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Assessing version control system skill gaps in undergraduate IT education: A needs assessment of academic and industry stakeholder perspective

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Abstract: This study presents a needs assessment evaluating undergraduate Information Technology (IT) students' Version Control System (VCS) competencies based on perspectives from IT instructors and IT entrepreneurs in Thailand. Using a structured questionnaire, data were collected from 49 stakeholders assessing both actual and desired skill levels across seven core VCS competencies. Paired-sample t-tests revealed statistically significant differences between actual and desired competencies for all skill factors ($p < .01$), underscoring considerable gaps. The highest Priority Needs Index (PNImodified) values were observed in writing effective commit messages, detecting and resolving errors, and tracking change history. Notably, instructors perceived more significant skill gaps than entrepreneurs, highlighting a need for improved curriculum alignment. The findings emphasize the urgency of enhancing higher-order VCS skills critical for agile and DevOps workflows. This study lays the groundwork for developing a new training curriculum integrating blended learning, problem-based learning (PBL), and generative AI tools to address these gaps and better prepare students for professional software development environments.

Keywords: *Needs assessment, Priority needs index, Version control system.*

1. Introduction

The role of Version Control System (VCS) skills in the software development industry cannot be overstated, as they have become a cornerstone of modern software engineering practices. VCS, such as Git, GitHub, GitLab, and Bitbucket, are integral to collaborative software development, enabling teams to manage code changes, track revisions, and maintain project integrity [1-3]. For Information Technology (IT) undergraduate students, acquiring proficiency in these tools is a technical skill and a critical professional competency that bridges the gap between academic learning and industry expectations.

1.1. Industry Demand for Version Control System Skills

The collaborative nature of modern software engineering drives the demand for VCS skills in the software development industry. Companies rely on version control systems to manage distributed teams, track changes and ensure code quality [1, 3]. Employers often expect graduates to be proficient in using tools like Git and GitHub, essential for professional software development [2, 4]. For instance, GitHub portfolios are frequently used for hiring, emphasizing the importance of technical proficiency and the ability to collaborate and showcase work in a professional setting [2]. Furthermore, the ability to use configuration management systems and produce unit tests for code is critical. Yet, many graduates struggle with these skills, highlighting the need for better preparation in undergraduate education [4].

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The industry's emphasis on agile methodologies, continuous integration/continuous deployment (CI/CD), and DevOps further underscores the importance of VCS skills. These practices require developers to work in dynamic environments, where VCS is essential for managing frequent code changes and ensuring smooth collaboration [5, 6]. As the software industry evolves, the demand for professionals who can effectively navigate these tools will only grow, making VCS skills a cornerstone of employability for IT graduates.

1.2. Challenges in Developing VCS Skills in Undergraduate Education

Despite the apparent industry demand, integrating VCS skills into undergraduate curricula presents several challenges. One major issue is the steep learning curve associated with version control systems, which can overwhelm students and educators [1]. The complexity of these tools often leads to confusion, particularly when they are introduced in isolation from real-world scenarios. Additionally, many educational institutions lack the resources or tailored materials to teach VCS concepts effectively, further hindering student learning [1, 7].

Another challenge is the lack of alignment between academic curricula and industry expectations. While many undergraduate programs focus on theoretical knowledge, they often neglect practical skills like version control, which are critical in professional settings [6, 8]. This mismatch can leave graduates unprepared for the demands of the software development industry, where collaboration and version control are integral to daily workflows [3, 4]. Moreover, the rapid evolution of software engineering tools and methodologies exacerbates the challenge of keeping curricula current, requiring continuous adaptation to meet industry needs [6].

In conclusion, the role of VCS skills in the software development industry is critical and transformative. As the industry continues to evolve, the demand for professionals who can effectively navigate these tools will only grow. For IT undergraduate students, acquiring VCS skills is a technical and professional necessity that will shape their success in the software development industry.

