Research Article

Prioritizing software development skill needs for Thai pre-service computer technology teachers

Surachai Pimsalee [1]
 0009-0009-6602-990X

Aukkapong Sukkamart [1*]
 0000-0002-1234-4033

Paitoon Pimdee [1]
 0000-0002-3724-2885

Chontawat Meedee [1]
 0000-0003-3341-8414

[1] School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, THAILAND
* Corresponding author: aukkapong.su@kmitl.ac.th

ARTICLE INFO	ABSTRACT
	This study aimed to evaluate the current and desired software development skills within the context of Thai undergraduate teacher education. Specifically, the study investigated pre-service computer technology students' perceptions of secondary learners' software skill needs in authentic classroom contexts. Seventy-nine participants, including pre-service students, instructors, and teaching mentors, were selected via simple random sampling in June 2025. Data were collected using a 5-point Likert-scale questionnaire measuring current (D) and ideal (I) skill levels, with internal consistency coefficients of 0.87 and 0.96, respectively. The *PNI_{modified}* (priority needs index modified) method and paired t-tests were used to analyze the gaps. Results showed that participants perceived actual skill levels as generally 'competent', while the desired levels were rated as 'proficient'. The highest training needs were observed in *deployment & maintenance* (GSA6), followed by *programming* (GSA4), *requirements analysis* (GSA2), *testing* (GSA5), *design* (GSA3), and *planning* (GSA1), respectively. These findings highlight the need to align educational curricula with real-world software development practices, including DevOps, secure coding, and testing frameworks.

INTRODUCTION

Rapid advances in software and digital technology are reshaping industry demands, requiring higher education to continually adapt curricula. In Thailand, graduates of Bachelor of Industrial Education programs in computer technology must be prepared not only for roles in education but also for direct entry into the technology sector. This dual career pathway demands both pedagogical expertise and technical proficiency, especially in software development skills that align with real-world workplace needs.

Information technology (IT) stands at the forefront of global economic growth, unlocking limitless possibilities for innovation in an increasingly connected world (Wuttikamonchai et al., 2024). With AI and Industry 4.0 transforming how people work, learn, and communicate, students entering information and communications technology (ICT) and software fields must be innovative, agile, and digitally fluent to meet emerging demands (Aithal & Maiya, 2023; Kaliraj & Devi, 2022; Sahai & Rath, 2021).

Software development has emerged as a core competitive force in the digital economy, with a study from Gartner (2025) showing that spending in Thailand on software and related data centers will reach $27.9 billion in 2025 (Gartner Forecasts Worldwide IT Spending, 2024), while global IT spending will reach a staggering $5.74 trillion in 2025, an increase of 9.3% from 2024 (Gartner, 2025). Although these numbers show phenomenal growth, the skilled labor needed to support the infrastructure and its growth is woefully lacking, according to various recent studies and reports.

Thailand's Ministry of Education has emphasized developing quality technology teachers to drive the nation toward a skilled digital era (Chompoowong et al., 2025; Klinbumrung et al., 2025). The computer technology major in the faculty of industrial education and technology stands in a unique position, straddling both the technology and education disciplines in its teaching and research activities. As such, graduates should be highly proficient in technical skills and able to transfer that knowledge into effective teaching practices that will enable those taught to become technologically proficient. Beyond pursuing a career as a computer teacher, graduates should also be well-equipped to enter the burgeoning technology industry in Thailand, where software development skills pegged to industry demand are keenly sought.

The Importance of Needs Assessment

Needs assessment is crucial for identifying the gap between the current and desired states (Watkins & Meiers, 2012). In software development, the challenge becomes more complex as it requires integrating technical knowledge, business understanding, and problem-solving skills. Borriraklert and Kiattisin (2021) point out that developing a competency model for software developers necessitates a comprehensive and accurate needs assessment to identify the required knowledge, skills, and abilities (Hao & Kenikasahmanworakhun, 2023).

The Institute for the Promotion of Teaching Science and Technology has highlighted that current technology teachers must possess capabilities in using technology for teaching (Julkaew & Buaraphan, 2025), developing digital teaching materials, and designing learner-centered learning experiences. Simultaneously, if students choose a career path in the private sector, they must possess practical software development skills that meet real business needs.

