges underscore the importance of providing nurses with entrepreneurial training early in their education. However, most existing research primarily focuses on nurse entrepreneurs already in practice, with limited attention given to designing educational programs that integrate entrepreneurial skills into nursing curricula. This gap is where innovative course designs, such as the Nursepreneur Mastery program, come into play.

This course aims to incubate entrepreneurial thinking in nursing students by integrating vocational education and entrepreneurship principles. Building on your expertise in InnoTVET (Thailand Innovation in Vocational Education and Training), it incorporates vocational education's hands-on, skills-based approach to develop creativity and practical problem-solving in healthcare contexts (Effendy et al., 2023). The course leverages design thinking, an essential tool that encourages innovative solutions to real-world healthcare challenges. As healthcare rapidly evolves with technological advancements like AI diagnostics and telemedicine (Haggerty, 2017), nursing education must proactively integrate entrepreneurship and innovation into its curriculum (Cusson et al., 2020). Integrating digital systems and entrepreneurial education in vocational settings prepares future nursepreneurs to adapt to and lead these changes. In the U.S., where the demand for innovative healthcare solutions is high, nursing educators have begun incorporating entrepreneurship into their programs to empower nurses as caregivers and innovators (Neergård, 2020).

The proposed course aligns with this shift by offering students interdisciplinary education that merges healthcare with business analysis, marketing strategies, and entrepreneurship. This approach encourages students to translate business concepts

into healthcare contexts through tailored learning activities such as hands-on projects, case studies, and situation analysis (Vannucci and Weinstein, 2017). These methods align well with vocational education's practice-oriented nature, equipping nursing students with technical and entrepreneurial skills critical for future healthcare innovation. Crucially, the course also aims to foster entrepreneurial mindsets by guiding students through Boore and Porter's (2011) stages of entrepreneurial learning: from awareness and interpretation to integration and implementation. By doing so, the course enables students to overcome initial resistance to business concepts and better contextualize them within nursing. Through the Mastery Learning framework, students also develop proficiency in emerging areas like personalized medicine and telehealth services, ensuring they are prepared to become not only healthcare providers but also key innovators driving patient-centered care and broader healthcare advancements (Cusson et al., 2020).

1.3. Design thinking and vocational education in nursing

This course integrates design thinking to foster healthcare innovation, bridging theory and practice. Students engage in projects emphasizing social entrepreneurship and intrapreneurship, positioning nurses as proactive change agents (Gilmartin, 2013). Nurses can significantly enhance patient care and address healthcare inequalities by leveraging advancements such as AI and liquid biopsy technology for early cancer detection (Haggerty, 2017). Design thinking promotes empathy, interdisciplinary collaboration, and creative problem-solving, essential for tackling complex healthcare challenges (Altman et al., 2018; Abookire et al., 2020). Integrating these principles into nursing curricula can transform education, fostering innovation and empathy among future providers (Ku and Lupton, 2020). This transformation is crucial for preparing nurses to navigate and lead in a rapidly evolving healthcare landscape.

The curriculum emphasizes advocacy competency and consists of critical components: observation, collaboration, rapid learning, and prototype creation (Liu, 2023). These elements cultivate innovation self-efficacy, empowering students to create and market healthcare solutions (Cusson et al., 2020). Additionally, applying the Instructional Design Mastery Learning (IDML) model enhances nursing education by implementing a cyclical process that includes pre-assessment, targeted instruction, continuous evaluation, and personalized support (Yusup and Chang, 1997). This model facilitates mastery of nursepreneurship, ensuring that students can adapt to various challenges they may face in healthcare settings. By intertwining InnoTVET principles with nursing education, this course prepares students to innovate and lead effectively in healthcare, ultimately contributing to a more equitable and efficient healthcare system.

Integrating InnoTVET principles into nursing education significantly benefits nurse entrepreneurs while enhancing the vocational education sector. By emphasizing innovation within vocational education and training, InnoTVET equips nursing students with essential entrepreneurial skills, empowering them to develop and implement creative solutions to pressing healthcare challenges (Anna Cecilia et al., 2023). This approach positions nurses as proactive change agents in healthcare while strengthening the overall vocational education framework by promoting real-world

applications and interdisciplinary collaboration. Furthermore, as nursing education evolves through InnoTVET, a cyclical relationship emerges whereby innovations in nursing practice can inform and elevate vocational training methodologies, ensuring that the sector remains responsive to emerging healthcare trends and technologies. This dynamic interplay between entrepreneurial development and vocational education ultimately leads to a more adaptable and skilled workforce capable of addressing complex healthcare needs.

2. Conceptual framework

This study utilizes the Instructional Systems Design (ISD) model as a foundational guideline for developing a high-quality entrepreneurial course tailored for health-related students, employing a mastery learning approach and design thinking process. The key objectives of this course include creating relevant content, conducting two expert reviews, enhancing students' advocacy and awareness toward entrepreneurship, and implementing project assessments. The framework is grounded in several theoretical underpinnings, including ISD, mastery learning theory, entrepreneurship education, and the design thinking process. Specifically, the ISD model is divided into two phases: Phase One focuses on determining content relevance and adaptability within the healthcare context. In contrast, Phase Two involves delivering the instructional package to nursing students. This phase includes aligning learning objectives, monitoring student progress, and refining instructional materials to meet the evolving needs for nursing innovation, as depicted in **Figure 1**.

