



Design Thinking for Fostering 21st-Century Skills Among Thai Public Health Undergraduates: A Design-based Research

Approach

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Abstract

Background: Design Thinking (DT) has gained increasing recognition in health professions education for its ability to foster key 21st-century skills such as creativity, critical thinking, collaboration, and adaptability. **Objective:** This study employed a Design-Based Research approach to develop and evaluate a Design Thinking (DT)-driven pedagogical innovation aimed at streamlining curriculum delivery while fostering 21st-century skills among Thai undergraduate public health students. **Methods:** The intervention was co-constructed with students, faculty, alumni, employers, and community stakeholders (December 2022–May 2023) and assessed using a one-group pretest-posttest design with paired-samples t-tests. A 15-week integrated prototype, implemented among 53 third-year students, restructured conventional lecture-based instruction into a hybrid ecosystem comprising interactive sessions, integrated modules, an autonomous Self-study Café, and field-based projects. Data were collected through self-administered questionnaires and after-action reviews (AARs) with students and instructors. The innovation reduced formal classroom contact hours by 21% without an apparent reduction in learning depth, based on qualitative feedback. **Results:** Findings revealed significant improvements across all six dimensions of 21st-century skills ($p < 0.001$, $d = 0.91–1.93$). Students' perceptions of teaching-learning management were significantly more positive under the integrated model than the traditional model ($p < 0.001$), with high overall satisfaction toward the prototype (mean 4.38–4.51). AARs findings indicated that reducing lecture-intensive content facilitated deeper engagement and greater student agency, while also reducing

academic anxiety and appearing to strengthen professional identity through authentic problem-solving. **Conclusion:** Findings align with Cognitive Load Theory, suggesting that reduced extraneous cognitive load facilitated higher-order learning. This DT-driven model constitutes a potentially viable framework for educational reform in health professions education, bridging theoretical knowledge and public health practice. Multi-site, longitudinal research is recommended to examine the model's scalability and sustained impact.

Keywords: Design-based research, Design thinking, Curriculum redesign, Active learning, 21st-century skills, Health professions education

What was Known

- DT is primarily taught as a subject rather than used as a curricular design framework.
- Health curricula often suffer from content overload, leading to high cognitive strain.
- A persistent gap exists between theoretical classroom learning and field-based practice.

What's New and Next

- Using design thinking as a framework to optimize curriculum efficiency and student agency.
- Reducing lecture hours enhances creativity and professional skills through generative learning.
- Future research should apply this model to diverse health professions using longitudinal data.

Introduction

The landscape of global health is becoming increasingly volatile, uncertain, and complex, demanding a fundamental shift in how future professionals are trained. In this era of rapid transformation, higher education must move beyond the traditional 'information-delivery' model toward a framework that cultivates a comprehensive suite of 21st-century competencies. The Partnership for 21st Century Learning ⁽¹⁾ categorizes these essential skills into three core domains: Learning and Innovation Skills (the 4Cs: critical thinking, communication, collaboration, and creativity), Information, Media, and Technology Skills, and Life and Career Skills. The urgency of this educational shift is further underscored by the World Economic Forum ⁽²⁾, which identifies these competencies, particularly analytical thinking, creative problem-solving, and adaptability as the primary drivers of success and resilience in a volatile, AI-integrated global labor market. For public health education, the challenge is twofold: students must not only master a vast body of evolving scientific knowledge but also develop the transformative competencies needed to navigate complex social systems and design resilient community solutions ⁽³⁾. However, despite international calls for

competency-based reforms, many curricula remain overcrowded with theoretical content, often at the expense of students' ability to apply their learning in authentic, real-world contexts.

Design Thinking (DT) has gained increasing recognition in health professions education for its ability to foster key 21st-century skills such as creativity, critical thinking, collaboration, and adaptability ^(4,5). Rooted in constructivist learning theory, DT shifts the educational focus from passive content reception to the active construction of knowledge through experience and reflection ⁽⁶⁾. By engaging students in an iterative process of empathy, ideation, and prototyping, DT fosters a deep understanding of complex issues through real-world problem-solving. Recent evidence in health professions education further supports this approach; a multi-institutional study demonstrated that DT-driven instruction significantly enhances students' creative confidence and their ability to navigate ambiguous, wicked problems in healthcare ⁽⁷⁾. Furthermore, DT provides a robust framework for addressing complex educational challenges, with research across various higher education actors demonstrating its positive impact on students' capacity for creative problem-solving ⁽⁸⁾. Current findings in dental education and systematic reviews further underscore its value in enhancing student engagement and reflective learning ⁽⁹⁻¹⁰⁾.

Similarly, the successful redesign of faculty development programs in clinical education illustrates how structured DT-based innovations can significantly improve teaching effectiveness and professional learner outcomes ⁽¹¹⁾. Despite its growing adoption, many educators remain uncertain about how to integrate DT effectively into their teaching practices. While DT has shown success in addressing context-specific challenges and promoting deeper learning, its systematic application within undergraduate public health curricula—particularly as a unified framework for developing 21st-century skills—remains limited. Existing empirical evaluations of DT in health professions and higher education have largely examined single, standalone courses ⁽⁸⁾, while broader narrative and systematic reviews ^(9,10) indicate that curriculum-level, multi-course implementations remain uncommon; the novelty of the present study lies in applying DT as a curriculum-level redesign framework spanning multiple integrated courses, rather than as a standalone teaching technique.

