

Research Article

GUIDELINES FOR ENHANCING DESIGN THINKING FOR STUDENT TEACHERS

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Abstract

The world in the VUCA era is characterized by rapid technological changes, which have significant impacts on all sectors, especially the education sector, which needs to address human development. In the era of VUCA, a new generation of student teachers must be instilled with the qualities of “design thinking” in order to design and develop learning programs that keep up with the changes. This research, thus, aims to 1) assess the need regarding design thinking in student teachers, 2) analyze the process of managing teaching programs under the teacher training curriculum to promote design thinking in student teachers, and 3) develop guidelines for enhancing design thinking in student teachers. The research is divided into 3 stages. The first stage is the analysis and exploration. The research samples comprise a total of 264 student teachers selected from random sampling. The data were obtained using a 5-level rating scale as an assessment tool to measure the qualities of design thinking in student teachers. Then, the needs were analyzed using the Modified Priority Needs Index (PNI_{modified}). The second stage is the analysis of the process of managing teaching programs under the teacher training curriculum by interviewing 8 student teachers. The last stage is the development of guidelines for enhancing design thinking in student teachers by summarizing and analyzing the research findings at each stage and allow the experts to assess the suitability of the guidelines and refine them. The research found the following: 1) student teachers demonstrated the needs to develop the qualities of design thinking in all aspects, with design thinking skills requiring development the most, followed by the design thinking mindset, and 2) the process of managing the teaching programs under the teacher training curriculum, which encompasses the process of managing teaching programs and the process of professional teaching training, did not adequately enhance design thinking in student teachers, and 3) the guidelines for enhancing design thinking in student teachers, namely the 6-point action by the curriculum provider, the 2-point action by the teachers, and the 2-point action by teacher mentors and schools.

Keywords: Design Thinking, Student Teachers, Guidelines, Needs Assessment

Introduction

There were many occurrences in Thailand and around the world during 2020 – 2023, which led to uncertainty, including the global economic jitters, PM 2.5 that has affected many countries around the world, international security, drought, and – also recently - COVID-19, which has had impacts on humans' physical and mental wellbeing as well as economies. These situations contribute to the "VUCA World" (Giles, 2018), which is characterized by rapid technological changes, competition in the business world, and domestic and international economies. All of these have significantly affected all sectors, especially education, which needs to take into account the impacts to address human development in the VUCA world.

An analytical World Economic Forum article (2023) concludes that the essential ability to prepare students for various situations and changes is design thinking. Design thinking is an individual's process of finding solutions to problems by exploring diverse ideas through collective brainstorming and find new ways to work with an emphasis on a human-centric approach in order to respond to an individual's needs within a particular context. Recently, design thinking has been adopted in education and promoted among executives, teachers, and relevant personnel. Document searches found that manuals, research articles, academic articles, and books place put an interest on the notions of "design thinking schools", "design thinking teaches", and "design thinking classrooms". (IDEO, 2012; Luka, 2014; Wrigley & Straker, 2017)

In addition, design thinking is an approach to address problems and finding solutions, as well as creating new innovations that are in line with technologies and changing social contexts. Innovation is an important factor in driving society in the new era, influences development, and serves societal needs at the national and international levels. This is a key mission serves the Master Plan under National Strategy on Research and Innovation Development (B.E. 2561 – 2580), which underscores the promotion of innovation development that covers all aspects, and the National Scheme of Education (B.E. 2560 – 2579), Strategy 2: Development of research and innovation workforce to enhance national competitiveness.

The results of using design thinking in managing the teaching programs in other countries show that teachers found design thinking in the teaching programs to be beneficial to students. Each stage of design thinking led to positive skills and qualities, helped change students' old ways of thinking, and influenced new and different ways of thinking (Retna, 2016). Moreover, according to a study by Rhinow et al. (2012), design thinking helped students form new knowledge on their own, in line with the constructivist theory, which leads to effective learning. A study by Rojsangrat (2016) is also in consistent with a study by Lloyd (2013), which suggests that design thinking teaching helps students gain creativity skills as well as leads to systematic problem solving.

Studies in the past did not show clear data on the enhancement of design thinking in student teachers, even though they are the subject of the teacher training curriculum, which is aimed at develop learners, as learning in the digital era has changed radically. Traditional way of teaching management is, thus, not in keeping with technological and communication advance. The new generation of students and teachers

must be instilled with the idea of using design thinking in designing teaching programs and form new knowledge to develop or find new ways to address problems (Chatuporn & Wongwanich, 2022).

As for the encouragement to use design thinking in Thailand, there are mostly personnel development courses in the business sector. There haven't been evidence that design thinking is adopted in the education sector. For that reason, the topics in that research aim to provide answers on the needs regarding design thinking in student teachers to yield findings that address the needs in various aspects and analyze the process of managing teaching programs under the teacher training curriculum, which will lead to the development of guidelines for enhancing design thinking for student teachers. This will prepare them for the role of in-service teachers who can use design thinking in class to help students achieve excellence or desired behavior.