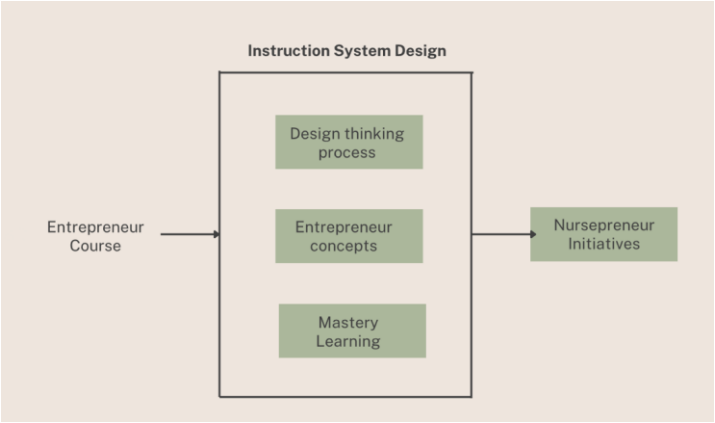

Figure 1. Conceptual framework.

Objectives

1) To develop a course guideline for promoting nursepreneur mastery learning using a design thinking innovation approach
2) To provide the materials, activities, and tasks for healthcare instructors to engage entrepreneurship in the coursework.

3. Methods

This study utilized the ISD model to develop a course integrating InnoTVET principles to promote entrepreneurial skills and policy awareness among nursing

students. The course objectives include developing content that aligns entrepreneurial education with healthcare policy formation, conducting expert reviews, and enhancing students' advocacy skills in entrepreneurship and healthcare innovation within the vocational education and related healthcare business.

The ISD involved three components: lecture-based activities, project-based tasks, and design thinking exercises, emphasizing policy implications within healthcare. Students attended lectures on entrepreneurship and healthcare policy, completed assignments, and participated in activities advocating innovative healthcare solutions. The final project required students to design value-added healthcare products, promote them through media campaigns, and consider relevant policy frameworks to support their initiatives.

To ensure a course's validation and objectives, two levels of review were conducted: (1) a focus group comprising six domain experts in vocational education, entrepreneurship, and healthcare policy, and (2) an international panel of entrepreneur educators. The focus group evaluated the course's alignment with current industry demands, while the international panel with 20 entrepreneur educators served as experts and provided insights to enhance its global applicability. Feedback from both groups was systematically integrated into the course design, refining instructional materials and project-based activities to address real-world challenges better and align with future workforce expectations.

The study employed a mixed-methods research design, incorporating both quantitative and qualitative approaches to evaluate the effectiveness of the course. The quantitative component included a pre-and post-course survey using a validated 28-item entrepreneurial mindset scale to measure changes in entrepreneurial skills and policy awareness among nursing students (n = 36). The qualitative component included open-ended responses, thematically coded and cross-validated by independent analysts to ensure reliability and transparency.

3.1. Participants

Thirty-six nursing students enrolled in English for Communication and Entrepreneurial capstone courses, jointly offered to freshmen undergraduate students as part of a 4-year nursing program at a leading Nursing institute in central Thailand.

3.2. Quantitative analysis

The entrepreneurial mindset scale measured factors such as problem-solving ability, innovation, leadership tendencies, and risk-taking. Participants completed the survey before and after the course. Each item was rated on a Likert scale, and the responses were analyzed to determine changes in mean scores. Paired sample t-tests were performed to identify statistically significant differences between pre-and post-course scores, ensuring robust validation of findings.

3.3. Validation techniques

The content was reviewed using the principles of constructive alignment, ensuring a clear connection between learning outcomes, teaching methods, and assessment tasks. A focus group of six domain experts examined the "Mapping

Template and Examples of Entrepreneur Projects" to verify that the course structure supported the intended learning objectives effectively. Feedback from an international panel of entrepreneur educators further ensured the course's global applicability and alignment with best practices in entrepreneurship education.

3.4. Transparency in analysis

Independent coders thematically analyzed open-ended questionnaire responses to identify key themes related to entrepreneurial mindset development. To ensure a comprehensive analysis, this study employed triangulation by systematically integrating qualitative insights from thematic analysis with quantitative results from *t*-tests, providing a richer understanding of the course's impact on entrepreneurial competencies.

Students completed a validated 28-item entrepreneurial mindset scale and a survey measuring their understanding of design thinking and policy formation. The data were analyzed using paired sample *t*-tests to identify significant changes in entrepreneurial skills and policy awareness. Qualitative data from open-ended questionnaire responses were thematically coded and cross-validated by independent analysts to enhance transparency and reliability.

The ISD process was implemented between January and March 2023, followed by course offerings in March 2023 and March 2024. **Figure 2** illustrates the alignment of course learning outcomes with specific topics and activities, ensuring a coherent instructional approach. Adjustments based on expert and panel feedback included integrating case studies on sustainable healthcare entrepreneurship and enhancing project-based learning tasks.

