Learning Policies and Strategies
Volume: 5 Issue: 2 Year: 2026
ISSN: 2957-4110

KMF Publishers
www.kmf-publishers.com/lps/

Volume: 5, Issue: 2, Year: 2026

DOI: https://doi.org/10.64907/xkmf.v5i2.lps.2

Learning Policies and Strategies RESEARCH ARTICLE

Received: 2 May 2026
Accepted: 25 June 2026

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Disclosure statement
No potential conflict of interest was reported by the author(s).

Team-Based Software Projects and Professional Skill Formation: An Ethnographic Study in Undergraduate CSE Classrooms

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Abstract: Team-based software projects have become a central pedagogical strategy in undergraduate Computer Science and Engineering (CSE) education, aiming to bridge the gap between technical knowledge and professional skill requirements. This study adopts an ethnographic perspective to examine how collaborative project environments contribute to the formation of professional skills among undergraduate students. Using a qualitative research design based on secondary data, including published ethnographic studies, case analyses, and reflective narratives, the study explores the sociocultural dynamics of teamwork in CSE classrooms. Anchored in social constructivism, communities of practice, and experiential learning theory, the findings reveal that team-based projects significantly enhance communication, leadership, conflict resolution, and time management skills while facilitating the development of professional identity. However, challenges such as unequal participation, communication barriers, and interpersonal conflicts can limit learning outcomes if not properly managed. The study highlights the importance of structured pedagogical interventions, reflective practices, and inclusive team design in maximising the benefits of collaborative learning. Overall, the research underscores that professional skills are not merely taught but are socially constructed through participation in authentic, practice-based learning environments.

Keywords: team-based learning, software engineering education, professional skills, ethnography, collaborative learning, experiential learning, communities of practice.

Citation information
Cite this article as Sinha, N.H., & Mannan, K.A. (2026). Team-Based Software Projects and Professional Skill Formation: An Ethnographic Study in Undergraduate CSE Classrooms. *Learning Policies and Strategies*, 5(2), 1-17. DOI: https://doi.org/10.64907/xkmf.v5i2.lps.2

1. Introduction

The contemporary software industry is characterised by rapid technological change, global collaboration, and increasingly complex project environments. In response to these evolving demands, employers are no longer satisfied with graduates who possess only technical expertise; instead, they seek individuals equipped with a broad spectrum of professional competencies, including communication, teamwork, adaptability, leadership, and problem-solving skills (National Association of Colleges and Employers [NACE], 2020). Within this context, undergraduate Computer Science and Engineering (CSE) education faces the critical challenge of preparing students not only as competent programmers but also as effective collaborators in professional settings.

One pedagogical response to this challenge has been the integration of team-based software projects into the CSE curriculum. These projects simulate real-world software development environments in which students work collaboratively to design, implement, test, and deliver software systems. Such collaborative learning approaches align with industry practices, particularly Agile and Scrum methodologies, which emphasise teamwork, iterative development, and continuous feedback (Beck et al., 2001). By engaging in team-based projects, students are expected to acquire both technical and non-technical skills that are essential for professional success.

Despite the widespread adoption of team-based learning (TBL) in engineering education, questions remain regarding how these collaborative experiences contribute to the formation of professional skills. While existing research has demonstrated that active and collaborative learning approaches improve student engagement and academic performance (Prince, 2004), less attention has been given to the sociocultural processes through which professional competencies are developed. In particular, there is a need to understand how students navigate interpersonal dynamics, negotiate roles, manage conflicts, and construct professional identities within team-based project environments.

An ethnographic perspective offers a valuable lens for exploring these processes. Ethnography, as a qualitative research approach, focuses on understanding the lived experiences, cultural practices, and social interactions of individuals within specific contexts (Hammersley & Atkinson, 2007). In the context of CSE classrooms, ethnographic inquiry can reveal how students experience teamwork, how group norms are established, and how learning occurs through interaction and participation. Such an approach moves beyond measuring outcomes to examining the processes and meanings associated with collaborative learning.