Objectives

1. To assess the needs regarding design thinking in student teachers
2. To analyze the process of managing teaching programs under the teacher training curriculum to enhance design thinking
3. To develop guidelines for enhancing design thinking for student teachers

Methodology

Stage 1: The analysis and exploration of the needs regarding design thinking in student teachers

1. Research samples

The research samples are fourth-year student teachers currently studying in the Faculty of Education, Chulalongkorn University, and have completed the professional teaching training as required by the Bachelor of Education curriculum, Academic Year 2023. The researcher determined the sample size using the G*Power program and set the effect size at 0.25, the alpha value at 0.05, and the power value at 0.95. The sample size obtained is the minimum of 125 individuals. Previous studies that collected data on student teachers found that the response rate is about 40 – 70%. Therefore, the researcher doubled the sample size for this study to 250 individuals using stratified random sampling. The research randomly selected student teachers from each of the 11 disciplines, with each discipline consisting of 24 students. The result is a total research sample of 264 students.

2. Variables and research tools

The research tools used for this research at this stage is a quantitative data collection tool. The design thinking teacher rating scale was developed from the concepts by Chatuporn and Wongwanich (2022) and was used to collect data for the analysis of the needs regarding the design thinking mindset and design thinking skills, with the operational definition of variables and the content structure of measurement determined as follows:

2.1 Variable definitions

Design thinking refers to the attributes of individuals who are design thinkers and use the design thinking concept in their teaching management consists of 2 elements as follows:

1) Design thinking mindset refers to the perceptions and beliefs regarding problem solving and the use of design thinking in problem solving. It comprises 3 principles as follows:

1.1) Human centeredness and empathy (students are at the center of problem solving) are fundamental aspects of finding solutions that are relevant to the problems and students' actual needs.

1.2) Collaboration is the act of individuals with diverse thoughts and experiences coming together to collaborate, interacting with one another, learning and exchanging perspectives, and forming new ways and approaches to problem solving.

1.3) Creative confidence and optimism encompass the belief in the power of creativity and doing new things without the fear of failure. It's the readiness to start learning and innovating with the belief the innovation will be more effective than ever.

2) Design thinking skills refer to the ability to solve problems or carry out work using design thinking. They comprise 4 elements, as follows:

2.1) The skill to prepare information, knowledge, and experience needed to work on the process of design thinking.

2.2) The skill to observe, collect data, analyze data, and synthesize data needed as part of the design thinking process.

2.3) The skill to use tools, techniques, and methods to work collaboratively.

2.4) The skill to present, summarize points, and communicate thoughts during the process of design thinking.

2.2 Research tools

The research tool is a design thinking teacher measurement divided into two parts: 1) general information of the questionnaire respondents and 2) the questionnaire for the measurement of two research variables, namely the design thinking mindset and the design thinking skills. The questionnaire is a 5-level Likert scale consisting of 16 items with a specification table as shown in Table 1.

Table 1*The structure of the measurement tool for assessing design thinking in student teachers*

Research variables	Number of questionnaire items
1. Design thinking mindset	6
1) Human centeredness and empathy	(2)
2) Collaboration	(2)
3) Creative confidence and optimism	(2)
2. Design thinking skills	10
1) The skill to prepare information, knowledge, and experience	(3)
2) The skill to observe, collect data, analyze data, and synthesize data	(3)
3) The skill to use tools, techniques, and methods to work collaboratively	(2)
4) The skill to present, summarize points, and communicate thoughts	(2)

2.3 Verifying the quality of tools

1) Verifying content validity

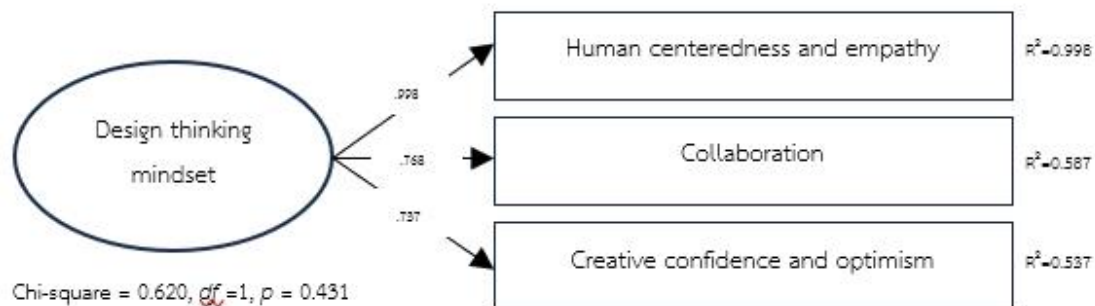
Content validity is verified by three relevant experts, two of whom are in the assessment field and another in development education. They verified content validity, the comprehensiveness of content, accuracy, and language clarity using the Item Objective Congruence (IOC) index, with an IOC score greater than 0.50 taken into consideration. The verification found that the IOC score of the instrument range 0.67 – 1.00