However, there is a significant concern in Thailand's IT education that there is a disconnect between what is taught in academia and what is practiced in the workplace. Therefore, Al-Ismail et al. (2023) have suggested that ongoing needs assessments are an important mechanism to minimize this gap, particularly in disciplines characterized by rapid technological developments.

Moreover, the Thai Software Industry Promotion Association has also reported that the majority of new graduates from IT professions are not able to perform tasks fluently because they lack basic practical skills such as software development skills, teamwork, and responding to the needs of customers (Sureeyatanapas et al., 2024). This problem reflects that reviewing and improving the curriculum must be consistent with the labor market.

The priority needs index modified ($PNI_{Modified}$), developed by Wongwanich and Wiratchai (Janpirom et al., 2025), was adapted to suit the Thai context. Needs assessment methods have been widely applied in educational (Prasittichok & Klaykaew, 2022), medicine (Al-Ismailet al., 2023; Civaner et al., 2022), IT (Borriraklert & Kiattisin, 2021), and human resource development (Chimnoy et al., 2023) research globally because it can accurately reflect real needs and appropriately prioritize them.

Thai industrial education and technology students majoring in computer technology have specific objectives that make them unique compared to other students in other technology-related fields. This is due to their need to prepare for various future tasks, ranging from a career as a teacher, a software developer, or an industry technology leader. According to Khang et al. (2023), it is necessary to develop a competency model suitable for the context of each group of workers, especially those with occupations that require both technical and pedagogical knowledge, skills, and attitudes.

Therefore, the present study is significant because it is fundamental to curriculum development, instructional activity design, and skill development planning for Bachelor of Industrial Education in computer technology students. It aims to align these elements with the real needs of society and technological changes, using empirical data obtained through systematic needs assessment.

Problem Statement

Although skilled software developers are desperately needed, there are still three longstanding challenges facing software development education in Thailand. Firstly, no systematic and comprehensive needs assessment exists to gather empirical evidence about graduates' software development skills. Without the relevant empirical evidence, curriculum design and instructional planning are not based on reliable reference points. Hence, training may not necessarily match the market needs.

Second, there is a substantial perception gap between key stakeholders—students and instructors/mentors—regarding the significance of different software development skills. Such divergence may cripple the effectiveness of both teaching and learning. Lastly, the absence of skill development prioritization causes uneven allocation of educational resources.

To overcome these challenges, software development life cycle (SDLC) skills were evaluated and prioritized from pre-service computer technology (PSCT) teachers and instructors/mentors' perspectives using the SDLC framework. Although the skills in all phases of the SDLC were considered in this study, the study primarily focused on the prioritization of programming skills in the implementation/development phase of the SDLC life cycle. The study results are intended to offer a clear data-driven rationale for aligning curriculum, teaching, and skills development endeavors at all levels with societal needs and technological change.

Research Objectives

RO1: To assess the needs for enhancing the software development skills of Bachelor of Industrial Education students in computer technology.

RO2: To prioritize the needs for enhancing software development skills by comparing the perspectives between the student and instructor/mentor groups.

Research Questions

RQ1: Based on stakeholder perceptions, what are the current and desired software development skills of Bachelor of Industrial Education students in computer technology?

RQ2: What are the prioritized training needs for software development skills, and how do they differ between student and instructor/mentor groups?

Problem Statement

Software development education in Thailand faces three main challenges. The first is the lack of systematic and comprehensive needs assessment, with educational institutions lacking empirical data on the software development skills of graduates they produce for roles in the education sector or the labor market. This results in curriculum development and instructional management lacking reliable reference points, so students may not be developed in high-demand and urgent skills.

The second and final challenge is the perception gap between stakeholders (the student group and the instructor group), having differing views on the importance of various skills. The final challenge is the lack of skill prioritization, leading to inefficient allocation of educational resources.

Therefore, this research aims to assess the needs for developing PSCT education students' SDLC skills by asking their perception of skill gaps based on their experience and anticipated classroom practice with real students during teaching practicum. However, within the implementation and development phase, primary emphasis was placed on programming skills. It also aims to prioritize these skills as a guideline for effective curriculum and instructional development.