However, conducting primary ethnographic research can be resource-intensive and context-specific. As an alternative, this study adopts a qualitative approach based on the analysis of secondary data, including published ethnographic studies, case reports, and reflective student narratives. By

synthesising insights from diverse sources, the study aims to provide a comprehensive understanding of how team-based software projects contribute to professional skill formation across different educational settings.

The importance of this inquiry is particularly pronounced in developing countries such as Bangladesh, where the CSE sector is rapidly expanding and contributing significantly to economic growth. Universities are under increasing pressure to produce graduates who can compete in the global software market. However, traditional lecture-based teaching methods often dominate the educational landscape, limiting opportunities for students to develop practical and interpersonal skills. Team-based software projects thus represent a critical pedagogical innovation for bridging the gap between academic training and industry expectations.

This study is guided by three central research questions:

- How do team-based software projects facilitate the development of professional skills among undergraduate CSE students?
- What social and cultural dynamics influence skill formation in collaborative project environments?
- What challenges and limitations affect the effectiveness of team-based learning in software engineering education?

To address these questions, the study is grounded in three complementary theoretical frameworks: social constructivism, communities of practice, and experiential learning theory. Social constructivism emphasises the role of interaction in knowledge construction (Vygotsky, 1978), while communities of practice highlight learning as participation in shared social activities (Lave & Wenger, 1991). Experiential learning theory underscores the importance of learning through experience and reflection (Kolb, 1984). Together, these frameworks provide a robust foundation for analysing how professional skills emerge within collaborative learning environments.

The significance of this study lies in its contribution to both theory and practice. Theoretically, it advances understanding of professional skill formation as a socially situated process. Practically, it offers insights for educators seeking to design effective team-based learning experiences that foster both technical and professional development.

2. Literature Review

Team-based learning (TBL) has emerged as a transformative pedagogical approach in higher education, particularly in engineering and computer science disciplines. Rooted in active learning principles, TBL emphasises student engagement, collaboration, and application of knowledge to real-world problems (Michaelsen et al., 2008). In contrast to traditional lecture-based instruction, TBL shifts the focus from passive reception of information to active participation in learning processes.

In the context of CSE education, team-based software projects are particularly relevant because they mirror industry practices. Modern software development is inherently

collaborative, involving cross-functional teams that work together to design, develop, and maintain complex systems. Agile methodologies, such as Scrum and Extreme Programming, further reinforce the importance of teamwork, communication, and iterative development (Beck et al., 2001).

Empirical studies have consistently demonstrated the benefits of TBL in engineering education. For instance, Prince (2004) found that active and collaborative learning approaches lead to improved academic performance, greater retention of knowledge, and enhanced critical thinking skills. Similarly, Felder and Brent (2016) argue that teamwork fosters deeper understanding by requiring students to articulate their ideas, challenge assumptions, and integrate diverse perspectives.

However, the effectiveness of TBL is not uniform across contexts. Factors such as group composition, task design, and instructor facilitation significantly influence learning outcomes. Without proper structure, team-based projects can lead to issues such as social loafing, unequal participation, and conflict among team members (Oakley et al., 2004).

2.1 Professional Skills in the Software Engineering Context

Professional skills, often referred to as soft skills or employability skills, encompass a range of competencies that enable individuals to function effectively in workplace environments. These include communication, teamwork, leadership, problem-solving, adaptability, and ethical decision-making (Robles, 2012).

In the software engineering domain, the importance of professional skills has been widely recognised. Employers frequently report that technical proficiency alone is insufficient for success; rather, they seek graduates who can collaborate effectively, communicate with stakeholders, and adapt to changing requirements (NACE, 2020). This is particularly important in global software development, where teams are often distributed across different geographical and cultural contexts.

Despite their importance, professional skills are often underemphasized in CSE curricula. Traditional teaching methods focus primarily on technical knowledge, leaving limited opportunities for students to develop interpersonal competencies. Team-based projects offer a potential solution by providing authentic contexts in which students can practice and refine these skills.