In Thailand, national and institutional policies have increasingly prioritized 21st-century skills development. At the study institution, data from the office of student affairs indicate a declining trend in student engagement in these activities, with average participation hours decreasing from 306 in 2019 to 78 in 2023, partly reflecting disruptions during the COVID-19 pandemic ⁽¹²⁾. As these activities

have historically been offered as voluntary, extracurricular add-ons rather than components of required coursework, this decline highlights the limitations of add-on delivery and points to the need for an integrated approach, embedded directly within the formal curriculum, that reduces the workload burden on both instructors and students. Addressing this gap, this study employs a Design-Based Research (DBR) framework to develop a DT-driven learning innovation ⁽¹³⁾. DBR was selected because it enables iterative co-design and refinement of the curriculum-level innovation with stakeholders across empathize, define, ideate, prototype, and test cycles, rather than simply testing a fixed, pre-specified intervention. This research contributes to the field by examining whether DT can serve as a structured framework to streamline curriculum delivery while supporting students' 21st-century competencies and pedagogical efficiency.

This study is significant in advancing competency-based public health education by examining how DT may function as a structured instructional framework to cultivate creativity, collaboration, and critical thinking within regular coursework. Beyond addressing a local institutional need, the findings offer transferable theoretical and practical insights for embedding DT into health professions education. By doing so, the study contributes to regional and global efforts to prepare future-ready graduates who can navigate the complexity and uncertainty of 21st-century health systems. Accordingly, this study aimed to develop and evaluate, using a DBR approach, a DT-driven integrated learning innovation for fostering 21st-century skills among Thai public health undergraduates.

Materials and Methods

This study employed a DBR approach to develop an integrated learning model based on the five-stage DT framework: empathize, define, ideate, prototype, and test ⁽⁵⁾ (Table 1). Within this DBR framework, the one-group pretest-posttest design served as the evaluative Test stage of the iterative DBR cycle, rather than as a separate study design. The study was conducted within the Bachelor of Public Health program at Mahidol University, Amnatcharoen Campus, Thailand

1. Participants

The study population comprised 53 third-year undergraduate students (81.1% female, $n = 43$) enrolled in the Bachelor of Public Health program during the second semester of the 2022 academic year. Instruction was delivered by an interdisciplinary team of five faculty members co-teaching three integrated subjects. Participants were selected through purposive sampling based on their enrollment in these three subjects, which occurred at the third-year curricular stage and were

designated for the redesigned curriculum. All 53 enrolled students participated throughout the study, with no refusals or withdrawals, and intervention fidelity was maintained through consistent facilitation by the same teaching team across all sessions.

2. Instruments

The research instruments comprised (1) a self-administered questionnaire and (2) an interview guideline for After Action Review (AAR) sessions, all reviewed by three content experts (item-level IOC = 0.7–1.0) with good reliability (Cronbach's alpha = 0.91–0.94). The details are described below.

A self-administered questionnaire: The 21st-century skills assessment scale, adapted from Panthumas et al.,⁽¹⁴⁾ comprised 20 items (Cronbach's alpha = 0.92). The teaching-learning management scale and the prototype-opinion questionnaire, consisting of 15 and 8 items respectively, were developed by the research team, yielding Cronbach's alpha coefficients of 0.94 and 0.91, respectively. All items used a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Interview guideline: An interview guideline was developed to facilitate two 45-minute AAR sessions, conducted with all 53 students and the five-member teaching team following the 15-week Test stage. These sessions focused on reflective inquiry, performance-enhancement areas, and shared experiences transitioning from traditional to integrated learning. Key discussion questions addressed the innovation's responsiveness to learner needs, the appropriateness of the learning experience design, its contribution to 21st-century skill development, and suggestions for improvement.

3. Data collection and Procedure

The Empathize and Define stages were conducted in December 2022; the Ideate and Prototype stages, from January to February 2023; and the Test stage, comprising the 15-week integrated implementation, March to May 2023. As detailed in Table 1, qualitative data for the Empathize and Ideate stages were collected through student, alumni, and employer surveys; four years of curriculum-review data; focus group discussions with instructors and students; and consultative meetings and co-creation workshops with faculty, academic administrators, and subject-matter experts. Quantitative data were collected via two self-administered questionnaires (10–15 minutes each). Before implementation, a 35-item questionnaire assessed students' 21st-century skills

and perceptions of teaching-learning practices under the conventional learning model. After implementation, a 43-item questionnaire assessed students' 21st-century skills, perceptions of the DT-driven integrated model, and overall appraisal of the prototype's effectiveness.

4. Data analysis

SPSS software, version 30, under the Mahidol University license, was utilized to conduct descriptive statistics. A paired-samples t-test was conducted to compare pre- and post-intervention scores, with statistical significance set at $p < 0.05$. Prior to conducting the paired-samples t-test, the normality of the score distributions was assessed using skewness (-2 to +2) and kurtosis (-7 to +7) criteria. In addition, Cohen's d was reported with the following effect size criteria: small (0.20-0.49), medium (0.50-0.79), and large (>0.80)⁽¹⁵⁾.

Data from interviews and focus group discussions were thematically analyzed. Two researchers independently coded transcripts and developed a codebook. Discrepancies were resolved through discussion, and codes were organized into themes. Preliminary findings were shared with five participants (two faculty and three students) for verification. Trustworthiness was further supported through investigator triangulation, achieved by independent coding and reflexive discussion between the two researchers throughout the analytic process.