2) Verifying construct validity

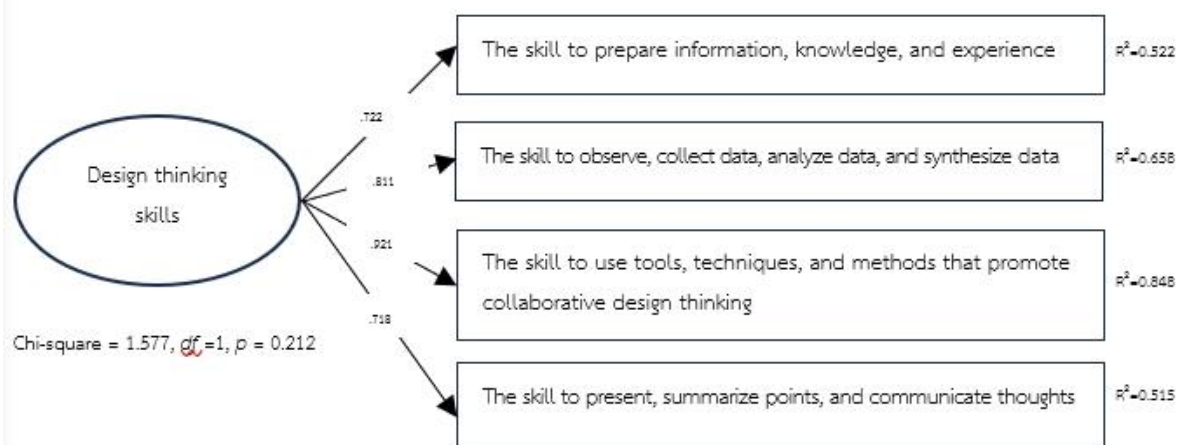
Verifying construct validity of the variables for the design thinking mindset and the design thinking skills was carried out by the confirmatory factor analysis using the MPLUS program in order to analyze the first-order confirmatory factors. The analysis found that research tools show construct validity. The theoretical variable measurement model is consistent with the empirical data. The analysis results are as follows:

Figure 1

The results of the analysis of confirmatory factor analysis for the design thinking mindset model

**Figure 2**

The results of the analysis of confirmatory factor analysis for the design thinking skills



3) Verifying reliability

Internal consistency reliability was verified using the revised questionnaire as suggested by experts. The questionnaire was then used with a non-research sample group of 30 persons. Cronbach's alpha coefficient was used. The result shows that reliability of the tools is high in all aspects, with a reliability range of 0.73 – 0.92, higher than the criteria where reliability must be greater than 0.70 (Nunnally & Bernstein, 1994), as shown in Table 2

Table 2*Reliability of the research instruments*

Research variables	No. of items	Reliability
1. Design thinking mindset	6	0.92
1) Human centeredness and empathy	2	0.83
2) Collaboration	2	0.80
3) Creative confidence and optimism	2	0.82
2. Design thinking skills	10	0.90
1) The skill to prepare information, knowledge, and experience	3	0.87
2) The skill to observe, collect data, analyze data, and synthesize data	3	0.82
3) The skill to use tools, techniques, and methods to work collaboratively	2	0.80
4) The skill to present, summarize points, and communicate thoughts	2	0.73

3. Data collection

The researcher coordinated with the teachers overseeing each discipline to inform them of the research objectives and request permission to collect data. The researcher appointed dates and times for data collection and collected data herself on the appointed date and time. The researcher sent the Google form link containing the questionnaire to student teachers and spent approximately a month collecting data.

4. Protection of the rights of the research samples

This research has been approved by the Human Research Ethics Committee, Multi-Institutional Group, Set 2: Social Sciences, Humanities, and Fine Arts, Chulalongkorn University. Research Project no. 670074. Certificate of Approval (COA) No.183/67, 11 April 2024.

5. Data analysis

The analysis of the needs regarding design thinking in student teachers covers the design thinking mindset and design thinking skills. The research identified the difference between the actual state (actuality) of the student teachers and their potential state (potentiality). Then, the differences of average scores are arranged in order using PNI_{modified} index. The needs will be considered from the PNI_{modified} index. The sequence of the needs is arranged from highest to lowest. The high-value index denotes the high level of needs and requires development more than the low-value index.

Stage 2: Analyzing the process of managing teaching programs under the teacher-training curriculum**1. Data provider**

Data providers are student teachers –fourth-year students – who answered the questionnaire as research samples. Convenience sampling was used and the criteria for student teachers' qualification are as follows: 1) they must be student teachers that consent to giving interviews, 2) they must be student teachers who are currently studying at the undergraduate level at the Faculty of Education, Chulalongkorn University,

and 3) they must be student teachers who have completed professional teaching training. The research brought together 8 student teachers who were willing to provide data. The determination of the number of data providers is in line with the approach of Nastasi & Schensul (2005), which specifies that there can be at least 10 data providers for case studies on specific topics. However, in case of data saturation, the number can go up or down.