By incorporating multi-level validation, statistical analysis, and transparent data processing, this study ensures the course effectively equips nursing students with entrepreneurial competencies and policy insight, preparing them to innovate and lead in a dynamic healthcare environment.

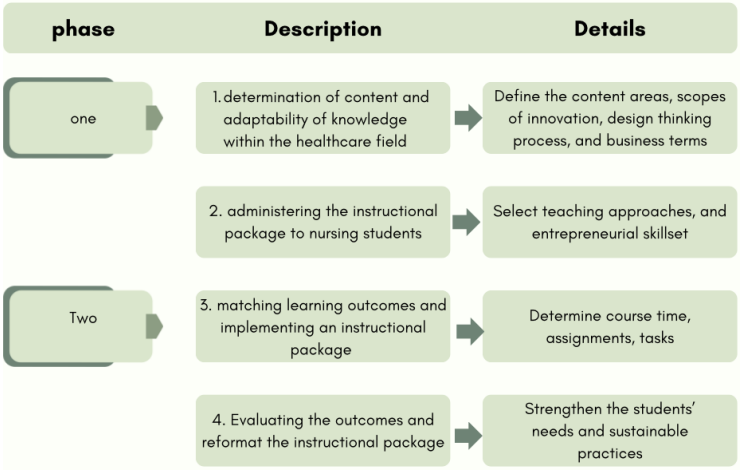

Figure 2. Framework for designing the instructional system design for the nursing.

Building upon the conceptual framework that integrates InnoTVET principles into nursing education through the ISD model and project-based learning, the following hypotheses are proposed to investigate the impact of this innovative

approach on students' entrepreneurial mindset, design thinking proficiency, and overall engagement in the course.

Hypothesis 1: Implementing InnoTVET principles in the nursing entrepreneurship course will significantly enhance students' entrepreneurial mindset scores, as the pre-and post-course questionnaires measure, indicating that exposure to innovation-focused education fosters an entrepreneurial disposition.

Hypothesis 2: Students participating in project-based learning activities that incorporate InnoTVET methodologies will significantly improve their design thinking proficiency, as assessed by their self-reported evaluations, compared to their initial assessments before the course.

Hypothesis 3: Integrating InnoTVET principles within the ISD framework will result in higher student engagement and satisfaction levels, as measured by post-course surveys, compared to previous course formats that did not utilize InnoTVET approaches.

The outcomes of this study will provide empirical evidence to support or refute the proposed hypotheses, offering insights into the effectiveness of integrating InnoTVET principles and design thinking methodologies in enhancing students' entrepreneurial mindset, design thinking proficiency, and engagement in the nursing curriculum.

4. Results

The instructional approach incorporated three key components: lecture-based activities, project-based tasks, and design thinking exercises. These elements were designed to emphasize policy formation in healthcare, as outlined in **Table 1**, which details the steps, active learning activities, and corresponding assignments to ensure a structured and engaging learning process.

In the initial phase, students participated in lectures and assignments covering entrepreneurship and relevant healthcare policies. This engagement demonstrated their understanding and commitment to applying entrepreneurial principles within the regulatory context. As the course progressed, students culminated their learning in a final project that involved designing innovative healthcare products, promoting them through media campaigns, and advocating for supportive policies to enhance their initiatives.

Throughout the course, notable individual differences emerged in students' self-assessed proficiency in design thinking and their understanding of policy implications. Many students reported improvements in their ability to creatively synthesize insights about potential users and effectively navigate the complexities of healthcare regulations. However, some expressed a decline in optimism regarding their innovative capabilities. Despite this, the enhanced perceived proficiency in creative synthesis and awareness of policy implications empowered aspiring nurse entrepreneurs, fostering their ability to innovate and advocate effectively within the healthcare system.

Table 1. Steps, activities, and assignments/tasks for nursepreneur instructional design.

Steps	Actvities	Assignments/tasks
1) Preparation and motivation	Reflect on previous experiences, challenges. Analyze healthcare policies impacting entrepreneurship.	Discussion on previous entrepreneur or family business Reflection on the regulatory landscape of healthcare.
2) Research and problem identification	Provide nursing and entrepreneur in healthcare research. Identify healthcare gaps, problems, issues. Encourage students' perspectives to pitch business ideas in healthcare business.	1. Assign an interview with experts in the healthcare field. 2. Identify "healthcare business opportunities and threats" in health-related communities.
3) Information retrieval and solution validation	Set goals and healthcare innovation design and actions Implement solutions that target hands-on experience towards nurse entrepreneur. Target information on stakeholders and allocate of resources.	1. Conduct a literature review on healthcare innovation. 2. Assign students to search for entrepreneur role models in healthcare. 3. Retrieve the issues that entrepreneurs are facing and how they resolve the problems. 4. Set goals for healthcare products that they desire to own or start a business.
4) Development and validation of nursing innovation prototypes	Propose and design prototype or innovation concepts within healthcare business meeting policy and industry standards.	1. Use all the learning contents and materials, propose a product that could solve the current healthcare problems. 2. Design a product or innovation of choice using Business Model Canvas and Product Design Template that instructor has simplified.
5) Dissemination and reflective learning	Present innovations emphasizing contributions to policy discussions.	1. Present a potential target market, marketplace, price, materials. 2. Present key benefits as an alternative way to solve the problems. 3. Pitch ideas on social media platforms. 4. Pre-assessment of key contribution and potential prototype.
6) Mastery learning	Pre-assessments evaluating policy awareness.	1. Use group-based initial instruction and group reflection. 2. Provide parallel formative assessments for nursing entrepreneurial alignment.