Table 1 Description of the design thinking process in developing the integrated learning innovation

Stage	Description	Participants/ Data source	Expected result
Empathize	Gained a comprehensive understanding of challenges and unmet needs in the current integrated public health teaching-learning. Data sources included student feedback, alumni and employer surveys, four years of curriculum reviews, and focus group discussions with instructors and current students. Key limitations of traditional teaching and gaps in 21st-century skill development were identified.	Students, Faculty, Alumni, Employers	Identification of curricular gaps and stakeholder needs

Table 1 Description of the design thinking process in developing the integrated learning innovation
(Cont.)

Stage	Description	Participants/ Data source	Expected result
Define	Synthesized insights from the Empathize stage to articulate core problems, unmet needs, and areas for improvement in teaching-learning practices during the second semester of the 2022 academic year.	Researchers	A synthesized problem statement identifying the gap between academic instruction and professional requirements
Ideate	Conducted consultative meetings and co-creation workshops with faculty, academic administrators, and subject-matter experts to generate innovative and practical strategies for redesigning the learning process. Encouraged open discussion, knowledge sharing, and collaborative idea generation.	Faculty, Academic administrators, Experts	A set of feasible, stakeholder-endorsed strategies for restructuring the curriculum
Prototype	Developed the integrated learning model based on insights from the Ideate stage.	Researchers	A fully specified integrated learning model ready for implementation
Test	Implemented the prototype with public health students using a one-group pretest-posttest design. Quantitative data were collected via self-administered questionnaires, and qualitative feedback was gathered through after-action reviews (AAR).	Students, Teaching team	Empirical evidence of the model's impact on students' 21st-century skills and perceptions of teaching-learning management

Results

The development of the integrated learning innovation yielded specific findings at each stage of the DT process. In brief, the Empathize and Define stages identified curricular gaps and synthesized these into a clear problem statement; the Ideate stage produced a stakeholder-endorsed restructuring strategy; the Prototype stage yielded the integrated learning model itself; and the Test

stage produced empirical evidence of the model's impact on students' 21st-century skills, perceptions of teaching-learning management, and satisfaction with the prototype.

1. *Empathize (identifying curricular gaps)*: Stakeholder feedback identified critical challenges within the existing public health curriculum. Analysis revealed an over-reliance on traditional lecture-based instruction, which limited students' opportunities to cultivate essential 21st-century competencies, such as critical thinking, creativity, communication, and cross-cultural agility. This pedagogical approach also reduced active engagement and classroom participation. These curriculum-delivery concerns emerged primarily from current students and instructors through focus group discussions, whereas employers and alumni, through the Empathize-stage surveys, raised broader workplace-readiness concerns, specifically noting deficiencies in students' flexibility and practical application skills.

2. *Define (synthesizing the problem statement)*: These findings highlighted a distinct gap between academic instruction and professional requirements, underscoring the urgent need for a student-centered, competency-based curriculum designed for real-world complexity.

3. *Ideate (strategic curricular restructuring)*: To address the identified challenges, integrated learning strategies were developed to strengthen 21st-century skills and achieve the intended course learning outcomes. Core competencies were embedded into existing courses through active learning and field-based projects, while modules on health innovation promoted creativity and problem-solving. Guided by the 80/20 Pareto principle ⁽¹⁶⁾, course restructuring prioritized essential content and high-impact activities to maximize learning effectiveness. Student achievement was evaluated through a combination of individual course assessments (70%) and a collaborative field project (30%), that applying knowledge across three integrated courses. Additionally, real-world public health problems and fieldwork were introduced from the third year onward to progressively develop practical skills and enhance workforce readiness. Feedback from faculty consultations and co-creation workshops during this stage directly informed iterative refinements to the design, including the specific allocation of reclaimed lecture hours to the Self-study Café and the sequencing of integrated sessions before the prototype was finalized. The decision to combine these three courses was supported by the curriculum-review and stakeholder-consultation evidence gathered during the Empathize and Ideate stages, which identified shared course learning outcomes and overlapping field-based competencies across the three subjects.

4. *Prototype (the integrated learning model)*: The prototype was designed for third-year students enrolled in three typically separate courses totaling 120 hours over 15 weeks. Under the integrated learning model, 40 lecture hours were replaced with five 3-hour interdisciplinary sessions, reducing total lecture time to 95 hours, representing a 21% decrease. The reclaimed hours were allocated to a “Self-study Café,” where students engaged in collaborative group tasks guided by project advisors, and to integrative projects that applied knowledge across the three subjects. This design promoted out-of-class learning and fostered 21st-century skills through peer interaction, reflection, and self-directed exploration.

The prototype included four key components: 1) Course selection: courses were collaboratively redesigned to ensure coherence in content, skills, and assessment; 2) Pre-class planning: teaching teams aligned learning objectives, identified shared themes, and mapped competencies; 3) Class timeline: 10 regular sessions plus 5 integrated sessions blending theory and hands-on activities; 4) Self-study Café: five 2-hour sessions linked to integrated sessions, as illustrated in Figure 1 and Table 2.