Research has shown that participation in collaborative projects enhances professional skill development. For example, Lingard and Barkataki (2011) found that software engineering students who engaged in team projects demonstrated significant improvements in communication, teamwork, and project management skills. Similarly, Passow and Passow (2017) identified teamwork and communication as critical learning outcomes in engineering education.

2.2 Ethnographic Studies of Classroom Interaction

Ethnography provides a powerful methodological approach for understanding the complexities of learning in social contexts. By focusing on lived experiences

and cultural practices, ethnographic studies offer rich insights into how students interact, collaborate, and learn within classroom environments (Hammersley & Atkinson, 2007).

In engineering education, ethnographic research has highlighted the importance of social interaction in learning processes. Johri and Olds (2011) argue that learning is not merely an individual cognitive activity but a socially situated process that occurs through participation in communities of practice. Their work emphasises the role of identity, culture, and context in shaping learning experiences.

Ethnographic studies of team-based learning environments reveal that group dynamics play a crucial role in shaping outcomes. For instance, students often develop informal norms and roles that influence participation and decision-making. Leadership may emerge organically based on expertise or personality traits, rather than being formally assigned. Additionally, communication patterns, both formal and informal, affect the flow of information and the effectiveness of collaboration.

These studies also highlight challenges associated with teamwork, including conflict, power imbalances, and cultural differences. Understanding these dynamics is essential for designing effective collaborative learning environments.

2.3 Theoretical Perspectives on Collaborative Learning

Several theoretical frameworks provide insights into the processes underlying team-based learning and professional skill formation.

Social Constructivism: Social constructivism posits that knowledge is constructed through interaction with others and the environment (Vygotsky, 1978). Learning occurs as individuals engage in dialogue, share perspectives, and negotiate meanings. In team-based projects, students co-construct knowledge by working together to solve problems and complete tasks.

Communities of Practice: The concept of communities of practice (CoP), developed by Lave and Wenger (1991), emphasises learning as participation in social groups engaged in shared activities. In this framework, newcomers gradually move from peripheral participation to full membership as they gain experience and competence. Team-based projects can be viewed as micro-communities of practice in which students develop professional identities through participation.

Experiential Learning: Kolb's (1984) experiential learning theory highlights the role of experience in learning. According to this model, learning involves a cyclical process of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Team-based projects provide opportunities for students to engage in this cycle, thereby enhancing both technical and professional competencies.

2.4 Challenges and Gaps in Existing Research

Despite the growing body of literature on team-based learning and professional skills, several gaps remain. First, much of the

existing research focuses on quantitative outcomes, such as grades and test scores, rather than qualitative experiences and processes. This limits understanding of how skills are actually developed in practice.

Second, there is a lack of research that integrates multiple theoretical perspectives to provide a holistic understanding of collaborative learning. While individual theories offer valuable insights, combining them can provide a more comprehensive framework for analysis.

Third, there is limited research on the use of secondary qualitative data in ethnographic studies. Most ethnographic research relies on primary fieldwork, which can be time-consuming and context-specific. Secondary data analysis offers a valuable alternative for synthesising insights across diverse settings.

Finally, there is a need for more context-specific research, particularly in developing countries. Educational practices and cultural dynamics vary significantly across contexts, and findings from Western settings may not be directly applicable elsewhere.

3. Theoretical Framework

Understanding how professional skills emerge within team-based software projects requires a multidimensional theoretical foundation that captures both cognitive and social dimensions of learning. This study draws on three complementary theoretical perspectives, social constructivism, communities of practice, and experiential learning theory, to explain how undergraduate CSE students develop professional competencies through collaborative engagement. Together, these frameworks provide a holistic lens for examining learning as a socially situated, participatory, and experience-driven process.