METHODS

Research Design

The research design for this study was structured to assess the essential needs for enhancing software development skills among students from the faculty of industrial education and technology, majoring in

Table 1. Core domains

Skill area	Code	Items	Cronbach's alpha
1. *Planning*	GSA1	7	0.89
2. *Requirements analysis*	GSA2	8	0.91
3. *Design*	GSA3	9	0.88
4. *Programming*	GSA4	15	0.94
5. *Testing*	GSA5	8	0.90
6. *Deployment & maintenance*	GSA6	6	0.87
Overall reliability	-	53	**0.96**

computer technology, as well as their instructors and teaching mentors. A quantitative research approach was employed, applying the *PNI_{modified}* methodology (Wuttikamonchai et al., 2024).

Population and Sample

The target population consisted of:

- Ninety-five undergraduate students majoring in computer and computer technology at the faculty of industrial education and technology, King Mongkut's Institute of Technology Ladkrabang, who had completed either *fundamentals of software development* or *software design and development I* during the academic years 2023 and 2024.

- Six course instructors teaching in King Mongkut's Institute of Technology Ladkrabang's computer technology program.

- Nineteen teaching mentors, i.e., schoolteachers supervising student-teachers during their practicum in software-related subjects in educational institutions across Thailand during the 2024 and 2025 academic years.

A simple random sampling technique was applied to select 62 students, all six instructors, and 11 mentors, resulting in 79 participants. The sample was divided into two assessment groups:

- Group 1: Students (n = 62)

- Group 2: Instructors and mentors (n = 17)

The sample size was determined using a standard formula for sample selection with a confidence level of 95% and a margin of error not exceeding 5% (Singh & Masuku, 2014). This was done to ensure that the research results have less deviation and are highly reliable.

Ethics Clearance

This study did not involve vulnerable populations, identifiable personal data, or intervention. It was therefore exempt from formal ethics review per Thailand's Guidelines for Conducting Human Subjects Research in Behavioral Science, Social Sciences, and Humanities (Phuangsuwan et al., 2024).

Research Instrument

The research instrument was a structured questionnaire to assess the perceived need for enhancing software development skills. The questionnaire employed a 5-point rating scale, where:

- 5 = Having the ability to perform independently without guidance,

- 4 = Having the ability with minimal reference to the document,

- 3 = Having some ability with moderate reliance on the document,

- 2 = Having limited ability requiring both guidance and reference, and

- 1 = Unable to perform or never attempted.

The instrument focused on six core skill domains in software development, totaling 53 items, as detailed in **Table 1**.

The questionnaire underwent content validation through the index of item-objective congruence, which was reviewed by five experts from two external institutions (not affiliated with King Mongkut's Institute of

Table 2. General information of the respondents (*n* = 79)

Item	Categories	Frequency (N)	Percentage (%)
Position	Students	62	78.5
	Instructors/mentors	17	21.5
Gender	Male	49	62.0
	Female	30	38.0
Age	≤ 25 years	62	78.5
	26-35 years	4	5.1
	≥ 36 years	13	16.5
Work experience	≤ 2 years	60	75.9
	3–9 years	5	6.3
	≥ 10 years	14	17.7

Table 3. Mean scores and proficiency levels of software development skills (*n* = 79)

Skill area	Code	*M* (D)	SD	Level	*M* (I)	SD	Level
Planning	GSA1	3.30	0.67	Competent	4.39	0.54	Proficient
Requirements analysis	GSA2	3.27	0.68	Competent	4.43	0.56	Proficient
Design	GSA3	3.23	0.70	Competent	4.44	0.58	Proficient
Programming	GSA4	3.04	0.73	Competent	4.48	0.58	Proficient
Testing	GSA5	3.03	0.84	Competent	4.46	0.59	Proficient
Deployment & maintenance	GSA6	2.87	0.94	Competent	4.37	0.73	Proficient
Overall		3.12	0.67	Competent	4.44	0.54	Proficient

Note. Mastery (4.50-5.00); Proficient (3.50-4.49); Competent (2.50-3.49); Developing (1.50-2.49); Novice (1.00-1.49)

Technology Ladkrabang's programs). All Cronbach's alpha values exceeded the .80 threshold, indicating high internal consistency.