2. Research instruments

The research tools are interviews on student teachers with an emphasis on questions regarding the process of managing teaching programs by the teacher training institutions and the problems encountered during the professional teaching training. The quality of interview questions was assessed by one senior teacher, who 1) has an academic rank of Assistant Professor or above and 2) has done research on topics related to that particular research. It was found that the interview questions are suitable for data collection.

3. Data collection

At this stage, the data were collected through one-on-one interviews with student teachers who had completed the professional teaching training. The researcher made an appointment in advance and sought cooperation on data collection from data providers. Data collection through interviews was carried out in April 2024. The interviews took about 30 – 40 minutes for each person.

4. Data analysis

Stage 2 of the research requires qualitative data analysis by reducing the amount of data obtained from the interviews. Then, content analysis was used to categorize data and determine the themes for the analysis of the process of managing teaching programs by the Faculty of Education, Chulalongkorn University, which are aimed at promoting design thinking in student teachers.

Stage 3 The development of guidelines to enhance design thinking in student teachers

1. Research tools

The research tools are a rating scale for assessing the suitability of the draft guidelines for enhancing design thinking in student teachers.

2. Data collection

Data collection began with a consultation with the senior teachers to select qualified experts in the teaching profession. The criteria for selecting 5 experts are as follows: 1) over 5 years of experience in teaching in the Faculty of Education and 2) over 5 years of experience in being mentor teachers to students. Then, the experts were asked to assess the suitability of the draft guidelines and provide suggestions. The questionnaire was sent out to the experts via email.

3. Data analysis

The data obtained from the assessment of the suitability of the draft guidelines by experts were analyzed using mean calculation. The criteria for interpreting the mean of the suitability were shown in Table 3.

Table 3

The criteria for interpreting the mean of the suitability of the guidelines for enhancing design thinking in education teachers

Mean levels	Definition
4.50 - 5.00	Most suitable
3.50 - 4.49	Very suitable
2.50 - 3.49	Moderately suitable
1.50 - 2.49	Not very suitable
1.00 - 1.49	Least suitable

Results

1. The results of assessing the needs regarding design thinking in student teachers

Student teachers show the need to develop design thinking in all aspects, with the design thinking skills requiring development the most, followed by the design thinking mindset.

Table 4

The results of assessing the needs regarding design thinking in student teachers

Design thinking	The mean of the potential state (I)	The mean of the actual state (D)	(I-D)	(I-D)/D	Order
1. Design thinking mindset	5.00	3.92	1.08	0.28	2
■ Human centeredness and empathy	5.00	3.94	1.06	0.27	2
■ Collaboration	5.00	4.00	1.00	0.25	3
■ Creative confidence and optimism	5.00	3.83	1.17	0.31	1
2. Design thinking skills	5.00	3.80	1.18	0.31	1
■ The skill to prepare information, knowledge, and experience	5.00	3.71	1.29	0.35	2
■ The skill to observe, collect data, analyze, and synthesize data	5.00	3.49	1.51	0.43	1
■ The skill to use tools, techniques, and methods to work collaboratively	5.00	3.89	1.11	0.29	3
■ The skill to present, summarize points, and communicate thoughts	5.00	4.09	0.81	0.20	4

* The full score of 5.00 is the criteria that student teachers should achieve (I)

When considering the sub-elements, element 1: the design thinking mindset of student teachers, it can be concluded that the sub-element of creative confidence and optimism needs development the most, followed by human centeredness and empathy, and collaboration, in that order. For element 2: the design thinking skills of student teachers, it can be concluded that the sub-element of the skill to observe, collect data, analyze data, and synthesize data needs development the most, followed by the skill to prepare information, knowledge, and experience; the skill to use tools, techniques, and methods to work collaboratively; and the skill to present, summarize points, and communicate thoughts, in that order. The range of the Priority Needs Index is 0.20 – 0.43.

2. The process of managing teaching programs under the teacher training curriculum

For the results of the interviews about student teachers' experiences on the process of managing teaching programs under the teacher training curriculum, the researcher analyzed the data from the interviews and arranged them based on the research variables, namely 1) the design thinking mindset and 2) the design thinking skills. The researcher also synthesized the data along with the research findings in Stage 1 to offer draft guidelines for enhancing design thinking in student teachers in the form of the following table.