3.1 Social Constructivism and Collaborative Knowledge Construction

Social constructivism, primarily associated with the work of Vygotsky (1978), posits that learning is fundamentally a social process in which knowledge is constructed through interaction with others and the surrounding cultural environment. Unlike individualistic theories of learning that emphasise internal cognitive processes, social constructivism highlights the role of dialogue, collaboration, and shared meaning-making in knowledge development.

A central concept in Vygotsky's theory is the Zone of Proximal Development (ZPD), which refers to the gap between what a learner can achieve independently and what they can accomplish with guidance or collaboration. In team-based software projects, students operate within each other's ZPDs by sharing knowledge, providing feedback, and collaboratively solving problems. For instance, a student with stronger programming skills may assist peers in debugging code, thereby facilitating collective learning.

Language and communication play a crucial role in this process. Through discussions, code reviews, and collaborative problem-solving, students articulate their ideas, negotiate meanings, and refine their understanding. These interactions not only enhance technical knowledge but also

contribute to the development of professional communication skills (Mercer & Littleton, 2007).

Moreover, social constructivism underscores the importance of context in learning. Team-based projects provide authentic contexts that mirror real-world software development environments, allowing students to apply theoretical knowledge in practical situations. This contextualization enhances the relevance and transferability of learning outcomes (Jonassen, 1999).

3.2 Communities of Practice and Professional Identity Formation

The concept of communities of practice (CoP), introduced by Lave and Wenger (1991), extends the social constructivist perspective by emphasising learning as participation in social groups engaged in shared practices. According to this framework, learning is not merely the acquisition of knowledge but a process of becoming a member of a community and developing an identity within that community.

In team-based software projects, student groups function as micro-communities of practice. Members engage in shared activities such as coding, testing, documentation, and project management. Through these activities, students learn not only technical skills but also the norms, values, and practices associated with the software engineering profession.

A key concept within CoP is legitimate peripheral participation, which describes how newcomers gradually move from peripheral roles to more central positions as they gain experience and competence. In the context of CSE classrooms, novice students may initially take on simpler tasks, such as documentation or testing, before progressing to more complex roles like system design or team leadership. This progression reflects the development of both competence and confidence.

Identity formation is a critical outcome of participation in communities of practice. As students engage in collaborative projects, they begin to see themselves as software developers, team members, and problem-solvers. This transformation is reinforced by interactions with peers and instructors, as well as by the successful completion of project tasks (Wenger, 1998).

Furthermore, CoP theory highlights the importance of shared repertoire, including tools, language, and practices. In software projects, this may include programming languages, version control systems (e.g., Git), and development methodologies. Mastery of these tools contributes to students' professional competence and integration into the broader software engineering community.

3.3 Experiential Learning Theory and Skill Development

Experiential learning theory, developed by Kolb (1984), provides a complementary perspective by emphasising the role of experience in learning. According to Kolb, learning is a cyclical process involving four stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation.

Team-based software projects inherently support this learning cycle. Students engage

in concrete experiences by working on real or simulated software development tasks. They then engage in reflective observation by evaluating their performance, discussing challenges, and receiving feedback from peers and instructors. This reflection leads to abstract conceptualisation, where students develop general principles or strategies for problem-solving. Finally, they apply these insights through active experimentation in subsequent iterations of the project.

This iterative process is particularly relevant in Agile development environments, where continuous improvement and adaptation are central principles (Beck et al., 2001). Through repeated cycles of action and reflection, students develop not only technical skills but also professional competencies such as adaptability, resilience, and critical thinking.

Experiential learning also emphasises the importance of learning by doing, which is essential for skill acquisition in complex domains like software engineering. Unlike theoretical instruction, hands-on project work allows students to encounter real-world challenges, make mistakes, and learn from them. This process fosters deeper understanding and long-term retention of knowledge (Kolb & Kolb, 2005).

3.4 Integrative Perspective

While each of these theoretical frameworks offers valuable insights, their integration provides a more comprehensive understanding of professional skill formation. Social constructivism explains how knowledge is co-constructed through interaction; communities of practice highlight the role of participation and identity; and experiential learning emphasises the importance of action and reflection.