1.3. How Imperative is a Needs Assessment?

Needs assessment (NA) is crucial in educational research and curriculum development as it identifies skill gaps and guides evidence-based improvements. Initially conceptualized by the United Nations Development Programmed (UNDP), the NA framework was designed to diagnose social, economic, and educational challenges and prioritize targeted interventions [9, 10]. In Thailand, this methodology has evolved into a localized tool known as the Priority Needs Index modified (PNImodified), which has been adapted to address national educational contexts and priorities [11-14].

A needs assessment is not merely a diagnostic tool but a strategic process for improving the relevance and effectiveness of educational outcomes [12]. It enables educators, administrators, and policymakers to align instructional goals with learner needs and industry demands. This approach has been applied in diverse contexts across Thailand. For instance, digital literacy needs were assessed in community colleges [15] school administrative participation was explored [16] digital competencies in open universities were investigated [17] and 21st-century citizenship development in private schools was addressed [18].

The effectiveness of the PNImodified model in guiding curriculum planning and professional training is further demonstrated through the development of a model for STEM-focused teacher development [19] and the proposal of an innovative school model under Thailand's basic education system [20].

In conclusion, a needs assessment is imperative for identifying shortcomings and formulating responsive and future-focused education strategies. Its structured, stakeholder-driven methodology ensures curriculum development and training interventions are grounded in real-world demands and evolving learner needs.

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1.4. Research objectives

This research aims to conduct a needs assessment to explore the perceived competencies in VCS skills among undergraduate IT students. The evaluation focuses on insights from two key stakeholder groups—IT entrepreneurs and academic instructors—associated with the Bachelor of Science in Information Technology program at the Faculty of Industrial Technology and Management, King Mongkut's University of Technology North Bangkok (KMUTNB), Prachinburi Campus, Thailand.

More specifically, the study investigates the extent of the skill gap by comparing the expected proficiency levels with the actual capabilities students currently demonstrate in using VCS tools. Emphasis is placed on identifying critical areas needing improvement, such as writing commit messages and troubleshooting version control issues. The results will inform future curriculum planning and promote instructional strategies that align with industry requirements.

1.5. Statement of Problem

In the rapidly evolving software development sector, proficiency in VCS has become a critical competency employers seek. Nonetheless, numerous IT graduates continue to enter the professional realm inadequately equipped in this pivotal domain. This deficiency arises from several significant challenges inherent in undergraduate education. The intrinsic complexity of VCS tools, such as Git, can present considerable learning obstacles for students, especially when pedagogical approaches are disconnected from practical, real-world applications. Furthermore, educational institutions frequently encounter resource limitations and a scarcity of specialized instructional materials, exacerbating the challenges associated with effectively incorporating VCS skills into academic curricula.

Additionally, a continual misalignment exists between academic instruction and industry demands, with conventional IT curricula emphasizing theoretical knowledge over practical, job-specific competencies. Consequently, graduates often discover themselves ill-prepared for professional settings where VCS proficiency is not merely advantageous but imperative for successful collaboration and productivity in software development. Considering the growing emphasis on agile methodologies, continuous integration, and continuous deployment (CI/CD) practices within the industry, this disparity significantly influences the employability and preparedness of IT graduates.

Therefore, undertaking a comprehensive needs assessment (NA) is essential to identify the precise deficiencies in VCS competencies among IT students. Such an assessment will illuminate critical areas requiring enhancement, such as commit messaging and error resolution, thereby directing educators and industry stakeholders towards focused curriculum development and educational strategies that more closely align with professional standards and expectations.

2. Research Methods

2.1. Research Design

This research was designed as a quantitative descriptive study utilizing a needs assessment framework to evaluate and prioritize VCS skill development among undergraduate students in information technology. The investigation focused on assessing students' current (actual) versus expected (desired) competencies, as perceived by two stakeholder groups: IT instructors and IT entrepreneurs.

The study employed a structured questionnaire as the primary data collection tool to achieve this. The responses were analyzed using statistical methods appropriate for educational needs assessment, including the Priority Needs Index modified (PNImodified) to identify skill gaps and determine their relative importance. Paired-sample t-tests were also applied to test the statistical significance of the differences between actual and desired skill levels. The findings provide a foundation for identifying instructional priorities and guiding future curriculum development efforts.