Table 5

The results of data analysis and synthesis to form the draft guidelines

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
1. Design thinking mindset				
1.1 Human centeredness and empathy ($PNI_{mod} = 0.27$ denoting the need for development)	Student teachers haven't studied teaching methodology as much as they should, making it fairly difficult	<i>"...The Chemistry major contains the teaching methodology subject, which imagines a scenario where friends are students and I became a teacher. It's a very good subject, but it's only one course throughout the curriculum, which means that it</i>	Student teachers have studied a lot of teaching methodology to accrue more experiences of being an analytical teacher so they can get to know	1) The course should include teaching methodology subjects to help students assume the role of teachers and practice designing ways to solve student-related problems. Teachers in the class should stimulate the thinking process to help students

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
	to imagine themselves as teachers who analyze or understand students.	<i>doesn't allow us to train adequately, despite the course being very useful...</i> Student A, 22 April 2024	and understand students in a sufficient, profound way.	understand problems in the classroom in a profound way.
	The activities under Teaching Practicum 1 and 2 do not allow student teachers to participate in the schools as much as they should.	<i>"...I think Teaching Practicum 1 and 2 should be designed to be activities that allow us to participate more in schools. For example, an opportunity to talk with students to collect real-life data, or an opportunity to do something else beyond just observing ..."</i> Student C, 23 April 2024	Student teachers got to actively observe in the classroom to understand students and analyze the problems that occur in the actual classroom settings.	The curriculum should be designed in a way that Teaching Practicum 1* and Teaching Practicum 2* allow student teachers to make an active observation in the actual classroom settings to study the problems and the relevant contexts, so that they understand students adequately and profoundly.
1.2 Collaboration ($PNI_{mod} = 0.25$ denoting the needs for development)	Student teachers got only a few opportunities to study and work in group with peers from different disciplines or faculties.	<i>"...The Course Design subject is the only subject that put us with peers from other disciplines and allowed us to work with them in group. I like working with peers from different fields because we gained more new ideas from working. And when we had to design an integrated course, we didn't have</i>	Student teachers got the opportunity to do group activities, which could be assignments from various courses or university/faculty activities. This	1) Teachers should encourage student teachers to work in a collaborative way by designing activities within the courses in the form of challenging scenario-based tasks, so that student teachers learn that they won't succeed a task on their own within limited

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers’ problems	Examples of supportive data obtained from interviews with student teachers		
		<i>sufficient knowledge. So having friends from different disciplines really helps.” Student C, 23 April 2024</i>	helps them see the benefits of collaborating with different groups of people who help form new ideas and solutions to problem.	time constraints, as brainstorming is required. Using diverse skills inherent in each student teacher will help them solve problems successfully.
	Student teachers may not be able to manage problems that occur in the classrooms as effectively as they should. They still need to rely on cooperation from those involved to handle problems.	<i>“...During the teaching practice for Teaching Practicum 4, the problems found in the classroom each day were different. I was new and wanted to talk with the mentor, but the mentor should be experienced enough to teach us...” Student E, 24 April 2024</i>	Student teachers need to get advice from teacher mentors and supervisors.	2) Schools should select teacher mentors who have sufficient knowledge, skills, and experience to support the professional teaching training, generate new ideas, and inspire new ways to solve problems for student teachers. They should not hinder the development of teaching methods and student teachers’ self- improvement.

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
1.3 Creative confidence and optimism ($PNI_{mod} = 0.31$ denoting the need for development)	Some teachers and mentors are unable to inspire confidence in students to perform various tasks.	<i>"...I only practiced teaching with classmates for just one subject throughout the course and studied only one subject a week, even though I got an opportunity to teach in front of the class twice, it did not instill much confidence ..."</i> <i>Student D, 23 April 2024</i> <i>"...Teachers serve as a role model who build our confidence through constructive feedback, listen to us, and allow us to teach in the real-world settings. This allows us to be open with teachers. And teachers are the role model of an educator. However, not all teachers are like that."</i> <i>Student H, 26 April 2024</i>	Teachers and mentors are able to communicate positively to inspire confidence in student teachers, as well as encourage them to open up their perspectives by looking at their small achievements to enhance their confidence.	1) Teacher mentors and supervisors should play a role in communicating positively with student teachers and be able to analyze the difference between some student teachers and respond to them with understanding, as well as offer assistance with sincerity without comparing them, give harsh criticism, or become disillusioned with students' abilities.
2. Design thinking skills				
2.1 The skill to prepare information, knowledge, and experience	Things learned in the curriculum, such as forming	<i>"...During Teaching Practicum 3, we had to form lesson plans to teach in schools for 9 hours per week, but we'd recently started to learn the</i>	The sequencing of various courses in the curriculum should be in	1) Various courses in the curriculum should be sequenced in the way that correlates with one another in order to equip

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
($PNI_{mod} = 0.35$ denoting the need for improvement)	lesson plans and teaching simulations, may not translate directly to real-world applications in schools.	<i>teaching methodology course, which we learned to create plans ourselves, leaving us no time to digest what we learned before applying it..."</i> <i>Student D, 23 April 2567</i> <i>"...The Faculty has taught us a lot, but in terms of practical experience, especially in teaching, it's still lacking. We rarely got an opportunity to practice teaching. As for our understanding about writing lesson plans, I feel we're not as ready as we should be. I understand that each school should form different lesson plans, but today we don't know which criteria or necessary information goes into the plans..."</i> <i>Student F, 24 April 2024</i>	relation to the Teaching Practicum courses.	students with necessary skills, such as writing lesson plans and teaching methodology, prior to the actual teaching practice to help students handle different situations effectively.
	Selecting schools without taking their diverse contexts into	<i>"...Prior to practicing teaching in Teaching Practicum 4, I was quite concerned because from the experience in Teaching Practicum 3, we</i>	Student teachers got to practice professional teaching in various school	2) The curriculum should be designed to allow student teachers to learn about different contexts in at least 2 different schools