Together, these perspectives suggest that professional skills are not simply taught but are emergent properties of participation in collaborative, practice-based learning environments. Team-based software projects thus serve as fertile grounds for the development of both technical expertise and professional competencies.

4. Methodology

This study adopts a qualitative research design with an ethnographic orientation, focusing on the interpretive analysis of secondary data. Qualitative research is particularly suitable for exploring complex social phenomena, such as professional skill formation, where the aim is to understand meanings, experiences, and interactions rather than to measure variables (Creswell & Poth, 2018).

An ethnographic orientation allows the study to examine the cultural and social dynamics of team-based learning environments. While traditional ethnography involves prolonged fieldwork and participant observation, this study employs a secondary data ethnography approach, synthesising existing qualitative research to generate new insights (Heaton, 2004).

4.1 Data Sources and Selection Criteria

The study draws on a diverse range of secondary data sources to ensure a comprehensive analysis. These include:

- Peer-reviewed journal articles on team-based learning and software engineering education
- Ethnographic studies of classroom interactions
- Case studies and project reports from CSE programs
- Student reflective journals and narratives
- Institutional and curriculum evaluation reports

To ensure relevance and quality, the following inclusion criteria were applied:

- Publications between 2000 and 2025
- Focus on undergraduate engineering or computer science education
- Emphasis on team-based or collaborative learning
- Inclusion of qualitative data (e.g., interviews, observations, reflections)

A total of approximately 45–60 sources were selected for analysis.

4.2 Data Analysis Procedure

The study employs thematic analysis, a widely used method for identifying, analysing, and interpreting patterns within qualitative data (Braun & Clarke, 2006). The analysis was conducted in several stages:

Familiarisation: The researcher first reviewed all selected sources to gain a comprehensive understanding of the content. Key excerpts related to teamwork, communication, leadership, and other professional skills were identified.

Coding: Relevant data segments were coded using an inductive approach. Codes were assigned to recurring concepts such as "peer collaboration," "conflict resolution," "role distribution," and "identity development."

Theme Development: Codes were grouped into broader themes that captured patterns across the data. For example, codes related to communication and interaction were combined into a theme of "collaborative communication."

Interpretation: Themes were interpreted in light of the theoretical frameworks discussed in Section 3. This step involved linking empirical findings to concepts such as ZPD, communities of practice, and experiential learning cycles.

4.3 Trustworthiness and Rigour

Ensuring the credibility and reliability of qualitative research is essential. This study adopts several strategies to enhance trustworthiness:

- **Credibility:** Triangulation of multiple data sources helps validate findings (Lincoln & Guba, 1985).
- **Transferability:** Detailed descriptions of contexts and themes allow readers to assess applicability to other settings.
- **Dependability:** A transparent and systematic analysis process ensures consistency.

- **Confirmability:** Findings are grounded in data and supported by citations, minimising researcher bias.

4.4 Ethical Considerations

As the study relies on publicly available secondary data, issues related to informed consent and participant confidentiality are minimised. However, ethical research practices are maintained by:

- Properly citing all sources
- Avoiding misrepresentation of original findings
- Respecting intellectual property rights

Additionally, the study adheres to academic integrity standards by ensuring accurate interpretation and acknowledgement of prior work (Mannan & Farhana, 2026).

4.6 Limitations of the Methodology

Despite its strengths, the methodology has certain limitations. First, the reliance on secondary data means that the researcher has limited control over data quality and context. Second, the absence of direct observation may restrict the depth of ethnographic insights. Third, findings may be influenced by the contexts of the original studies, which may vary across institutions and cultures.

Nevertheless, the use of diverse data sources and rigorous analytical methods helps mitigate these limitations and provides a robust foundation for understanding professional skill formation in team-based learning environments.