Data Collection

Data were collected in June 2025 via an online survey using the Microsoft Forms platform. Participants included 62 students and 17 instructors/mentors.

Data Analysis

Data analysis focused on identifying gaps between current and desired software development skill levels. The $PNI_{modified}$ technique used by many international researchers was employed (Al-Ismailet al., 2023; Borriraklert & Kiattisin, 2021; Chimnoy et al., 2023; Civaner et al., 2022; Janpirom et al., 2025; Khamcharoen et al., 2022; Prasittichok & Klaykaew, 2022; Yurayat & Seechaliao, 2021). This method calculates $PNI_{modified}$ = (I-D)/D, where *PNI* is the priority needs index, *I* is the mean score for the desired skill level, and *D* is the mean score for the current skill level.

Higher $PNI_{modified}$ values indicate greater need and priority for skill development. This analysis enabled a systematic ranking of software development skills based on the perceived necessity of improvement from both student and educator perspectives. The application of $PNI_{modified}$ aligns with its wide usage in Thai educational research (Khamcharoen et al., 2022; Yurayat & Seechaliao, 2021)

RESULTS

Participant Demographics

Seventy-nine participants completed the questionnaire, including 62 undergraduate students (78.5%) and 17 instructors/teaching mentors (21.5%). Most participants were male (62.0%), under 25 years old (78.5%), and had less than two years of work experience (75.9%). Detailed demographics are shown in **Table 2**.

Descriptive Statistics of Current and Desired Skill Levels

The *M* ratings for current (D) and desired (I) skill levels across six software development domains are presented in **Table 3** for all 79 study participants (instructors and their student teacher candidates). Additionally, it reveals their perceptions of what level (desired) of achievement their students (instructor's perceptions), current and future students (student teacher perceptions), should achieve. Across all skill areas,

Table 4. $PNI_{modified}$ and paired sample t-test results (n = 79)

Skill area	M (I)	M (D)	$PNI_{modified}$	Rank	t-value	p-value	Cohen's d
Deployment & maintenance	4.37	2.87	0.53	1	13.00	< .01	1.52
Programming	4.48	3.04	0.47	2	15.04	< .01	1.74
Testing	4.46	3.03	0.47	3	13.78	< .01	1.59
Requirements analysis	4.43	3.22	0.38	4	14.42	< .01	1.45
Design	4.44	3.23	0.38	5	13.50	< .01	1.36
Planning	4.39	3.30	0.33	6	13.78	< .01	1.28
Overall	4.44	3.12	0.42	-	15.47	< .01	1.65

Note. Cohen's d > 0.8 indicates a large effect size; Mastery = 4.50-5.00; Proficient = 3.50-4.49; Competent = 2.50-3.49; Developing = 1.50-2.49; Novice = 1.00-1.49

Table 5. $PNI_{modified}$ and t-test results**,** classified by sample group type

Group skill aspect	Students (n = 62)					Teachers/mentors (n = 17)				
	Index of essential needs				t	Index of essential needs				t
	M (I)	M (D)	$PNI_{modified}$	Rank		M (I)	M (D)	$PNI_{modified}$	Rank	
Planning (GSA1)	4.39	3.28	0.34	6	11.64**	4.36	3.36	0.30	6	8.55**
Requirements analysis (GSA2)	4.40	3.17	0.39	4	12.30**	4.54	3.37	0.35	3	7.84**
Design (GSA3)	4.47	3.22	0.39	4	11.86**	4.36	3.26	0.34	4	6.45**
Programming (GSA4)	4.47	2.94	0.52	2	13.56**	4.50	3.39	0.33	5	7.46**
Testing (GSA5)	4.46	2.98	0.50	3	12.18**	4.44	3.21	0.38	2	6.63**
Deployment & maintenance (GSA6)	4.33	2.76	0.57	1	11.40**	4.51	3.25	0.39	1	6.81**
Overall	**4.43**	**3.06**	**0.45**		**13.43**	**4.46**	**3.32**	**0.34**		**8.59**

** Significance < .01; Significance level = .01

students and educators rate current proficiency as *competent* (mean 2.87-3.30) and the desired proficiency as *proficient* (mean 4.37-4.48), based on a five-point scale.