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
	consideration prevents student teachers from seeing the real-world settings. As a result, when they become teachers, they may struggle to adapt to real-life situations.	<i>made an observation in a mixed-gender school, but the actual teaching took place in an all-female school..."</i> <i>Student A, 22 April 2024</i> <i>"...In Teaching Practicum 1, we all did a job training at Chulalongkorn University Demonstration Secondary School, which personally I found to be a well-equipped school so we didn't get a multi-faceted experience. We should be taken to various places so that we get a more diverse picture of what it's like out there..."</i> <i>Student A, 22 April 2024</i>	and classroom contexts.	so that they understand the diversity of schools in various aspects, such as students, teachers and school management. This enables student teachers to handle the situations during the professional teaching training effectively.
2.2 The skill to observe, collect data, analyze data, and synthesize data (PNI _{mod} = 0.43 denoting the need for improvement)	The practice is insufficient and lacking of a correlation with the real-world settings, namely in schools.	<i>"...I'd like the courses for the semester that also includes Teaching Practicum 3 to be designed in the way that allows us to apply actual cases in the group work in class. This should help us develop observation skills and collect data for real-life analysis ..."</i>	The curriculum should stipulate that the courses taught in the same semester as Teaching Practicum are interconnected. For instance, Research, which is taught in the	1) The activities under the curriculum should be designed to be connected with Teaching Practicum taught in that semester to allow student teachers to apply what they've learned to the real-world environments and use the actual classroom data to form classroom lessons

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
		<i>Student A, 22 April 2024</i> <i>"..It's like we start from scratch because everything is different from what we learned, contextually..."</i> <i>Student A, 22 April 2024</i>	same semester as Teaching Practicum, can be designed in the way that allows student teachers to use real data to practice observation skills, data collection and data analysis.	and practice necessary skills, such as observation, data collection, and data synthesis. This will enable students to see the correlation between theory and practice.
2.3 The skill to use tools, techniques, and methods to work collaboratively (PNI _{mod} = 0.29 denoting the need for improvement)	Student teachers lack an understanding on selecting design thinking tools.	<i>"...My generation grows up with technology and went through COVID, which helps us understand the use of digital tools or techniques. But when it comes to traditional tools, such as creating exams, assessments, or evaluation criteria on paper, we're not proficient yet. We don't know anything about design thinking tools at all."</i> <i>Student H, 26 April 2024</i>	Student teachers have knowledge and understanding about using design thinking tools to promote participation.	1) Teachers should arrange the course activities or teacher-enhancement activities for the Faculty, with the aim of promoting the understanding of selecting design thinking tools, whether they are techniques, methodology (interview for empathy Context mapping 2x2 matrix "How might we...." Question) or documents created in different ways to promote participation.
2.4 The skill to present,	Student teachers will	<i>"...The Faculty trained us extensively to become</i>	Student teachers have practiced	1) The curriculum should allow student teachers to

Data from the research				
Stage 1 (Quantitative summary)	Stage 2 (Qualitative summary)		Potentiality (potential state) based on the obtained data	Draft guidelines
The results of the needs assessment	Summary of student teachers' problems	Examples of supportive data obtained from interviews with student teachers		
summarize points, and communicate thoughts ($PNI_{mod} = 0.20$ denoting the need for improvement)	gain more skills if they're trained under various contexts.	<i>teachers. We didn't have a lot of teaching methodology courses, but we were able to digest and simplify complex information. When I studied at other Faculties and watch other students present, they still read from the slides. But we've been trained to be teachers that make sense of what we have to say beforehand and convey it in an understandable way ..."</i> <i>Student B, 22 April 2024</i> <i>"...If we have the opportunity to teach across various educational levels, it will be more challenging and will enhance our skills..."</i> <i>Student H, 26 April 2024</i>	professional training in diverse classroom contexts.	organize activities with students in the real-world settings in schools with diverse contexts, so that students can learn to work at the actual school, which will help them enhance the presentation skills and communication and become professional teachers.

3. Guidelines for enhancing design thinking for student teachers

The result of the assessment of guidelines for enhancing design thinking in student teachers by experts can be summarized as follows:

Table 7

The result of the assessment of the guidelines for enhancing design thinking in student teaches by experts

Topics for assessment		Average score		Suggestions for revision
		By item	By aspect	
Clarity	1. Clear details	4.20 (High)		Details of activity examples should be included.
	2. Easy to understand	4.20 (High)	4.20 (High)	The organization of guideline content of each group should be divided into subgroups according to 3 relevant groups, which are 1) the action taken by the curriculum provider/faculty, and university 2) the action by teachers, and 3) the action by teacher mentors and schools.
Possibility of applicability	1. Applicable	4.40 (High)		The guidelines are applicable.
	2. Able to enhance design thinking in student teachers	4.60 (Very high)	4.50 (Very high)	The guidelines can enhance design thinking for student teachers.