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2.2. Population

This study aimed to assess the need for developing VCS skills among undergraduate IT students based on the perspectives of two stakeholder groups: IT instructors and IT entrepreneurs. These groups were selected due to their close involvement in curriculum delivery and student skill application in real-world cooperative education environments.

The population consisted of:

1. 23 IT instructors from the Department of Information Technology, Faculty of Industrial Technology and Management, King Mongkut's University of Technology North Bangkok (KMUTNB), Prachinburi Campus, Thailand.
2. 66 IT entrepreneurs representing companies and organizations that hosted students for cooperative education during the 2024 academic year.

In summary, the defined population comprising IT instructors and entrepreneurs provides comprehensive insights into the development needs of undergraduate IT students. Their direct involvement in educational and professional contexts ensures a robust assessment of current skill gaps and industry expectations.

2.3. Research Tools

The research tool used in this study was a structured questionnaire developed to assess the need for developing VCS skills among undergraduate information technology students based on the perceptions of IT instructors and IT entrepreneurs.

The questionnaire comprised two parts as follows:

Part 1: General Information: This section gathered demographic and background information about the respondents, including gender, age, educational background, years of professional service, and professional role (e.g., IT instructor or IT entrepreneur). The data were analyzed using descriptive statistics (frequency and percentage), and the results are presented in Table 2.

Part 2: Actual and Desired Skill Assessment: this section assessed the respondents' perceptions of both the actual (current) and desired (expected) skill levels of undergraduate students in seven aspects VCS skills (see Table 1)

Each skill factor was measured through multiple items using a 5-point Likert scale (1 = least proficient, 5 = most proficient). Respondents rated students' actual competency levels and their desired competency levels separately. The collected data were used to compute:

- Means and standard deviations for both actual and desired scores (see Table 3)
- Priority Needs Index (PNImodified) calculated using the formula: PNImodified = $(I - D) / D$; where: I = mean score of desired skill level D = mean score of actual skill level.
- Paired-sample t-tests to determine whether the difference between actual and desired scores was statistically significant
- Group comparisons between IT instructors and IT entrepreneurs (see Table 5)

The questionnaire's internal consistency was assessed using Cronbach's Alpha for each of the seven skill factors. The alpha coefficients for all skill categories were above 0.80, indicating a high level of reliability (see Table 1).

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Table 1.
Reliability coefficients for surveyed competency factors.

Skill factors	Label	Item count	α
1. Using basic Version Control System commands	SF1	5	0.88
2. Branching and merging	SF2	4	0.87
3. Reviewing code and managing pull request	SF3	5	0.88
4. Writing effective commit messages	SF4	4	0.84
5. Tracking change history	SF5	6	0.87
6. Managing repository and workflow	SF6	6	0.87
7. Detecting error and resolution	SF7	3	0.79
Overall		33	0.97

2.4. Data Collection

The data collection process was carried out in the following steps:

1. Preparation of the instrument: The finalized questionnaire was reviewed by experts for content validity and pilot-tested for clarity and consistency.
2. Distribution: The questionnaire was distributed in both digital and paper-based formats, depending on participant accessibility. IT instructors received the questionnaire directly at the university, while IT entrepreneurs were contacted through email or coordinated with company representatives.
3. Response period: A simple random sampling technique was employed to select participants from each group during March 2025. The final sample included 11 IT instructors and 38 IT entrepreneurs, totaling 49 participants. This sampling approach ensured unbiased representation across academic and industry perspectives. Participants were given approximately two weeks to complete and return the questionnaire. Reminders were sent periodically to encourage timely responses and increase participation rates.
4. Data verification: Upon collection, responses were checked for completeness and accuracy. Any incomplete or inconsistent responses were excluded from the analysis.

All respondents were informed of the research's purpose, assured of confidentiality, and participated voluntarily. The complete and validated dataset was then used for further statistical analysis.