5. Findings and Analysis

The thematic analysis of secondary qualitative data reveals that team-based software projects play a multifaceted role in shaping professional skills among undergraduate CSE students. These findings are organised into six interrelated themes: collaborative communication, leadership and role negotiation, conflict resolution and emotional regulation, time management and accountability, technical–professional skill integration, and identity formation and professional socialisation. Each theme reflects not only observable behaviours but also deeper sociocultural processes that align with the study's theoretical frameworks.

5.1 Collaborative Communication as a Core Competency

Communication emerged as one of the most consistently reported outcomes of team-based learning environments. Students engaged in frequent interactions through meetings, code reviews, online collaboration platforms, and informal discussions. These interactions contributed to the development of both technical communication (e.g., explaining algorithms, documenting code) and interpersonal communication (e.g., negotiating ideas, providing feedback).

From a social constructivist perspective, communication functions as the primary medium through which knowledge is co-constructed (Vygotsky, 1978). Ethnographic accounts indicate that students learn to articulate complex ideas more clearly when required to explain their reasoning to peers. This process not only enhances understanding but also promotes critical

thinking, as students must justify their decisions and respond to alternative viewpoints (Mercer & Littleton, 2007).

However, communication was not always smooth or effective. Several studies reported challenges such as misinterpretation of messages, lack of clarity in task assignments, and language barriers in multicultural teams. These issues often led to delays and misunderstandings, highlighting that communication skills are not automatically acquired but require deliberate practice and guidance (Lingard & Barkataki, 2011).

5.2 Leadership and Role Negotiation in Collaborative Contexts

Leadership within student teams was found to be dynamic and context-dependent. Rather than being formally assigned, leadership often emerged organically based on individual competencies, initiative, or prior experience. This aligns with the concept of distributed leadership, where multiple team members contribute to leadership functions depending on the task at hand (Bolden, 2011).

Students assumed various roles such as project manager, lead developer, tester, or documentation specialist. These roles were not static; instead, they evolved as team members negotiated responsibilities and adapted to project demands. This process reflects the principles of communities of practice, where participation and role-taking are central to learning (Lave & Wenger, 1991).

Importantly, leadership experiences contributed significantly to professional skill development. Students who assumed leadership roles reported improvements in decision-making, coordination, and conflict management. However, challenges such as unequal participation and dominance by certain individuals were also observed. In some cases, strong personalities overshadowed quieter team members, limiting their opportunities to contribute.

These findings suggest that while team-based projects provide opportunities for leadership development, the quality of these experiences depends on group dynamics and the presence of supportive structures.

5.3 Conflict Resolution and Emotional Regulation

Conflict is an inevitable aspect of collaborative work, and team-based software projects are no exception. The analysis revealed that conflicts often arose from differences in opinions, work ethics, skill levels, and commitment. While some conflicts were task-related and constructive, others were interpersonal and disruptive.

From an experiential learning perspective, conflict situations serve as valuable learning opportunities. Students learn to navigate disagreements, negotiate solutions, and develop emotional regulation skills (Kolb, 1984). Ethnographic studies indicate that students who successfully managed conflicts developed greater resilience and adaptability.

However, not all students were equipped to handle conflicts effectively. In some cases, conflicts remained unresolved, leading to frustration, reduced motivation, and compromised project outcomes. Cultural factors also played a role, particularly in

contexts where hierarchical norms discouraged open disagreement.

These findings highlight the importance of emotional intelligence in team-based learning environments. Skills such as empathy, self-awareness, and conflict management are essential for maintaining positive team dynamics (Goleman, 1995). Without these skills, the benefits of collaboration may be undermined.

5.4 Time Management and Accountability

Time management and accountability emerged as critical competencies developed through team-based projects. Students were required to coordinate schedules, meet deadlines, and manage interdependent tasks. This often involved the use of project management tools and techniques, such as task boards, timelines, and version control systems.

The collaborative nature of these projects increased students' sense of responsibility, as individual performance directly affected team outcomes. This aligns with the concept of positive interdependence, where team members rely on each other to achieve shared goals (Johnson & Johnson, 2009).