Gap Analysis Using $PNI_{modified}$

The $PNI_{modified}$ index was used to quantify the gaps between desired and current skill levels (**Table 4**). All skill areas showed statistically significant differences (p < .01), with *deployment & maintenance* ($PNI_{modified}$ = 0.53) ranking as the most critical need, followed by *programming* (0.47) and *testing* (0.47). The *planning* domain showed the smallest gap (0.33). Respondents rated students' current skill levels as 'competent' and the desired levels as 'proficient' across all areas.

Needs Assessment Comparison and Priority Results

Table 5 presents a comparative analysis of perceived software development skill needs between students (self-assessment) and their instructors/mentors (student assessment), using the $PNI_{modified}$ and paired-sample t-test results. The $PNI_{modified}$ index quantifies the gap between perceived importance (I) and current competence (D) for each skill area.

Both groups identified *deployment & maintenance* as the highest-priority development area. Students ranked *programming* second, followed by *testing*, *requirements analysis*, *design*, and *planning*. In contrast, instructors/mentors placed *testing* second, followed by *requirements analysis*, *design*, *programming*, and *planning*. Despite these differences in intermediate rankings, the two groups' overall prioritization patterns were broadly consistent, with statistically significant gaps (p < .01) in all skill areas. This suggests shared recognition of deficiencies, particularly in later stages of the software development lifecycle, while also highlighting minor differences—most notably the higher value students place on programming compared to instructors.

When analyzed separately (**Table 6**), both groups ranked *deployment & maintenance* first, confirming its importance as a skill gap. Students consistently reported larger $PNI_{modified}$ values across all domains, suggesting greater self-perceived deficiency. Students ranked *programming* second ($PNI_{modified}$ = 0.52), reflecting possible anxiety over coding complexity and the rapid evolution of programming tools and languages. Instructors, however, ranked *testing* higher ($PNI_{modified}$ = 0.38), likely due to professional experience emphasizing the role of quality assurance in real-world software development.

Table 6. $PNI_{modified}$ comparison by group

Skill area	Students (n = 62)	Rank	Instructors/mentors (n = 17)	Rank
Deployment & maintenance	0.57	1	0.39	1
Programming	0.52	2	0.33	5
Testing	0.50	3	0.38	2
Requirements analysis	0.39	4	0.35	3
Design	0.39	4	0.34	4
Planning	0.34	6	0.30	6
Total $PN_{Modified}$	0.45	-	0.34	-

Table 7. $PNI_{modified}$ and t-tests by group

Skill area	Students (n = 62)				Instructors/mentors (n = 17)			
	I	D	$PNI_{modified}$	Rank	I	D	$PNI_{modified}$	Rank
GSA1–*Planning*	4.39	3.28	0.34	6	4.36	3.36	0.30	6
GSA2–*Requirements analysis*	4.40	3.17	0.39	4	4.54	3.37	0.35	3
GSA3–*Design*	4.47	3.22	0.39	4	4.36	3.26	0.34	4
GSA4–*Programming*	4.47	2.94	0.52	2	4.50	3.39	0.33	5
GSA5–*Testing*	4.46	2.98	0.50	3	4.44	3.21	0.38	2
GSA6–*Deployment & maintenance*	4.33	2.76	0.57	1	4.51	3.25	0.39	1
Total	4.43	3.06	0.45	-	4.46	3.32	0.34	-

Note. All t-tests for both groups were statistically significant at $p < .01$

Results Interpretation

The comparative analysis clearly indicates that *deployment & maintenance* is the most urgent area to focus on for skill development in both groups. This agreement implies that students and instructors share the same mindset when it comes to post development processes including software deployment, maintenance, and version control that are not well covered in undergraduate education but are essential in practice.

However, there is a difference in the prioritization of intermediate priorities. Students ranked *programming* as second priority, followed by *testing,* which suggests that students might be more concerned about their programming skills, as well as the fast-changing landscape of programming tools. This result also confirms findings in the literature: many novice developers feel intimidated when they are asked to apply knowledge learned from theoretical-based courses to concrete programming environments. On the other hand, instructors ranked *Testing* as second priority, and *programming* as fifth, which suggests a stronger focus on quality assurance and validation processes based on realistic software development scenarios.