2.5. Data Analysis and Needs Assessment

The collected data were analyzed using descriptive and inferential statistical methods to assess the needs for developing VCS skills among undergraduate IT students, as perceived by IT instructors and IT entrepreneurs. SPSS software was utilized for all statistical calculations, including descriptive statistics (mean scores and standard deviations) and inferential statistical analyses, specifically paired-sample t-tests, to evaluate the statistical significance of differences between actual and desired competency levels.

The needs assessment specifically aimed to identify the gap between students' actual and desired competencies across seven key VCS skill areas. Respondents rated competencies using a 5-point Likert scale (1 = least proficient, 5 = most proficient). The differences between actual and desired skill levels represented skill gaps, quantified using the Priority Needs Index modified (PNImodified). A higher PNImodified value indicated a greater need for skill enhancement.

Additionally, separate analyses were conducted for IT instructors and IT entrepreneurs to examine differences in their perceptions, providing a comprehensive understanding of stakeholders' views and guiding focused curriculum development initiatives.

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3. Results

3.1. Stakeholder Information

The stakeholders participating in this study were selected from two primary groups directly involved in the education and application of VCS skills: IT instructors and IT entrepreneurs. A total of 49 individuals were surveyed, comprising 11 IT instructors (22.45%) from the Department of Information Technology, Faculty of Industrial Technology and Management, King Mongkut's University of Technology North Bangkok (KMUTNB), and 38 IT entrepreneurs (77.55%) from companies and organizations that hosted students for cooperative education in the 2024 academic year.

Table 2.
Demographic profile of respondents (n=49).

Category	Frequency	Percent
Job role		
IT entrepreneurs	38	77.55
IT instructors	11	22.45
Gender		
Male	36	73.47
Female	13	26.53
Age group		
< 30 years	30	61.22
30–40 years	7	14.29
> 40 years	12	24.49
Highest education level		
Bachelor's degree	32	65.31
Postgraduate	17	34.69
Years of professional service		
Under 5 years	28	57.14
Between 5–10 years	8	16.33
11 years & up	13	26.53

Table 2 summarizes the general demographic characteristics of the respondents. Most stakeholders were male (73.47%), while 26.53% were female. Regarding age distribution, 61.22% were under 30, 14.29% were between 30 and 40, and 24.49% were 41 years or older.

Regarding educational background, most stakeholders held a bachelor's degree (65.31%), while 34.69% held a postgraduate degree. Regarding Years of professional service, 57.14% of the participants had less than five years of experience, 16.33% had between five and ten years, and 26.53% had over ten years of experience in information technology.

This diverse group of stakeholders provided a well-rounded perspective from academic and industry contexts, contributing to the validity of the needs assessment for Git-based version control skills. Their insights were instrumental in identifying gaps between students' current (actual) and expected (desired) competency levels.

3.2. Needs Analysis Results

The needs analysis examined the gap between undergraduate students' actual and desired skill levels concerning seven essential VCS skills. These skill factors were assessed based on stakeholder perceptions using a 5-point Likert scale (1 = least proficient, 5 = most proficient), and the results are presented in Table 3.

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The findings revealed that the average actual skill level across all seven factors was moderate proficiency, while the average desired skill level was rated as most proficient. This indicates a clear gap between the current competencies and stakeholders' expectations.

Table 3 presents the mean (M) and standard deviation (SD) metrics corresponding to each skill factor's actual and desired scores. The tiers of classification are specified in this way: HP equals Highly Proficient (4.50–5.00), CP stands for Competent (3.50–4.49), MP translates to Moderate Proficiency (2.50–3.49), LP indicates Less Proficient (1.50–2.49), and NP represents Not Proficient (1.00–1.49). These classifications elucidate how respondents assessed their current and aspirational proficiency levels.

Table 3.
Respondents' evaluations of actual vs. desired VCS competencies.