Remarks: Materials taught and lectured in class would not be included.

The study yielded two significant outcomes: a conceptual framework for mastery learning incorporating policy considerations and an ISD model integrating design thinking with an entrepreneurial mindset. These frameworks provide foundational principles for educators to develop a comprehensive learning strategy that prepares students to understand nursing practice's entrepreneurial and policy dimensions, ultimately contributing to a more robust vocational education system aligned with InnoTVET principles.

These enhancements clarify how your instructional design aligns with InnoTVET and emphasize the importance of policy formation, making your program more robust and relevant to current educational and industry standards. Following this, curriculum and instruction experts meticulously reviewed the lesson plan according to the ISD approach and university guidelines, submitting it to the nursing curriculum board for approval. Their assessment affirmed that the plan aligns with established learning outcomes and overarching course objectives.

The next step involves mapping and organizing content based on formulated learning outcomes and advocating for entrepreneurial competencies. This process requires logical and systematic procedures to ensure content coherence and promote

entrepreneurial initiatives. To measure content effectiveness, instructors employ a structured approach that engages students in personalized learning, health research, case studies, interprofessional partnerships, inquiry-based learning, mastery learning, and reflective thinking processes. This comprehensive methodology is designed to foster entrepreneurial mindsets among nursing students.

Various educational strategies—InnoTVET, mastery learning, Instructional System Design (ISD), and vocational education—are integrated into the entrepreneurial education framework for nursing students.

4.1. Course structure and methodology

The course spans 15 weeks, encouraging entrepreneurial mindsets among nursing students while promoting empirical interpretation and implementation from concepts to practice, closely aligned with mastery learning objectives. Incorporating feedback and reflection mechanisms throughout the course is crucial for continuous improvement and engagement. By regularly assessing student progress and providing constructive feedback, instructors can identify strengths, weaknesses, and areas for entrepreneurial growth, facilitating informed adjustments to learning strategies. This iterative process empowers students to develop their entrepreneurial skills and mindset effectively.

As illustrated in **Figure 3**, the procedure demonstrates how to mobilize teaching strategies and learning outcomes while engaging advocacy in an active learning approach and mastery learning within the nursepreneur framework. Examples of healthcare content, tasks, assignments, and projects are categorized into three main areas, seamlessly integrated with overall learning objectives and course curriculum as follows:

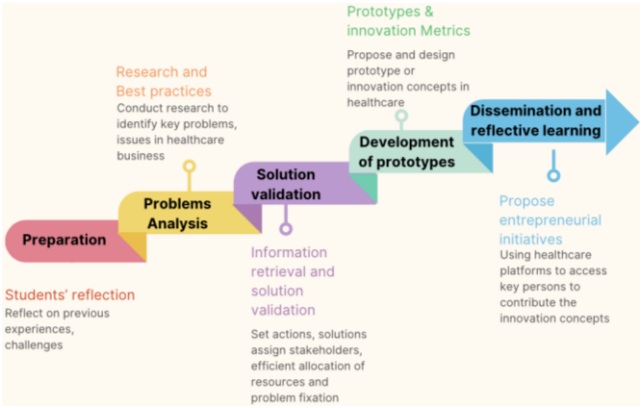

Figure 3. Adaptive design thinking process for nursepreneur course.

Preparation stage: The course begins with tasks for mastery learning that serve as an elite outlet to promote an entrepreneurial mindset. Students reflect on their previous experiences and challenges in healthcare, interviewing experts in the field to stimulate entrepreneurial learning. Exploring real-world scenarios, including interactions with front-line workers in nursing schools, enhances their understanding of the course context.

Problem Analysis stage—Healthcare assignments are spontaneously assigned as supplements every other week. These assignments include identifying healthcare gaps,

exploring entrepreneurial opportunities in nursing, and analyzing healthcare products through SWOT analysis. This stage encourages critical thinking and the application of theoretical concepts while allowing students to pitch business ideas based on their studies.

Solution Validation and Development of Prototypes stage - Students engage in final projects using tools such as the Business Model Canvas and the Design Thinking Process from the fifth week onward. In this stage, they develop and validate innovative solutions to current healthcare challenges, creating prototypes or innovation concepts that address specific needs within the healthcare system.

Dissemination and Reflective Learning stage: In the final weeks of the course, students present their prototypes, discussing potential target markets and how their innovations can effectively solve healthcare problems. They utilize social media platforms to pitch ideas and receive instructor and peer feedback. Incorporating reflection mechanisms throughout the course is crucial for continuous improvement and engagement. By regularly assessing student progress and providing constructive feedback, instructors can identify strengths, weaknesses, and areas for entrepreneurial growth, facilitating informed adjustments to learning strategies. This iterative process empowers students to develop their entrepreneurial skills and mindset effectively.