As detailed in Table 2, the five integrated sessions and ~~their~~ linked self-study components followed a progressive sequence. At the outset (i1), shared course learning outcomes were presented, and students were assigned a community case for their field project. Sessions then progressed from field-based data collection with an interprofessional team (i5), to instruction on health innovation design (i6), expert-facilitated refinement of innovation drafts (i10), and finally presentation and handover of completed innovations to community stakeholders (i15). Each integrated session was paired with a corresponding Self-study Café session, in which students, guided by project advisors, prepared case data (s1), reflected on field-collection insights (s5), drafted innovations (s6), prepared application reports (s10), and completed final project reports with self- and peer-assessment (s15).

The instructor’s facilitation role evolved correspondingly: guiding tool application and case assignment (i1); supporting data collection and providing tailored content (i5); directing innovation-design instruction (i6); delivering structured feedback with invited experts (i10); and coordinating final presentation and handover to stakeholders (i15).

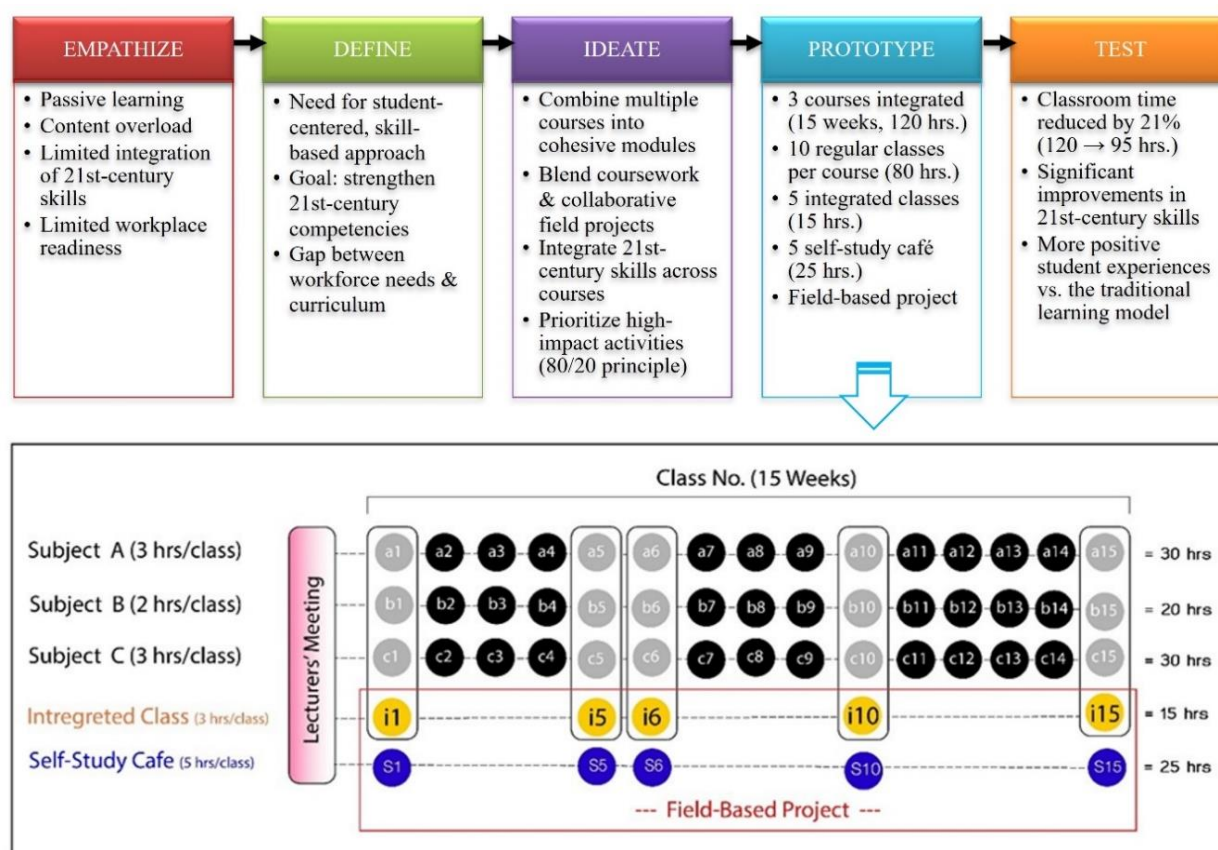


Figure 1 Flowchart of the study, key findings, and the integrated learning innovation

Table 2 Details of the integrated sessions and self-study café activities

Session	Description
i1	<i>In-class introduction:</i> The shared course learning outcomes (CLOs) of three courses were explicitly presented. Guided by the 80/20 Pareto principle, instruction focused on high-impact key concepts and essential tools. Students practiced applying these tools to prepare and plan effectively for fieldwork. Each group was assigned a case study for their field project.
s1	<i>Self-study preparation:</i> Each group reviewed its assigned case and developed a plan to collect additional community data, with guidance and support from a project advisor.
i5	<i>Field-based data collection:</i> Each group collected data on their assigned case in collaboration with instructors and an interprofessional team. Students presented challenges encountered, shared information, analyzed collected data, and identified the root causes of problems. Instructors provided additional content tailored to students' emerging needs and interests.
s5	<i>Reflection and exchange:</i> Students prepared presentations to share challenges and insights derived from their field data collection activities.

Table 2 Details of the integrated sessions and self-study café activities (Cont.)