Skill factor (SF)	Actual status			Desired status		
	M	SD	Tier	M	SD	Tier
SF1. Using basic Version Control System commands	3.59	1.05	CP	4.66	0.51	HP
SF2. Branching and merging	3.26	1.24	MP	4.54	0.77	HP
SF3. Reviewing code and managing pull request	3.22	1.24	MP	4.55	0.58	HP
SF4. Writing effective commit messages	3.06	1.12	MP	4.43	0.80	CP
SF5. Tracking change history	3.21	1.11	MP	4.56	0.60	HP
SF6. Managing repository and workflow	3.45	1.05	MP	4.6	0.58	HP
SF7. Detecting error and resolution	3.13	1.20	MP	4.54	0.73	HP
Overall average	3.29	1.04	MP	4.56	0.55	HP

All seven skill factors exhibited a positive difference between the desired and actual mean scores, suggesting a consistent need for improvement across the board. The most significant gaps were observed in:

SF4: Writing effective commit messages (Actual = 3.06; Desired = 4.43)

SF7: Detecting and resolving errors (Actual = 3.13; Desired = 4.54)

SF2: Branching and merging (Actual = 3.26; Desired = 4.54)

These findings serve as the basis for further prioritization through PNImodified calculations and statistical significance testing, as discussed in the next section.

3.3. Needs Prioritization

To identify the most critical areas for development in VCS skills, a Priority Needs Index (PNImodified) was calculated for each skill factor based on the gap between actual and desired competency levels. In addition, a paired-sample t-test was conducted to determine whether these differences were statistically significant. Table 4 summarizes the mean scores, standard deviations, PNImodified values, rankings, and statistical test results for each skill.

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Table 4.
Results of Gap Analysis and Statistical Test Results for VCS Skill Requirements.

Skill aspect (SF)	Status	Mean Score	Std. Dev.	Gap Index		Statistical Test Results	
				PNI	Rank	t-value	Sig.
SF1	Desired (I)	4.66	0.51	0.30	7	6.96**	<.01
	Actual (D)	3.59	1.05				
SF2	Desired (I)	4.54	0.77	0.39	5	6.52**	<.01
	Actual (D)	3.26	1.24				
SF3	Desired (I)	4.55	0.58	0.41	4	7.17**	<.01
	Actual (D)	3.22	1.24				
SF4	Desired (I)	4.43	0.80	0.45	1	7.52**	<.01
	Actual (D)	3.06	1.12				
SF5	Desired (I)	4.56	0.60	0.42	3	7.43**	<.01
	Actual (D)	3.21	1.11				
SF6	Desired (I)	4.60	0.58	0.33	6	7.21**	<.01
	Actual (D)	3.45	1.05				
SF7	Desired (I)	4.54	0.73	0.45	1	7.10**	<.01
	Actual (D)	3.13	1.20				
Total	Desired (I)	4.56	0.55	0.39		7.59**	<.01
	Actual (D)	3.29	1.04				

Note: **Significance < .01.

The findings from the needs prioritization analysis revealed that all seven VCS skill factors demonstrated statistically significant gaps between the actual and desired competency levels, with all differences significant at the Significance < .01 level. The overall Priority Needs Index (PNImodified) was 0.39, indicating a moderate to high level of need across the board. The highest-priority skills were writing effective commit messages (SF4) and detecting and resolving errors (SF7), with the highest PNImodified value of 0.45. These were followed by tracking change history (SF5), reviewing code and managing pull requests (SF3). In contrast, using basic Version Control System commands (SF1) and managing repository and workflow (SF6) received the lowest priority rankings, though they still reflected significant development needs.

The results of the prioritization of the needs show that while all VCS skill factors require development, the most urgent areas involve commit message writing, error detection, tracking changes, and collaborative review workflows. These findings offer valuable input for enhancing curriculum and training programs to align with industry expectations.

3.4. Need Assessment Comparison & Priority Results

To gain a deeper understanding of the perceived skill gaps in VCS competencies, a comparative analysis was conducted between two stakeholder groups: IT entrepreneurs and IT instructors. Both groups evaluated students' actual and desired competency levels across seven VCS skill factors. The Priority Needs Index (PNImodified) and paired-sample t-tests were calculated separately for each group to identify differences in priority rankings and statistical significance.