The guidelines for enhancing design thinking for student teachers are divided into 3 relevant groups as follows:

3.1 The action carried out by the curriculum provider, Faculty, and University

1) Course activities under the curriculum should be designed to be related to Teaching Practicum in that particular semester, so that student teachers have the opportunity to apply what they have learned in the real-world settings and use the data in the real-world settings to create classroom lessons and train prerequisite skills, such as observation, data collection, and data synthesis. This enables student teachers to see the correlation between theory and practice.

2) Each course under the curriculum should be related to one another, so that student teachers are well-equipped to have necessary skills, such as writing lesson plans and teaching methodology prior to doing the actual teaching. This helps student teachers handle different situations.

3) The curriculum should allow student teachers to have an experience in studying diverse school contexts in at least 2 different schools, so that they see various aspects at schools, such as students,

teachers, and internal management. Student teachers will be able to better handle different situations during the professional teaching training.

4) The curriculum should include courses on teaching methodology that enables students to practice being teachers and design proper ways to solve student-related problems. Teachers should stimulate the thinking process so that student teachers learn to understand the problems that occurs in the classroom in a profound way.

5) Teaching Practicum 1 and 2 under the curriculum should be designed with an emphasis on allowing student teachers to participate in observing the actual classroom, so they see the problems and the related contexts. This helps them understand students adequately and profoundly, before they can design solutions to problems for students in a proper way.

6) The curriculum should offer student teachers an experience to organize activities with students in the real-world environments, such as organizing short-term activities in class, teaching one subject, teaching for half a day, and teaching full day. The schools chosen in different semesters should be contextually different, so that student teachers learn how to work in the actual schools to increase presentation skills and communication, which in turn will help them become proficient and professional.

3.2 Action by teachers

1) Teachers should organize activities under the curriculum or teacher-enhancement activities for teachers at the Faculty to promote understanding on the selection of design thinking tools, which could be techniques or methodology, such as interview for empathy Context mapping 2x2 matrix “How might we.....” Question, or documents created in different ways to promote participation.

2) Teachers should let student teachers work in a collaborative way by including challenging scenario-based tasks in a subject, so that student teachers feel that working alone under time constraints will not be successful as brainstorming is required. Using different skillsets inherent in each student teacher will instead bring success to problem solving.

3.3 Action by teacher mentors and schools

1) Teacher mentors and supervisors should play a role in communicating positively with student teachers, analyze the differences among student teachers and respond with understanding, assist with sincerity and without comparing or giving harsh criticism, or become disillusioned with their abilities.

2) Schools should select teacher mentors that are knowledgeable, skilled, and experienced enough to ensure the professional teaching training for student teachers goes smoothly, help inspire new problem solving ideas for student teachers, doesn't hinder ideas to improve teaching, and promote student teachers' self-development.

Discussions

1. The needs of student teachers regarding design thinking

The research findings suggest that student teachers need to improve the design thinking qualities in all aspects, with the need to develop the design thinking skills the most, followed by the design thinking mindset. This demonstrates that student teachers show a proper design thinking mindset, but they still need to develop design thinking skills as the training is insufficient and the correlation between practice and the actual school settings is lacking. This is in consistent with Anderson (2012), who suggests that design thinking is directly linked to humans and everyone has the ability to design think, but developing the design thinking skills depends on training and application.

When considering the sub-elements, Element 1: the design thinking mindset of student teachers, it can be concluded that the sub-element of creative confidence and optimism needs development the most, followed by human-centeredness and empathy, and collaboration, in that order, as student teachers are in their Bachelor level, which can be demanding in terms of the assignments in each class, teachers, the responsibility of self-studying, and the expectation to finish university to find a job later. This environment is not conducive to building creative confidence and optimism, in consistent with the finding by Rauth et al. (2010), who suggest that certain educational environments contribute to fostering creativity of learners.

For Element 2: The design thinking skills of student teachers, it can be concluded that the sub-element of the skill to observe, collect data, analyze data, and synthesize data need development the most, followed by the skill to prepare information, knowledge, and experience; the skill to use tools, techniques, and methods to work collaboratively; and the skill to present, summarize points, and communicate thoughts, in that order. This demonstrates that student teachers show they have lower levels of skill to observe, collect, analyze, and synthesize data compared to other skills, as the skill to collect and analyze data is important and is difficult to train. This requires the experience in turning existing data into meaningful, suitable data for the subsequent steps (Chesson, 2017)

2. The process of managing teaching under the teacher training program

The research findings suggests that student teachers have not sufficiently learned teaching methodology, which make them struggle to imagine a scenario where they become teachers who solve student-related problems. Lessons learned in the curriculum are not sufficiently applied in the teaching practice, including writing lesson plans and teaching methodology. There is also a lack of practice in each subject and a correlation between practice and the actual school settings. The research findings are inconsistent with the study by Rukspollmuang et al. (2017), who suggest that graduates of a four-year program are less proficient in teaching, writing lesson plans, and managing classrooms compared to graduates of a 5-year program. This could lead to an explanation that the student teachers' teaching process requires some time to adequately develop professional teaching, theoretically and pragmatically, so that they are able to function as a teacher, especially when it comes to design thinking which requires practicing and a hands-on experience. (Anderson, 2012; Chesson, 2017).