Despite these benefits, challenges such as procrastination, uneven workload distribution, and lack of commitment were frequently reported. Social loafing, where some team members contribute less than others, was a recurring issue (Oakley et al., 2004). This not only affected project quality but also created tension within teams.

To mitigate these challenges, some studies highlighted the effectiveness of peer evaluation systems and structured milestones. These mechanisms helped ensure accountability and provided incentives for active participation.

5.5 Integration of Technical and Professional Skills

One of the most significant findings is the integration of technical and professional skills within team-based projects. Unlike traditional coursework, which often separates technical content from soft skills, collaborative projects require students to apply both simultaneously.

For example, debugging a piece of code may involve not only technical problem-solving but also communication with team members, coordination of tasks, and documentation of solutions. This integrated learning experience aligns with experiential learning theory, where knowledge is constructed through action and reflection (Kolb & Kolb, 2005).

Students reported that working on real-world projects enhanced their confidence and preparedness for professional environments. They developed a better understanding of software development processes, including requirement analysis, design, implementation, and testing.

However, the extent of skill integration varied across contexts. In some cases, projects were poorly structured or lacked clear objectives, limiting their effectiveness. This underscores the importance of thoughtful instructional design in maximising learning outcomes.

5.6 Identity Formation and Professional Socialisation

Perhaps the most profound outcome of team-based learning is its impact on students' professional identity. Through participation in collaborative projects, students begin to see themselves as members of the software engineering community.

This process of identity formation is central to the communities of practice framework (Wenger, 1998). As students engage in shared practices, they internalise the norms, values, and expectations of the profession. They learn not only how to code but also how to think and behave like software engineers.

Ethnographic accounts reveal that students often experience a shift in self-perception, from passive learners to active contributors. This transformation is reinforced by successful project outcomes, peer recognition, and feedback from instructors.

However, identity formation is not uniform across all students. Factors such as prior experience, confidence levels, and group dynamics influence the extent to which individuals identify with the profession. Some students may feel marginalised or excluded, particularly if they struggle to contribute meaningfully.

6. Discussion

The findings of this study provide a nuanced understanding of how team-based software projects contribute to professional skill formation in undergraduate CSE education. By interpreting these findings through the lenses of social constructivism, communities of practice, and experiential learning theory, this section offers deeper insights into the mechanisms underlying collaborative learning and its implications for pedagogy.

6.1 Learning as a Socially Situated Process

The prominence of communication, collaboration, and interaction in the findings underscores the fundamentally social nature of learning. From a social constructivist perspective, knowledge is not transmitted from instructor to student but co-constructed through dialogue and shared activity (Vygotsky, 1978).

Team-based projects create environments where students engage in meaningful interactions that facilitate learning. These interactions extend beyond formal classroom settings to include informal discussions, online communication, and peer feedback. Such interactions are critical for developing higher-order thinking skills and professional competencies.

However, the effectiveness of these interactions depends on the quality of communication and the inclusivity of the learning environment. Barriers such as language differences, cultural norms, and power dynamics can hinder participation and limit learning opportunities.

6.2 Participation and Identity in Communities of Practice

The findings strongly support the notion that team-based projects function as communities of practice. Students learn by participating in shared activities and gradually assuming

more central roles within the group (Lave & Wenger, 1991).

This participatory process is closely linked to identity formation. As students engage in collaborative work, they develop a sense of belonging and begin to identify with the professional community. This transformation is essential for preparing students to transition from academic settings to professional environments.

However, participation is not equally distributed among all students. Issues such as social loafing, dominance by certain individuals, and exclusion of less confident members can create inequities in learning opportunities. These challenges highlight the need for intentional design and facilitation of team-based learning environments.

6.3 Experiential Learning and Skill Integration

The integration of technical and professional skills observed in the findings aligns with experiential learning theory. Team-based projects provide concrete experiences that enable students to apply theoretical knowledge in practical contexts (Kolb, 1984).