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Table 5.
Comparison of Priority Needs Index (PNI), skill gap rankings, and t-test results between IT entrepreneurs and IT instructors across VCS skills.

Skill Factor	IT entrepreneurs (n=38)					IT instructors (n=11)				
	Gap Index					Gap Index				
	Desired	Actual	PNI	Rank	t-value	Desired	Actual	PNI	Rank	t-value
SF1	4.65	3.63	0.28	6	5.42**	3.45	4.69	0.36	7	5.69**
SF2	4.51	3.41	0.32	5	4.67**	2.73	4.64	0.70	3	7.42**
SF3	4.52	3.34	0.35	3	5.32**	2.78	4.65	0.67	4	6.83**
SF4	4.34	3.15	0.38	2	5.50**	2.75	4.75	0.73	1	8.07**
SF5	4.52	3.34	0.35	3	5.37**	2.74	4.70	0.71	2	9.06**
SF6	4.57	3.58	0.28	6	5.36**	2.97	4.70	0.58	6	6.51**
SF7	4.53	3.20	0.41	1	5.42**	2.88	4.58	0.59	5	6.53**
Total	4.52	3.38	0.34	-	5.29**	2.90	4.67	0.62	-	7.16**

Note: **Significance <0.01.

As shown in Table 5, all seven skill factors exhibited statistically significant differences between actual and desired skill levels for both stakeholder groups ($p < .01$). However, the magnitude of the gaps and the priority rankings varied between the groups.

The overall PNImodified for IT entrepreneurs was 0.34, while it was substantially higher for IT instructors at 0.62, indicating that instructors perceived greater competency gaps than their industry counterparts.

Both groups identified SF4 – Writing effective commit messages and SF7 – Detecting and resolving errors as top-priority skills. However, the rankings were more pronounced among instructors, who ranked SF4 and SF5 as their top two needs.

The most significant discrepancy between groups was observed in SF2 – Branching and merging, where instructors reported a much higher PNImodified (0.70) compared to entrepreneurs (0.32), suggesting stronger concerns from educators about student difficulties in managing branches.

Highlights by Skill factor

- SF4 (Writing commit messages): Ranked 1st by instructors (PNI = 0.73) and 2nd by entrepreneurs (PNI = 0.38).
- SF7 (Error detection and resolution): Highest priority for entrepreneurs (PNI = 0.41), ranked 5th by instructors (PNI = 0.59).
- SF5 (Tracking change history): Ranked 2nd by instructors (PNI = 0.71) and 3rd by entrepreneurs (PNI = 0.35).
- SF1 (Using basic Version Control System commands): Received the lowest ranking from both groups (entrepreneurs = Rank 6; instructors = Rank 7), indicating that students are relatively proficient in basic operations.

While both groups acknowledged gaps in all skill factors, instructors consistently reported higher PNImodified values, indicating more significant concern over student preparedness. This may be due to instructors' broader visibility into students' overall performance across multiple projects and assessment criteria. Conversely, entrepreneurs may focus more narrowly on the competencies demonstrated during cooperative education placements.

These comparative insights underscore the importance of aligning academic training with industry expectations—especially in advanced version control tasks such as collaborative workflows, error handling, and clear code documentation through commit messages.

4. Discussion

The findings from this research reveal significant competency gaps between actual and desired levels of VCS skills among undergraduate IT students. This study highlights the need for

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comprehensive skill enhancement in VCS competencies, aligning with current software engineering education trends. Bonakdarian [21] and Case, et al. [22] confirmed that proficiency in core VCS operations, including command-line interface usage, collaborative platforms, and meaningful commit messaging, is crucial for preparing students effectively for modern software development practices. However, the overall average PNImodified value of 0.39 indicates substantial room for improvement across all skill areas, underscoring a critical need to integrate structured VCS education into undergraduate curricula. Indeed, the reviewed literature emphasizes curriculum integration and structured guidance as effective strategies to close these gaps and improve professional readiness [22, 23].