In all six domains, the student-reported $PNI_{modified}$ *M* was higher than that of instructors, indicating greater self-perceived deficiencies. This is possibly due to the students' lack of confidence in their own abilities and/or their greater awareness of the demands of the workforce, students' feelings of deficient ability were countered by measured opinions of instructors, who may temper their expectations according to the scope of undergraduate education.

The high statistical significance of all the t-test results ($p < .01$) suggests that the perceived gaps are not merely a result of chance findings, conversely, they represent real development needs. These findings offer a scientific basis from which to select curriculum intervention priorities in *deployment & maintenance*, *programming*, and *testing* in order to better meet student domain knowledge gaps that align with industry needs.

The results in **Table 7** highlight both shared and divergent perspectives on essential software development competencies, offering valuable insight into where curricular emphasis should be adjusted. By comparing the magnitude and ranking of needs across groups, the findings provide a clear roadmap for targeted instructional interventions that address both technical proficiency and the confidence to apply these skills in authentic contexts.

DISCUSSION

Building on these insights, the discussion examines how the identified priority needs align with broader trends in software development education and workforce readiness. The strong consensus that the greatest

priority lay in *deployment & maintenance* corresponded to an ongoing push within the industry to hire graduates capable of maintaining, patching, and debugging complex systems. Meanwhile, contrasting ideas on whether *programming* or *testing* was most important underscores the influence that professional experience's role in skill valuation. Whereas students' responses prioritized mastery in coding as the biggest hurdle, instructors placed a greater emphasize on quality assurance as the leading factor of success in projects. Moreover, from the two research questions investigated in this study:

RQ1. Stakeholder perceptions estimated existing competencies in all six domains at merely a competent level while preferred levels hovered consistently around proficient levels. This mismatch identified the need for focused skill development throughout the entire SDLC, especially at the later stages (deployment, testing, & maintenance) that are typically underrepresented in undergraduate computer education curricula.

RQ2. With respect to prioritized needs, *deployment & maintenance* ranked first for both groups, followed by *programming* and *testing* for students, and *testing* and *requirements analysis* for instructors/mentors. While the overlap indicates agreement over areas that are highly needed, the change of ranking between *programming* and *testing* comes from the difference in frames of reference: students tend to focus on coding and see it as their biggest challenge, whereas instructors—having to situate themselves in real-world project flows—are more conscious of the importance of quality assurance and planning upstream.

The uniformly higher $PNI_{modified}$ reported by the students across all domains suggests that their self-perceived deficits, and hence, anxiety about readiness for the workforce, are greater than those of the instructors. Indeed, this matches previous findings related to computational thinking and problem-solving (Aroonsiwagool et al., 2025) that showed that students exhibit underestimated skills according to instructor opinions. On the other hand, the $PNI_{modified}$ ratings of the instructors, when compared to those of the students, may reflect their calibrated expectations of what they consider more realistically achievable at the undergraduate level.

The dual perspective presented here, that of self-assessment as undertaken by the students, and that of an external assessment from the instructors, enhances the richness of the interpretation of these gaps. For pre-service teachers, the results represent not only an insight into their own perceived levels of industry-readiness, but also their expectation of the digital skills they are likely to need to support digital skills development in their own students. This dual perspective adds further weight to the need to develop curricula that introduce not only technical competencies but also the capability to impart these competencies to others. This dual perspective adds further weight to the need to develop curricula that introduce not only technical competencies but also the capability to impart these competencies to others. These findings also align with Thailand's Ministry of Education's *digital teacher development framework*, which emphasizes strengthening educators' digital competencies and integrating emerging technologies into teacher preparation programs. From a practical perspective, these findings support three recommendations:

1. **Experiential learning integration**—Create practicums linked to industry, capstone projects with deployments, and DevOps bootcamps to provide students with the opportunity for hands on experience with operational environments, version control, and automated deployment pipelines.

2. **Early and sustained programming support**—Strengthen coding instruction with scaffolding and real-world projects to develop confidence, adaptability, and secure coding behaviors.

3. **Expectation alignment mechanisms**—Include formative feedback loops, reflective assessments, and co-evaluation by students and mentors, to close perception gaps and improve skill targeting.