The iterative nature of software development further enhances this learning process. Through cycles of action, reflection, and improvement, students develop a deeper understanding of both technical concepts and professional practices. This experiential approach is particularly effective in preparing students for the complexities of real-world software development.

Nevertheless, the quality of experiential learning depends on the design of the project and the availability of support mechanisms. Without clear objectives, guidance, and feedback, students may struggle to derive meaningful learning from their experiences.

6.4 The Role of Emotional and Interpersonal Skills

The findings highlight the critical role of emotional and interpersonal skills in collaborative learning. Conflict resolution, empathy, and communication are essential for maintaining positive team dynamics and achieving project goals.

These skills are often overlooked in traditional curricula but are increasingly recognised as vital for professional success (Robles, 2012). Team-based projects provide a natural context for developing these competencies, as students must navigate complex social interactions and manage interpersonal challenges.

However, the development of these skills is not automatic. Students may require explicit instruction and support in areas such as conflict management and emotional intelligence. Incorporating training and reflection activities into the curriculum can enhance these outcomes.

6.5 Implications for Pedagogical Practice

The findings of this study have several implications for educators:

- **Structured Team Formation and Role Assignment**: Carefully designed teams with balanced skills

and clear roles can enhance collaboration and reduce conflicts.

- **Integration of Soft Skills Training**: Professional skills should be explicitly taught and assessed, rather than assumed to develop naturally.
- **Use of Reflective Practices**: Encouraging students to reflect on their experiences can deepen learning and promote self-awareness.
- **Continuous Feedback and Evaluation**: Regular feedback from peers and instructors can help identify and address issues early.
- **Cultural Sensitivity and Inclusivity**: Recognising and addressing cultural differences can improve communication and participation.

6.6 Broader Implications and Future Directions

The study also has broader implications for engineering education and workforce development. As the software industry becomes increasingly global and collaborative, the ability to work effectively in teams is more important than ever.

Future research could explore:

- Longitudinal studies of skill development over time
- Cross-cultural comparisons of team-based learning
- Integration of digital collaboration tools

7. Conclusion

This study set out to explore how team-based software projects contribute to professional skill formation among undergraduate CSE students through an ethnographic and qualitative lens. Drawing on secondary data and grounded in established theoretical frameworks, the findings demonstrate that collaborative learning environments play a crucial role in bridging the gap between academic instruction and industry expectations.

One of the central conclusions of this research is that professional skills, such as communication, teamwork, leadership, and conflict resolution, are not acquired in isolation but emerge through sustained social interaction and shared practice. Team-based projects provide a unique platform where students engage in authentic problem-solving tasks, negotiate roles, manage interpersonal dynamics, and collectively construct knowledge. These processes align closely with the principles of social constructivism and communities of practice, emphasising that learning is inherently social and participatory.

Moreover, the study highlights the importance of experiential learning in fostering both technical and non-technical competencies. Through iterative cycles of action, reflection, and adaptation, students develop a deeper understanding of software development processes while simultaneously enhancing their professional capabilities. This integration of skills is particularly valuable in preparing graduates for the complexities of real-world software engineering environments.

However, the findings also reveal significant challenges that can hinder the effectiveness of team-based learning. Issues such as unequal participation, communication breakdowns, cultural differences, and conflict mismanagement underscore the need for intentional pedagogical design. Without proper structure and guidance, collaborative projects may fail to deliver their full educational potential.

In light of these insights, the study emphasises the role of educators in facilitating effective team-based learning experiences. Strategies such as structured team formation, clear role allocation, peer evaluation systems, and the incorporation of reflective practices can significantly enhance learning outcomes. Additionally, integrating explicit training in professional and interpersonal skills can help students navigate the complexities of teamwork more effectively.

In conclusion, team-based software projects represent a powerful pedagogical tool for holistic skill development in CSE education. By fostering both technical expertise and professional competencies, they prepare students to thrive in collaborative and dynamic work environments. Future research should continue to explore context-specific implementations and long-term impacts of such pedagogical approaches, particularly in diverse educational settings.

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