These categories span 15 weeks, encouraging entrepreneurial mindsets among nursing students while promoting empirical interpretation and implementation from concepts to practice, closely aligned with mastery learning objectives.

Moreover, incorporating feedback and reflection mechanisms throughout the course is crucial for continuous improvement and engagement. By regularly assessing student progress and providing constructive feedback, instructors can identify strengths, weaknesses, and areas for entrepreneurial growth, facilitating informed adjustments to learning strategies. This iterative process empowers students to develop their entrepreneurial skills and mindset effectively.

As illustrated in **Figure 3**, the procedure demonstrates how to mobilize teaching strategies and learning outcomes while engaging advocacy in an active learning approach and mastery learning within the nursepreneur framework.

Thirty-six female students attended the lectures and finished the assignments and tasks as listed above. They successfully followed the guidelines and demonstrated their ability to advocate for entrepreneurship through problem analysis, product design with solution validation and added benefits, prototype development, and dissemination followed by reflective learning, as illustrated in **Figure 3**.

Although the students have thoroughly researched the potential functions of the prototypes (e.g., materials, ingredients, color schemes, target markets, and possible funding opportunities), they could only use the digital alternatives to produce prototypes.

Due to limitations in manufacturing and industrial tools and equipment, progress in innovation stalled during the prototype design phase, hindering students' entrepreneurial experiences. To navigate this challenge, students turned to computer programs for conceptualizing and presenting their ideas. Despite these efforts, none of the initiatives advanced to the stage of actual product development.

In response to this setback, instructors implemented strategies aligned with InnoTVET principles and the ISD framework, focusing on leveraging social media

platforms as effective channels for pitching ideas to the public. Rather than pursuing traditional startup projects, students were tasked with showcasing digital versions of their prototypes. This included creating engaging videos that effectively articulated their entrepreneurial initiatives, allowing them to reach a broader audience and gain valuable feedback.

This approach enhanced students' digital literacy and encouraged critical thinking and problem-solving skills in alignment with current healthcare policies. By promoting the integration of entrepreneurial concepts within the regulatory context, students were better equipped to advocate for innovations that comply with industry standards and guidelines. This strategy empowered them to adapt their entrepreneurial initiatives in a dynamic and interactive environment, fostering a deeper understanding of the intersection between entrepreneurship, policy formation, and vocational education.

The evaluation of the teaching approach showed remarkably high satisfaction levels among nursing students. To assess students' progress, the instructor encourages students to critically evaluate their progress, learning experiences, and challenges encountered, fostering metacognitive skills and self-awareness. This reflective process enhances learning retention and promotes active engagement and ownership of the mastery learning journey. Moreover, feedback and reflection sessions during classes serve as valuable moments for dialogue between instructors and students, facilitating mutual understanding, communication, and collaboration in pursuit of academic excellence.

4.2. Integration of InnoTVET

The integration of InnoTVET principles and project-based learning methodologies has significantly enhanced students' entrepreneurial mindsets and design thinking capabilities. Instructional activities emphasized self-assessment, opportunity identification, and resource management, enabling students to engage in reflective practices and develop innovative solutions. This structured framework provided a holistic perspective of the entrepreneurship process, fostering critical skills essential for navigating the complexities of the healthcare sector. Furthermore, the focus on collaboration and real-world application deepened students' understanding of market needs, empowering them to envision and pursue entrepreneurial endeavors effectively. These outcomes are detailed in **Table 2**, which outlines the entrepreneurship domains, subtopics, and critical instructional points.

Table 2. Entrepreneurship domains, subtopics, and critical points for instruction.

Domains	Subtopic	Key questions
Potential self	Identify areas for improvement.	What am I do best? What are my main interests? Are they anything I truly like? What should I do to change myself?

Table 2. (*Continued*).

Domains	Subtopic	Key questions
Search for opportunity	Looking for new possibilities.	What are key issues in current products or services?
		What are trends of healthcare?
		What changes in laws and regulations that may affect the current products or services?
		What are new technical and technology that faciliate safe transition and deliver better care?
Ideation with value-added	Local outreach efforts with potential entrepreneurs.	Who are the keypersons in the fields?
		What do they do to make changes in the products or services?
		What are values that I could add to existing products or services?
Resources	Managing resources, financial assets, databases, materials, human capitals.	What are the important resources?
		How much are willing to invest in products or services?
		How much investment do we need?
		Who are our customers and how we can reach them?
		How many employees would be possible to drive a success in business?
Design and develop	Design prototypes using technology.	What program do I need to design a logo?
		Can I use a digital to support designing process?
		What are key attributes of products or services?
		Do the products or services fix the problems?

4.3. Key contributions to hypotheses

This structured framework visualizes entrepreneurship holistically, emphasizing self-assessment, opportunity identification, resource management, collaboration, and product development. The following points illustrate how the domains address the hypotheses:

1) Hypothesis 1: Focusing on the Potential Self encourages self-awareness and personal growth, enhancing students' entrepreneurial mindset. Exploring opportunities further fosters understanding market needs, aligning with InnoTVET principles.
2) Hypothesis 2: The domains of Ideation with Value-Added and Design and Develop directly target design thinking proficiency. Students develop creative problem-solving skills and practical application by engaging in local outreach and utilizing technology for prototyping, essential for effective entrepreneurial practices.