Session	Description
i6	<i>In-class problem-solving:</i> Instruction focused on designing innovations to address diverse health problems. Each group brainstormed potential solutions and drafted ideas for health innovations targeting the issues identified in i5.
s6	<i>Draft health innovation preparation:</i> Students prepared presentations of their brainstorming outcomes and initial drafts of their health innovations.
i10	<i>Innovation draft refinement:</i> Each group presented its health innovation draft to relevant experts and instructors, receiving constructive feedback and additional content. Students refined their innovations and applied them to assigned community case studies.
s10	<i>Innovation application report:</i> Students prepared presentations summarizing the results of applying their innovations, including any subsequent modifications.
i15	<i>Final presentation and handover:</i> Each group delivered a presentation of their health innovations and application results to experts, instructors, and relevant stakeholders. This was followed by reflective discussion, synthesis of learning outcomes, and formal handover of the innovation to the community.
s15	<i>Final report and assessment:</i> Students completed and submitted their comprehensive project reports and conducted self-assessments and peer-assessments of their group members' contributions.

5. *Test (evaluation of the learning innovation):* Following the implementation of the DT-driven integrated model, the evaluation phase focused on measuring its impact on student competencies and pedagogical efficiency.

Impact on 21st-century skills: As data collection was embedded within regular, registered coursework, all 53 participants completed both the pre- and post-intervention questionnaires with no missing responses. The findings revealed a significant increase in the overall mean score from 68.87 to 85.26, with this difference being statistically significant ($p < 0.001$). This improvement corresponded to a substantial effect size, Cohen's $d = 1.69$, indicating a large (Table 3).

Pedagogical efficiency and student experience: The study highlighted significant pedagogical efficiency, achieving a 21% reduction in formal lecture hours (from 120 to 95) without lowering academic standards. Impressively, all participants met the prescribed Course Learning Outcomes

(CLOs), indicating that the DT-driven model effectively optimized learning while preserving essential content mastery.

Additionally, students reported significantly more positive experiences with the integrated learning model compared to the traditional approach ($p < 0.001$, Table 4). Elevated satisfaction levels were further confirmed by post-intervention mean scores ranging from 4.38 to 4.51 (Table 5), with students emphasizing the importance of the interdisciplinary field-based projects. Among the individual items, overall satisfaction with the program (item 8, mean 4.51) and perceived applicability to future practice (item 2, mean 4.47) received the highest ratings, while perceptions of program duration (item 6, mean 4.38) received the lowest.

Table 3 Comparison of 21st-century skills mean scores between pretest and posttest (n = 53)

Dimensions of 21st-century skills	Number of items	Pre-test Mean (SD)	Post-test Mean (SD)	t (df)	p-value	Cohen's d
Overall, the 21st-Century	20	68.87 (8.35)	85.26 (10.92)	8.16 (52)	<0.001	1.69
-Creativity and Innovation	3	9.13 (1.53)	12.62 (2.06)	9.46 (52)	<0.001	1.93
-Critical Thinking & Problem-solving	3	10.73 (1.73)	12.73 (1.81)	5.29 (52)	<0.001	1.13
-Communication & Collaboration	3	10.55 (1.73)	13.11 (1.65)	7.71 (52)	<0.001	1.51
-Information, Media, & Technology	5	17.24 (2.90)	20.19 (3.54)	4.53 (52)	<0.001	0.91
-Initiative and Self-direction	3	10.15 (1.63)	13.15 (1.93)	8.17 (52)	<0.001	1.68
-Social & Cross-cultural	3	11.17 (1.73)	13.45 (1.81)	6.24 (52)	<0.001	1.29

Note. SD, standard deviation; p-value of paired-samples t-test; t, t-values; df, degrees of freedom; Cohen's d for paired data was calculated as the mean difference divided by the pooled standard deviation of the pre- and post-test scores

Table 4 Comparison of students' perceptions of teaching-learning management for 21st-century skills between traditional and integrated learning models (n = 53)

Dimensions of Teaching-Learning Management	Number of items	Traditional Mean (SD)	Integrated Mean (SD)	t(df)	p-value
Overall	15	50.00 (3.97)	64.43 (7.78)	11.28 (52)	<0.001
- Active Learning	5	16.64 (1.84)	21.26 (2.57)	9.84 (52)	<0.001
- Effective Teaching	5	16.90 (1.86)	21.77 (3.02)	10.74 (52)	<0.001
- Learning Environment	5	16.45 (1.65)	21.40 (2.82)	10.43 (52)	<0.001

Note. SD, standard deviation; p-value of paired-samples t-test; t, t-values; df, degrees of freedom

Table 5 Student opinions on the integrated learning model prototype (n=53)

Items	Mean (SD)
1. I gained new knowledge, concepts, skills, and experiences from participating in this program.	4.41 (0.53)
2. I can apply what I learned in this program to my current studies, future profession, or work practices.	4.47 (0.50)
3. The outcomes of this program met my expectations.	4.41 (0.60)
4. The instructional format facilitated more practical and applicable learning compared with traditional classroom methods.	4.45 (0.57)
5. The content and activities were conducive to learning and supported the development of my competencies.	4.45 (0.54)
6. The program duration was appropriate.	4.38 (0.69)
7. The instructors/facilitators effectively conveyed knowledge and supported my learning.	4.43 (0.60)
8. I am satisfied with the overall quality and experience of the program.	4.51 (0.50)

Note. SD, standard deviation

During the AAR sessions, students' reflections revealed three central themes that aligned with the observed statistical improvements:

Reduced content fatigue and cognitive ease. Students reported being less "overwhelmed by theoretical data" compared to traditional formats. The streamlined curriculum provided the "cognitive space" necessary for "meaningful application," reducing "content-heavy" lectures and academic anxiety while prioritizing "deeper understanding rather than rote memorization." This qualitative theme aligns with the quantitative gains observed in the Information, Media, and Technology and Initiative and Self-direction subscales, both of which depend on students' capacity to process and apply content independently rather than passively receive it.