3. Guidelines for enhancing design thinking for student teachers

The guidelines for enhancing design thinking for student teachers, which are developed from the study findings – both the quantitative research (the assessment of the needs using the questionnaire) and qualitative research (in-depth interviews with student teachers on topics related to the process of managing teaching programs under the teacher-training curriculum), demonstrate that enhancing design thinking in student teachers is an integrated process that requires the synchronization of the curriculum, the Faculty, and the university, as well as teachers, teacher mentors, and schools.

The curriculum is important in supporting student teachers in the process of managing teaching programs for each course, as well as in the professional teaching training to help student teachers develop design thinking qualities. There are studies that suggest that curricula designed to allow students to face challenges on innovation creation with a specific scope will influence teachers' teaching methods that aim to obtain results like developing the qualities of design thinking in student teachers (Seidel et al., 2020). In addition, there are also studies that suggest that today's education should include experts from different disciplines or professions when it comes to designing the curriculum, so that specialized knowledge is transferred along with additional advice on social issues, design ethics, and the contemporary world (Meyer & Norman, 2020).

Teachers play a highly crucial role in managing teaching programs for enhancing design thinking in student teachers, which is in line with the study by Schweitzer et al., 2016, which similarly discusses that teachers with positive attributes who show enthusiasm, like to exchange opinions, collaborate with others, and show diverse skills will help students develop the qualities of design thinking. The study by Carroll (2014) also found that consultation is essential for students to develop the ability to design think, and teachers should be trained to be confident and skilled in facilitating the learning of design thinking.

Teacher mentors and schools play an important role in supporting student teachers via the process the professional teaching training. The Bachelor of Education (a 4-year program), a modified curriculum B.E. 2562, the Faculty of Education, Chulalongkorn University mandates that student teachers practice professional teaching through Teaching Practicum 1, 2, 3, and 4. Student teachers will study the aforementioned courses in Year 2, 3, and 4 continuously, as shown in Table 8

Table 8

Professional training via Teaching Practicum courses

No	Course code	Course	Credits	Year 1		Year 2		Year 3		Year 4	
				Sem.1	Sem.2	Sem.1	Sem.2	Sem.1	Sem.2	Sem.1	Sem.2
1	2700101	Teaching Practicum 1	1			1	1				
2	2700201	Teaching Practicum 2	1					1			

No	Course code	Course	Credits	Year 1		Year 2		Year 3		Year 4	
				Sem.1	Sem.2	Sem.1	Sem.2	Sem.1	Sem.2	Sem.1	Sem.2
3	2700301	Teaching Practicum 3	2						2		
4	2700401	Teaching Practicum 4	8							8	

In summary, even though teaching management, which is in line with today's curriculum, does not clearly include design thinking, the teaching programs aimed at enhancing the qualities of design thinking is an important part in laying the educational foundation for students to become innovation creators, which in turn will help fulfil the educational purpose, as well as the Master Plan under National Strategy on Research and Innovation Development (B.E. 2561 – 2580) and the National Scheme of Education B.E. 2560 – 2579).

Recommendations

1. Recommendation on the research application

1.1 The research suggests the guidelines for enhancing design thinking for student teachers, which are an outcome from the assessment of the need regarding design thinking and student teachers' experiences gained from the process of the managing teaching programs under the teacher training curriculum. Those who would like to adopt the approaches in the research, such as by the course provider, Faculty, university, teachers, schools, and teacher mentors, must take into consideration the results of the assessment of the needs of student teachers first in order to see the elements that should be improved, so that the application of the research will be most beneficial.

1.2 Teacher training institutions should revise their courses so that the guidelines suggested in this research can be applied to enhance the qualities of design thinking in student teachers. The approaches can be revised in accordance with the context of each teacher training institution.

2. Recommendation on further research

2.1 The research findings suggest that the data from the assessment of the needs regarding design thinking in student teachers are vital pieces of information for suggesting adequate approaches to enhance design thinking in student teachers. Hence, each curriculum designed to train student teachers should assess the needs regarding design thinking in all students of each level to obtain findings that support the development of guidelines for enhancing design thinking that are suitable for students in their own curriculum.

2.2 The implementation of the guidelines for enhancing design thinking in student teachers developed by the researcher will be most beneficial if the curriculum incorporates information about the needs regarding design thinking in student teachers from the outset of their studies. Moreover, continuous assessment during both the study and professional teaching training is recommended, as it would provide data that will help student teachers develop in all aspects.

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