Table 3 presents a mapping template illustrating how course learning outcomes align with sub-objectives that foster entrepreneurial mindsets using the design thinking process and business model canvas. This framework facilitates the design of healthcare innovations and promotes a deeper understanding of entrepreneurship among students, aligning with the principles of InnoTVET and the ISD model. The integration of these elements ensures that the educational approach is both systematic and innovative, addressing the needs of the healthcare industry while emphasizing the importance of policy considerations in entrepreneurial initiatives.

3) Hypothesis 3: Integrating InnoTVET principles and the ISD model within the course curriculum will enhance students' entrepreneurial mindsets and competencies, enabling them to navigate the complexities of healthcare innovation and policy effectively.

Consequently, these hypotheses lead to the outcomes shown in **Table 2**, which outlines the course learning outcomes. After the content was delivered, students were assigned a group project with specific criteria and outlines as instructed in course learning outcomes below.

4.4. Course learning outcomes

After the content was delivered, students were assigned a group project with specificcriteria and outlines as instructed.
Students will be able to:

1) Conduct research on materials, financial procurement, and current products in the market, delivering a project using a presentation tool.
2) Demonstrate action plans, business plans, design sketches, beneficiaries, mood and tone, target market, and Business Model Canvas.

Table 3. Mapping template and examples of entrepreneur project.

Course Learning Outcomes		
After the content was delivered, students were assigned a group project with specific criteria and outlines as instructed.		
Students will be able to:		
… conduct a research on materials, financial procurement, current products in the market, deliver a project using a presentation tool		
… demonstrate action plans, business plan, design sketch, benefiary, mood and tone, target market, and Business Model Canvas		
Topic	Subtopic	Learning Points
Designing a healthcare product using adaptive design thinking process	Design thinking process Business Model Canvas	What are pain points in healthcare product of choice? Design principles and concepts Areas for improvement Other designs of other products
Collaboration and knowledge sharing using a discussion approach	Engaging students with inquiry-based learning and reflective thinking activities	Encouraging students' curiosity, questions, and ideas , which can inspire them to think creatively and envision their own entrepreneurial ventures. Allow students to search for new ideas, identify gaps or opportunities in the market, and develop innovative solutions to address unmet needs or challenges within the healthcare industry. Exchange ideas during class discussion offers insights, advice, and support as they navigate their entrepreneurial journey

According to **Table 3**, the course learning outcomes are clearly stated, along with examples of topics, subtopics, and key learning points that instructors could use for designing activities and educational materials. This structure assists students in identifying pain points in healthcare products, utilizing the Business Model Canvas to analyze and refine their business models, and examining competing products and their business models. By fostering an understanding of InnoTVET principles and policy implications, students acquire valuable insights into industry trends, innovative practices, and emerging opportunities, which can ignite their creativity and prompt them to envision entrepreneurial endeavors within a regulated framework.

In addition, **Table 3** outlines different domains of entrepreneurship along with respective subtopics and key points. Five domains of entrepreneurial mindset development are stated, accompanied by key questions. Each subtopic focuses on introspection and self-assessment for potential entrepreneurs, ensuring that students are prepared to navigate the complexities of both entrepreneurship and policy in the healthcare sector.

A mixed-methods approach is essential to comprehensively assess the impact of the nursing entrepreneurship course on students' entrepreneurial mindsets and skills. While quantitative analysis provides valuable statistical insights into the extent of change in entrepreneurial levels, qualitative analysis captures students' nuanced experiences and perceptions as they navigate the complexities of entrepreneurship education. This dual approach enables a holistic understanding of the effectiveness of the InnoTVET principles integrated into the curriculum. By combining numerical data with rich, descriptive insights, we can uncover how much students' entrepreneurial mindsets have improved and why these changes occur. This comprehensive evaluation is crucial for informing future curriculum development and enhancing the overall learning experience, ensuring that our educational strategies are aligned with the evolving demands of the healthcare industry.

The analysis of entrepreneurial levels before and after coursework demonstrates significant positive changes in students' entrepreneurial mindsets, as illustrated in **Table 4**. This data was collected from a cohort of 36 participants who completed a self-administered questionnaire utilizing a 5-point Likert scale to measure various aspects of their entrepreneurial attitudes.

Table 4. *T*-test results of entrepreneur levels before and after coursework (n = 36).