The top three priority skills identified in this study were writing effective commit messages (SF4), detecting and resolving errors (SF7), and tracking change history (SF5). The highest PNImodified values of 0.45 for commit messaging and error resolution indicate that these advanced skills are notably lacking among students. This outcome aligns closely with Lopes [24] and Tian, et al. [25] research, emphasizing that structured guidance and specific training on crafting clear and informative commit messages significantly improve code readability and facilitate collaboration. Additionally, Berg, et al. [26] suggest a scaffolding approach, introducing commit message skills incrementally through structured assignments, effectively building these competencies systematically.

Error detection and resolution skills, equally critical and prioritized highly by stakeholders, underline students' struggles with debugging and resolving version control conflicts—skills essential for agile and DevOps environments. This result is consistent with literature emphasizing real-world problem-solving scenarios and practical conflict-resolution training within educational frameworks [27, 28].

Tracking change history was the third-highest priority identified, reflecting stakeholders' perceptions that students often neglect the detailed examination of code evolution—which is essential for understanding development processes and collaborative work [28, 29] highlight that mastering change tracking is fundamental for transparency, reproducibility, and efficient collaboration in software projects.

These findings strongly advocate for a targeted curriculum reform incorporating structured teaching approaches, early exposure to distributed version control concepts, and practical application in collaborative environments. Such measures can significantly improve student preparedness in essential VCS competencies, narrowing the gap between academia and industry expectations. Consequently, developing a comprehensive training curriculum incorporating blended learning approaches, hands-on problem-based learning scenarios, and integrating advanced AI-supported tools (such as GitHub Copilot and CommitBERT) could further enhance student engagement and mastery of critical VCS skills.

5. Suggestions

Based on the findings of this needs assessment, the following recommendations are proposed:
Adopting blended learning and problem-based learning (PBL) approaches can provide a more flexible and engaging instructional model. Blended learning allows for a combination of self-paced online tutorials and face-to-face guidance, which is especially effective for technical subjects like VCS. Meanwhile, PBL promotes critical thinking and collaboration by engaging students in solving real-world problems using version control tools. These pedagogical strategies can help bridge the gap between theoretical instruction and practical application, addressing the challenges students and educators report.

Integrating generative AI technologies—such as GitHub Copilot and ChatGPT—can serve as intelligent learning assistants within the version control learning environment. These tools can offer real-time suggestions for commit messages, explain VCS commands, and help debug version control issues, making learning more efficient and personalized. Leveraging AI in this way can reduce students'

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cognitive load, increase learning motivation, and support the development of a deeper understanding of complex tasks.

Lastly, IT instructors and entrepreneurs should continue collaborating in designing and delivering training modules to ensure the curriculum remains aligned with current industry needs.

6. Conclusion

This study conducted a systematic needs assessment of Git-based version control system (VCS) skills among undergraduate IT students, as perceived by IT instructors and IT entrepreneurs. The results revealed significant skill gaps in all seven core VCS areas, particularly in commit messaging, error resolution, and collaborative repository management. The study identified critical priorities for curriculum enhancement using the Priority Needs Index (PNImodified) and paired-sample t-tests.

The consistency of stakeholder feedback confirms the urgent need to redesign existing instructional practices in VCS education. As a result, the next phase of this research will focus on the development of a training curriculum aimed at enhancing version control system skills through blended learning and problem-based learning (PBL) methodologies, augmented with Generative AI technologies. This future-oriented curriculum aims to bridge the academic-industry gap and empower IT graduates with the practical, collaborative, and adaptive skills required in modern software development environments.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Authors' Contributions:

Supeeti Kulchan conceptualized the study, designed the questionnaire, and led the data analysis. Paitoon Pimdee supervised the research framework and contributed to the literature review and methodology. Aukkapong Sukkamart provided critical revisions, assisted with statistical validation, and refined the overall structure of the article. All authors reviewed and approved the final manuscript.

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