Although we have a small sample size, a 93.75% response rate strengthens confidence in the trends observed. Future research should ask if these perception gaps are typical at other institutions? Does exposure to industry standard software applications influence the importance assigned to particular skill sets? How can specific exposures to deployment & maintenance in teacher education effect/strengthen overall SDLC skill development.

CONCLUSIONS

This study offers actionable insights into the perceived training needs in software development among pre-service computer education students and their instructors/mentors. Notably, the research design

captured how future ICT teachers evaluate the software development skill gaps in themselves and what they believe real-world students would require during practicum teaching in actual schools. This dual-layer perception adds complexity to the interpretation and underscores the importance of clarifying assessment contexts in educational needs studies.

The findings indicate urgent needs for skill development in three key areas: *deployment & maintenance* ($PNI_{modified}$ = 0.53), *programming* ($PNI_{modified}$ = 0.47), and *testing* ($PNI_{modified}$ = 0.47). These are aligned with industry demands, emphasizing DevOps practices, continuous delivery pipelines, secure coding, and quality assurance.

Both student and instructor/mentor groups identified *deployment & maintenance* as the top priority, demonstrating shared awareness of the importance of cloud deployment, containerization (e.g., Docker), and CI/CD pipelines. However, some divergence emerged:

- Students placed higher importance on *programming*, possibly due to self-doubt or limited real-world exposure.
- Instructors and mentors emphasized *testing*, likely reflecting their practical experience and understanding of software quality control.

These perception gaps align with previous studies (e.g., Janpirom et al., 2025; Wuttikamonchai et al., 2024), documenting differences between students' self-assessments and educators' evaluation of skill readiness in ICT and STEM education fields.

Strategic Improvements for Teaching Software Engineering

To adequately prepare students for ICT workplace rapid changes, course development should work to revisit and adapt existing courses critically. Much greater emphasis should be placed on high-priority areas of skills of practice, such as DevOps, automated testing, and secure programming practices, which are becoming ever more prominent in contemporary software development environments. The content of courses can be rebalanced towards these areas of knowledge to ensure graduates are being exposed to skills and practices that are relevant and immediately deployable in employment.

Instructional design must adapt with curriculum reform to bridge the disconnect between classroom education and real-world application. Integrating hands-on, experiential activities, such as Docker-based deployment, CI/CD pipeline integration, and real-time debugging scenario exercises, can afford students the experience using the tools and workflows leveraged in the field. More practically-minded activities stimulate engagement and promote the development of problem-solving and adaptability, skills critical to success in modern software positions.

Equally vital is instructor cultivation, in which faculty members must keep abreast of the latest software technologies and development practices. With relevant enrichment training and continuous learning opportunities, educators can better close the gap between classroom instruction and the dynamic needs of the workforce.

Finally, fostering stronger alignment between academic and industry stakeholders is essential. Organizing collaborative forums—such as workshops, panels, or focus groups—where pre-service teachers, faculty, and industry professionals can share insights and expectations, will help ensure educational outcomes align with labor market needs. These engagements can clarify the core competencies expected of graduates and highlight the practical challenges employers face, leading to a more coherent and effective educational strategy.

study commencement, either electronically or in writing. The study complies with the ethical standards of the Declaration of Helsinki (revised in 2013). The research also complies with Thailand's National Policy and Guidelines for Human Research 2015 (2015), which stipulates that social and behavioral research carried out anonymously and involving no physical or psychological risk to participants is not subject to formal institutional ethics review in Thailand Notwithstanding this exemption, the Research Ethics Committee of King Mongkut's Institute of Technology Ladkrabang (KMITL) issued research exemption certificate EC-KMITL_68_143, dated 7 August 2025 for the study. This was done to ensure compliance with international publication standards. All participants provided an informed consent form (ICF) prior to data collection—either by signing a written ICF for interviews or by confirming consent via a "Yes/No" choice in the Google Forms survey. No personally identifying data were collected, and participants could withdraw at any time without penalty. All participant data was subsequently secured in a password protected Excel spreadsheet.

AI statement: During the preparation of this manuscript, the authors used ScholarGPT and Google Translate to assist in translating the original content from Thai to English. Additionally, Grammarly Premium was employed to review the manuscript for English grammar, similarity, and AI-use scoring.

Declaration of interest: The authors declared no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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