Enhanced agency and professional identity. Participants described a "newfound sense of ownership" over their learning, including "practicing leadership and followership in team collaboration" and a shift from passive learners to "proactive health innovators" with "professional responsibility." As one student reflected, "Before, I didn't know what I could do with my knowledge as a public health professional. After hands-on practice, I felt more confident, valuable, and skilled, especially when seeing the smiles of the service recipients we helped." Students also linked this ownership to fair,

developmental assessment: “This kind of grading is good and also helps us develop ourselves. The workload was a bit heavy, but we did our best, and when the results came out and the service recipients liked it, we felt proud.” This theme corresponds to the quantitative gains in the Initiative and Self-direction and Communication and Collaboration subscales.

Authentic problem-solving and interdisciplinary practice. The model effectively broke down “academic silos” through “learning beyond the classroom through hands-on field practice.” Students emphasized “applying knowledge from multiple disciplines” to design programs for “complex issues across different age groups,” successfully “bridging the gap between classroom theory and community health practice.” One student summarized this shift: “We learned together not just in the classroom but also through practical field experiences. The tasks were engaging and based on real-world data we gathered ourselves. This is the active learning we need, not just lectures.” This theme is consistent with the largest quantitative gains observed, in Creativity and Innovation and Communication and Collaboration, both of which are directly exercised through interdisciplinary field-based problem-solving.

In focus group interviews, most students (85%) considered the integrated learning innovation appropriate for three academic-year levels, while 10% suggested it could extend across four levels and 5% considered two levels sufficient. Students also proposed several refinements, including incorporating case studies from more diverse age groups, extending field-practice durations, assigning a dedicated faculty advisor to each group, and having instructors join field activities directly.

Discussion

The integrated learning innovation developed through the DT framework effectively reduced classroom hours by 21% while significantly enhancing 21st-century skills. Time saved from lectures was reallocated to active learning modalities, including integrated classrooms, a Self-study Café, and field-based projects, resulting in greater learner motivation, teamwork, and confidence in addressing complex public health issues. This study advances beyond isolated workshops or single-course interventions ⁽⁸⁾ by implementing a systematic, curriculum-wide model over 15 weeks. Whereas those prior studies primarily reported short-term shifts in creative confidence within a single course or workshop, the present findings extend this evidence by showing sustained, curriculum-embedded gains across six distinct 21st-century skill dimensions over a full academic term. By actively engaging stakeholders during the empathize and define phases, the researchers ensured the curriculum’s

contextual relevance to real-world challenges⁽¹⁷⁾. The profound shift in students' perceptions reflected in their notably more positive experiences compared to the traditional approach, demonstrates that the redesign fundamentally transformed the learning journey. Students did not merely perceive the model as a change in format but as a meaningful bridge to their professional identity; as Kyriakopoulou⁽¹⁸⁾ suggests, such deep engagement arises when interactions with tasks, peers, and the environment are intentionally designed to foster agency.

This successful optimization of instructional time can be fundamentally explained through Cognitive Load Theory⁽¹⁹⁾, where the DT framework functioned as the primary instructional design tool. Rather than being a subject of study for students, DT was employed by the researchers to empathize with learner needs and prototype a streamlined curriculum. By applying the 80/20 Pareto Principle⁽¹⁶⁾, instructional delivery focused on the "vital few" core concepts that drive the majority of professional outcomes. This strategic reduction effectively minimized extraneous cognitive load, the mental effort spent on processing non-essential information and created the necessary "cognitive breathing room" for generative learning⁽²⁰⁾. Consequently, by freeing students' mental capacity, the DT-driven design enabled a transition from passive recipients of information to active agents of knowledge construction. It should be noted that cognitive load was not directly measured in this study, and the Cognitive Load Theory explanation is therefore offered as a plausible theoretical interpretation rather than an empirically verified mechanism. The high post-intervention satisfaction scores further confirm this, with students especially appreciating the interdisciplinary nature of field-based projects. This suggests that teaching effectiveness remained strong despite the decrease in formal instruction.

While the intervention was evaluated as a single integrated package, some intervention components plausibly contributed more to specific competency gains than others. The field-based data-collection session (i5), which required direct engagement with an interprofessional team and community stakeholders, likely contributed most to the gains observed in Communication and Collaboration. The innovation-design and refinement sessions (i6 and i10), which asked students to brainstorm and iteratively refine solutions to health problems, likely contributed most to the gains in Creativity and Innovation, the dimension with the largest effect size observed. This attribution is interpretive rather than causally tested, as the study design did not permit isolating the effect of individual sessions.