Items	pre		post		*t*	*p*-value
	Means	SD	Means	SD		
I am governed first by business interests and only then consider colleagues and their interests.	2.33	0.51	3.44	0.37	6.346	0.000***
I prefer to adjust to unfavorable circumstances rather than to change them.	3.62	0.34	3.76	0.57	0.483	0.632
When considering a project, I am more interested in seeing the big picture than the details.	2.81	0.47	4.12	0.53	5.317	0.000***
As a rule, I stand up for my own interests more often than I support and assist others.	3.34	0.5	4.31	0.47	4.414	0.000***
It is easy for me to see a different application for a familiar approach.	3.33	0.51	4.13	0.58	6.097	0.000***
When unfairly accused, I consider attack the best defense.	3.44	0.6	4.42	0.38	7.47	0.000***
It is always easier for me to see opportunities than limitations.	4.01	0.45	4.71	0.52	6.271	0.000***
When I am supposed to act, I waver and look for support.	3.98	0.44	4.55	0.59	2.086	0.044*
When something goes wrong, I more often seek additional information than a different solution.	3.77	0.42	4.12	0.56	1.589	0.121
When working on a task, I often come up with an innovative solution.	3.97	0.56	4.72	0.52	3.104	0.004**
When starting a new project, I am likely to doubt its success.	3.77	0.45	4.51	0.49	7.107	0.000***
I look for information to be complete and consistent rather than to bring new ideas or opportunities.	3.39	0.5	4.93	0.52	5.238	0.000***
It is my nature to assume responsibility at work.	4.02	0.45	4.29	0.31	1.013	0.318
I frequently see what can be changed and how.	4.43	0.57	4.45	0.35	0.14	0.889

Table 4. (*Continued*).

Items	pre		post		*t*	*p*-value
	Means	**SD**	**Means**	**SD**		
I am often the one who gives instructions to others.	3.77	0.51	4.06	0.57	2.127	0.041*
I am sure that in any business it is most important to follow your action plan systematically.	3.42	0.57	4.81	0.32	10.17	0.000***
When people deviate from the rules, I dislike it and let others know.	3.16	0.52	4.33	0.48	7.274	0.000***
I like to keep track of how things are progressing.	3.72	0.53	4.46	0.4	3.611	0.001***
In business, I am more concerned with insuring stability than with finding ways for growth.	3.86	0.37	4.51	0.3	3.487	0.001***
I am able to follow my own path even if the majority opposes.	3.73	0.43	4.83	0.34	6.951	0.000***
I feel more comfortable in pre-planned situations than when required to improvise.	3.54	0.53	3.98	0.47	1.979	0.056
I assist others more frequently by lending a hand than by offering good advice.	3.55	0.4	3.76	0.32	1.642	0.110
I tend to rethink a solution repeatedly instead of just proceeding.	2.98	0.31	3.76	0.57	4.923	0.000***
I lose my bearings easily in unfamiliar settings.	2.68	0.59	3.89	0.49	6.983	0.000***
When decision making, I rely more on a thorough analysis of the problem than on intuition.	2.87	0.6	4.13	0.41	6.589	0.000***
I persist in gaining my objective and never quit even if it becomes difficult.	2.67	0.5	4.67	0.48	7.781	0.000***
I can easily see how different parts can form a new pattern.	4.07	0.53	4.73	0.49	4.716	0.000***

***: $p \leq 0.001$ (highly significant), **: $p \leq 0.01$ (moderately significant), *: $p \leq 0.05$ (significant)

The **Table 4** demonstrates statistically significant improvements in entrepreneurial skills among nursing students, indicating the course's effectiveness. Notable changes are seen in items such as "Persist in gaining objectives," which had the most significant mean increase of 2.00 ($p \leq 0.001$), reflecting a substantial enhancement in students' resilience and determination. Similarly, "Complete and consistent information" showed a significant mean increase of 1.54, highlighting improved attention to detail and thoroughness. Most items achieved high statistical significance at $p \leq 0.001$, validating the robustness of the observed changes. However, a few items, such as "Assist by lending a hand" ($p = 0.110$) and "Comfortable with pre-planned situations" ($p = 0.056$), did not show significant changes, suggesting areas for potential refinement. Overall, the results highlight the course's success in fostering critical entrepreneurial skills such as resilience, innovative thinking, and problem-solving, aligning with its objectives to prepare students for entrepreneurial challenges in the healthcare sector. These findings validate the course design while identifying opportunities for future improvement.

5. Summary of findings

The results indicate significant improvements in various entrepreneurial competencies, providing robust support for Hypothesis 1 and Hypothesis 2. Notable highlights include a substantial increase in students' ability to see the big picture and apply innovative solutions, underscoring the effectiveness of project-based learning methodologies aligned with InnoTVET principles. The mean scores reflect a notable shift toward a more entrepreneurial mindset, evidenced by significant changes in students' perspectives regarding their responsibilities and approaches to opportunities

and challenges. Furthermore, qualitative insights validate these findings, showcasing students' enhanced self-awareness, increased confidence in problem-solving abilities, a deeper understanding of market dynamics, and vocational education policy formation. These findings suggest that the course effectively enhanced students' entrepreneurial competencies, equipping them with essential skills to navigate the complexities of healthcare innovation.

6. Conclusion and discussion

The findings of this study strongly advocate for integrating InnoTVET principles into policy frameworks as a transformative approach to enhance the quality of vocational education. This study, focused on the nursing sector, demonstrates how the interplay between InnoTVET and methodologies like design thinking and the ISD framework can create a foundation for entrepreneurial and innovative competencies. The success observed in nursing education provides compelling evidence for policymakers to consider InnoTVET as a cornerstone for broader educational reforms.