Furthermore, the structured sequence of activities served as the necessary scaffolding to redirect mental capacity toward germane load, the deep processing required for building complex mental models. Qualitative insights from the AARs confirmed that this design fostered a sense of “learning ownership” and agency, empowering students to take intentional action ⁽²¹⁾. The “fail-fast” philosophy embedded in the sessions created a psychologically safe, “safe-to-fail” environment, allowing students to experiment without fear of penalty, which was associated with measurable improvements in creativity and initiative. Such a culture confirms that DT is a powerful framework for fostering adaptive expertise in health professions education ^(22,23,24).

Beyond its measured outcomes, the DBR process generated transferable design knowledge: stakeholder feedback during the Ideate stage reshaped the balance between in-class sessions and Self-study Café time, illustrating how iterative co-design can calibrate the ratio of structured instruction to autonomous learning more generally in curriculum redesign. As one instructor summarized, “We identified effective methods to combine hard and soft skills learning, such as innovation or project-based approaches using the DT framework, academic-professional workshops (Labinar), guided self-study sessions with teachers (Self-study Café), and external showcases.” Scaling this model institutionally would require administrative flexibility in course scheduling, faculty training in DT facilitation, and sustained co-design partnerships with community stakeholders to maintain the authenticity of field-based projects.

More broadly, this stakeholder-driven, iterative approach to curriculum redesign is consistent with recommendations from the wider competency-based education literature, which emphasizes structured stakeholder engagement in competency framework development ⁽²⁶⁾ and identifies curriculum design, teaching methods, and assessment as the key domains requiring alignment when transitioning health professions curricula toward competency-based education ⁽²⁷⁾.

Ultimately, embedding these competencies within the formal curriculum addresses the persistent “theory-practice gap” in health professions education. As noted by Tambunan ⁽²⁵⁾, the disconnect between classroom theories and field realities remains a primary challenge. To mitigate this, DT serves as a vital bridge, shifting the pedagogical focus from theoretical knowledge toward innovative applications ⁽²²⁾. By integrating immersive, field-based tasks directly into the core syllabus, 21st-century skills are internalized as academic requirements rather than optional extras. This alignment with experiential learning principles ⁽⁶⁾ provides a scalable foundation for sustainable

educational reform, fostering graduates who are truly ready for the complexities of modern public health practice ⁽¹⁰⁾.

Key strengths of this study include its DBR approach, the co-design of the curriculum with student, faculty, and community stakeholders, and the integration of quantitative and qualitative evidence to evaluate the innovation. While this study demonstrates the significant efficacy of a DT-driven curriculum, several limitations should be acknowledged. First, the sample size was relatively small and limited to a single institution, which may affect the generalizability of the findings. Second, because a comparison group was not feasible within the existing curriculum structure, alternative explanations for the observed improvements—such as maturation, testing effects, and the Hawthorne effect—cannot be ruled out, and findings should be interpreted as associated with, rather than definitively caused by, the intervention. Third, while the 21% reduction in lecture hours proved beneficial, the optimal balance between formal instruction and autonomous learning may vary across different health disciplines. Future research should employ multi-center, longitudinal designs to evaluate long-term skill retention.

Conclusion

This study suggests that streamlining curricula through DT does not compromise quality and may enhance 21st-century skills. By applying the 80/20 Pareto Principle to focus on “the vital few” core concepts, the 21% reduction in lecture hours successfully minimized extraneous cognitive load, reallocating time toward immersive field-based projects and the Self-study Café. These findings underscore that within a psychologically safe, “safe-to-fail” environment, students demonstrated substantial gains in creativity and self-direction. Ultimately, this DT-driven model may offer a potential framework for bridging the theory-practice gap and fostering adaptive expertise in modern public health education. By strengthening these educational competencies, this model has the potential to contribute to future public health practice and improved community health outcomes.

Practical Recommendations

- 1) Curriculum shift: Institutions should transition from content-heavy models to interdisciplinary curricula, focusing on core concepts while prioritizing authentic, field-based learning.
- 2) Facilitative spaces: Establish autonomous learning environments like the Self-study Café, where educators act as facilitators to scaffold student agency.

3) Assessment reform: Shift from rote memorization toward evaluating problem-solving processes and the synthesis of knowledge through real-world projects.

4) Systemic support: Scalable reform requires administrative flexibility, faculty training in DT, and a co-design approach involving students and community stakeholders. Within this systemic support, the instructor's evolving role from content deliverer to facilitator and field-based mentor emerged as a key enabling factor for the model, warranting deliberate faculty development attention.

Future studies should employ longitudinal tracking to assess the long-term retention of 21st-century skills and conduct multi-site validations to test the model's adaptability across diverse academic disciplines and cultural contexts.

Ethical Approval Statement

Ethical approval was obtained from the Human Research Ethics Committee of the Institute for Population and Social Research, Mahidol University (COA. No. 2022/09-187) on September 29, 2022 and January 3, 2023. All participants provided informed consent before their participation.