InnoTVET's emphasis on innovation and entrepreneurship aligns perfectly with the demands of an evolving healthcare industry. Nursing students who engaged with InnoTVET-driven curricula developed critical competencies, including the ability to see the "big picture," create innovative solutions, and navigate complex market dynamics. These are not just abstract outcomes but tangible skills that position students as leaders in healthcare innovation. The study's results highlight measurable improvements in entrepreneurial mindsets. Therefore, when InnoTVET is embedded into vocational education, it catalyzes students' abilities to bridge theoretical knowledge with practical applications, particularly in interdisciplinary fields like healthcare.

The interplay between InnoTVET and the ISD framework deserves particular attention. The ISD framework, which provides a structured, student-centered approach, allows vocational educators to design courses that prioritize problem-solving, innovation, and inquiry-based learning. This synergy underscores the urgency of integrating InnoTVET principles into vocational policy, ensuring educators adopt these frameworks to foster entrepreneurial skills across all disciplines. The policy implications of this study are significant, in which it calls for a national mandate to institutionalize InnoTVET principles within vocational curricula, making entrepreneurial and innovative thinking core vocational education components. The nursing sector's success should serve as a model for other fields, demonstrating that entrepreneurial education is not limited to traditional business sectors but is critical for disciplines that demand practical, market-oriented solutions. Furthermore, policies must emphasize interdisciplinary learning to ensure students adapt to diverse and complex industry demands. For example, the study's integration of healthcare research, case studies, and design thinking exercises gave students a holistic perspective, enabling them to innovate in patient care and healthcare policy.

Policymakers must recognize that InnoTVET-driven vocational education is essential for enhancing Thailand's global competitiveness. In a rapidly changing global economy, producing a workforce with entrepreneurial and innovative capacities is desirable and necessary. This study demonstrates that by embedding InnoTVET

principles, Thailand can position its vocational education system as a benchmark for innovation, fostering graduates who can meet national and international challenges.

Incorporating InnoTVET into policy frameworks ensures that vocational education remains dynamic and responsive. As seen in this study, policies that prioritize evidence-based program design provide a clear roadmap for success. Regularly monitoring and evaluating these programs can sustain their relevance, ensuring continuous improvement and alignment with industry needs. Moreover, including assessment tools like the entrepreneurial quiz offers a practical means for evaluating the impact of these initiatives, providing actionable data to refine instructional strategies. The study's success in the nursing sector should inspire broader adoption of InnoTVET, proving that innovation and entrepreneurship are not confined to business sectors but are vital for healthcare and beyond. This approach challenges traditional notions of vocational education, demonstrating that it can be a powerful driver of interdisciplinary learning, innovation, and economic growth. By embedding InnoTVET principles into policy and practice, Thailand has the opportunity to lead a transformative shift in vocational education, producing a workforce that is skilled, visionary, adaptable, and equipped to shape the future.

7. Practical implications

The InnoTVET framework within vocational education, particularly in healthcare, emphasizes the need for policies supporting innovative teaching and learning methodologies. This study's findings reveal significant improvements in entrepreneurial competencies, showcasing the effectiveness of the ISD framework for mastery learning courses aimed at developing nursepreneurs. This approach's novelty lies in its alignment with global trends that prioritize entrepreneurial mindsets and the increasing demands for digitalization in vocational education. By integrating entrepreneurial skills with healthcare training, this study addresses contemporary workforce needs and prepares students to navigate an evolving landscape characterized by innovation and complex challenges.

1) The challenges faced in healthcare—such as the need for innovative solutions and universal relevance with an emphasis on entrepreneurship—are not confined to specific regions. As healthcare systems worldwide evolve, educators everywhere can benefit from integrating entrepreneurial skills into their curricula.
2) The emphasis on digitalization and entrepreneurial mindsets is a global trend. Many countries recognize the importance of preparing students for rapidly changing job markets, and educators can adopt similar frameworks to enhance their programs.
3) The InnoTVET framework and ISD model are adaptable to various educational contexts and can be tailored to meet local needs while still adhering to global best practices in vocational education.
4) Establishing partnerships between educational institutions and industry is a relevant strategy in any context. Collaborations can enhance the quality of education by providing students with real-world experiences and networking opportunities.
5) The need for expert assessment of student projects has yet to be conducted, future

course iterations are planned to validate further and refine the outcomes. This step will involve industry professionals and educators providing detailed evaluations of students' innovative solutions, ensuring alignment with real-world standards and enhancing the credibility of the findings.

By focusing on these practical implications, educators worldwide can enhance vocational programs and respond to the dynamic needs of their sectors and future challenges. Moreover, policymakers should consider establishing partnerships between educational institutions and healthcare organizations to facilitate real-world learning experiences, effectively bridging the gap between theory and practice. These collaborative efforts will ensure that vocational education remains responsive to the entrepreneurial needs of the healthcare sector while cultivating a new generation of healthcare innovators capable of driving positive change.

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Ethical approval: The study was conducted in compliance with international guidelines for human research protection, including the Declaration of Helsinki, the Belmont Report, the CIOMS Guidelines, and International Harmonization in Good Clinical Practice (ICH-GCP), as well as 45 CFR 46.101(b). It was exempted by the Kasetsart University Research Ethics Committee, with protocol code COE 67/095 and approval granted on 5 September 2024.

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