Author Contributions

SP and TC conceptualized the study. SP administered the project, curated the data, and acquired funding. SP and WK conducted the formal analysis and developed the methodology. SP and WK prepared the visualizations. SP and WK drafted the original manuscript. WS and TC critically reviewed and edited the manuscript. WK finalized the manuscript for submission.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Partnership for 21st Century Learning. Framework for 21st century learning definitions [Internet]. Battelle for Kids; 2019 [cited 2023 Jan 3]. Available from: https://www.battelleforkids.org/wp-content/uploads/2023/11/P21_Framework_DefinitionsBFK.pdf.
2. World Economic Forum. The future of jobs report 2023 [Internet]. 2023 [cited 2023 Apr 30]. Available from: <https://www.weforum.org/reports/the-future-of-jobs-report-2023/>.
3. Organisation for Economic Co-operation and Development. The future of education and skills: Education 2030 [Internet]. Paris: OECD Publishing; 2018 [cited 2023 Jan 20]. DOI:10.1787/54ac7020-en
4. Swallow D, Tomalin B. Design thinking in education: a paradigm shift in language learning. *Train Lang Cult*. 2024;8(4):86-94.
5. Stanford University Institute of Design. An introduction to design thinking: process guide [Internet]. Stanford: Hasso Plattner Institute of Design; 2010 [cited 2023 Dec 30]. Available from: <https://alnap.org/help-library/resources/an-introduction-to-design-thinking-process-guide/>.
6. Kolb DA. *Experiential learning: experience as the source of learning and development*. Englewood Cliffs (NJ): Prentice-Hall; 1984.
7. McLaughlin JE, Chen E, Lake D, Guo W, Skywark ER, Chernik A, et al. Design thinking teaching and learning in higher education: experiences across four universities. *PLoS One*. 2022;17(3):e0265902. DOI:10.1371/journal.pone.0265902
8. Guaman-Quintanilla S, Everaert P, Chiluiza K, Valcke M. Impact of design thinking in higher education: a multi-actor perspective on problem solving and creativity. *International Journal of Technology and Design Education*. 2023;33:217–40. DOI:10.1007/s10798-021-09727-z
9. Alvarado LF. Design thinking as an active teaching methodology in higher education: a systematic review. *Front Educ (Lausanne)*. 2025;10:1462938. DOI:10.3389/feduc.2025.1462938
10. Chuenjitwongsa S, Amir LR, Jessani A, Samaranayake LP, Osathanon T. Integrating design thinking into dental education. *Front Oral Health*. 2025;6:1547335. DOI:10.3389/froh.2025.1547335
11. Mustika R, Greviana N, Kusumoningrum DA, Pinasthika A. Redesigning a faculty development program for clinical teachers in Indonesia: a before-and-after study. *J Educ Eval Health Prof*. 2024;21:14. DOI:10.3352/jeehp.2024.21.14

12. Mahidol University, Amnatcharoen Campus, Office of Student Affairs. Annual report on student engagement in 21st-century skills activities, academic years 2019–2023. (In Thai).
13. McKenney S, Reeves TC. Conducting educational design research. 2nd ed. London: Routledge; 2018.
14. Panthumas S, Zaw K, Kittipichai W. Validation of the 21st century skills assessment scale for public health students in Thailand: a methodological study. *J Educ Eval Health Prof.* 2024;21:37. DOI:10.3352/jeehp.2024.21.37
15. Cohen J. A power primer. *Psychol. Bull.* 1992;112(1):155–59. DOI:10.1037/0033-2909.112.1.155
16. Koch R. The 80/20 principle: the secret of achieving more with less. London: Doubleday; 1998.
17. Abookire S, Plover C, Frasso R, Ku B. Health design thinking: an innovative approach in public health to defining problems and finding solutions. *Front Public Health.* 2020;8:459. DOI:10.3389/fpubh.2020.00459
18. Kyriakopoulou N. Reconceptualizing momentary engagement through the lens of conceptual change learning. *Frontline Learn Research.* 2025;13(2):122–30. DOI:10.14786/flr.v13i2.1587.
19. Sweller J. Cognitive load theory and individual differences. *Learn Individ Differ.* 2024;110:102423. DOI:10.1016/j.lindif.2024.102423
20. Mayer RE, Fiorella L, editors. The Cambridge handbook of multimedia learning. 3rd ed. Cambridge: Cambridge University Press; 2022. DOI:10.1017/9781108894333
21. Inouye K, Lee S, Oldac YI. A systematic review of student agency in international higher education. *High Educ.* 2023;86(4):891–911. DOI:10.1007/s10734-022-00952-3
22. Hajduk I, Nordberg A, Rainio E. Design thinking in healthcare education. In: Pakarinen A, Lemström T, Rainio E, Siirala E, editors. Design thinking in healthcare: from problem to innovative solutions. Cham: Springer; 2023. p.37–62. DOI:10.1007/978-3-031-24510-7_4
23. Kirschner PA, Hendrick C. How learning happens: seminal works in educational psychology and what they mean in practice. 2nd ed. London: Routledge; 2024. DOI:10.4324/9781003395713
24. Wang CC. Using design thinking for interdisciplinary curriculum design and teaching: a case study in higher education. *Soc Sci Commun.* 2024;11:13. DOI:10.1057/s41599-024-02813-z

25. Tambunan EH. Theory-practice gap during clinical learning: a descriptive qualitative study of nursing students' experiences and perceptions. *J Caring Sci.* 2024;13(2):74–81.
DOI:10.34172/jcs.33251
26. Lepre B, Palermo C, Mansfield KJ, Beck EJ. Stakeholder engagement in competency framework development in health professions: a systematic review. *Front Med (Lausanne).* 2021;8:759848. DOI:10.3389/fmed.2021.759848
27. Mani ZA. Transitioning to competency-based education in nursing: a scoping review of curriculum review and revision strategies. *BMC Nurs.* 2025;24:1111.
DOI:10.1186/s12912-025-03319-y