

***Beyond Content:  
Exploring the Impact of Team Characteristics in Effective Project-Based Learning***

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**Abstract**

Project-based learning (PBL) is a pedagogy that is widely adopted for its authentic, complex and collaborative learning experience. Many studies have shown that team effectiveness (TE) plays a pivotal role in determining the success of project outcomes. Effective teams are generally characterised by shared goals, clear communication, mutual respect and a commitment to collective success. This paper aims to study the specific mechanisms and conditions that optimally enhance team performance in PBL. It highlights the importance of effective team processes and team dynamics, including appropriate deployment of decision-making and conflict resolution strategies, task assignments, team feedback and reflections, in conjunction with the cohesive integration of each member's contribution with a growth mindset towards the development and evaluation of team competencies. Furthermore, it also explores the role of project supervisors in fostering team effectiveness through providing structured guidance, constructive feedback and appropriate resources to students. The framework of fostering a positive team culture is evaluated by four dimensions, namely Team Motivation (TM), Team Structure (TS), Team Dynamics (TD) and Team Excellence (TE). Empirical evidence inferred from their strong positive Spearman correlation ( $\rho > 0.82$ ) confirm the proposition that team characteristics are interrelated and mutually reinforcing for the facilitation of successful PBL learning outcomes.

Keywords: Project-Based Learning, Team Effectiveness, Team Motivation, Team Structure, Team Dynamics and Team Excellence

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## Introduction

Teamwork is the catalyst for success in project-based learning (PBL). By leveraging diverse perspectives and skills, teams can tackle complex challenges, foster innovation, and achieve exceptional outcomes. Effective collaboration is crucial for optimising learning and project quality. Given the significant impact of team effectiveness on student learning and performance, there is imperative to explore the key components of effective teams and identify strategies to cultivate positive team dynamics within the PBL framework. This research aims to answer the following questions:

1. What are the core characteristics of a high-performing team in a PBL context?
2. Which strategies can educators implement to foster a positive and collaborative team environment within PBL projects?

To fully understand and enhance team effectiveness in PBL setting, this study will adopt a multidimensional framework comprising Team Motivation (TM), Team Structure (TS), Team Dynamics (TD) and Team Excellence (TE).

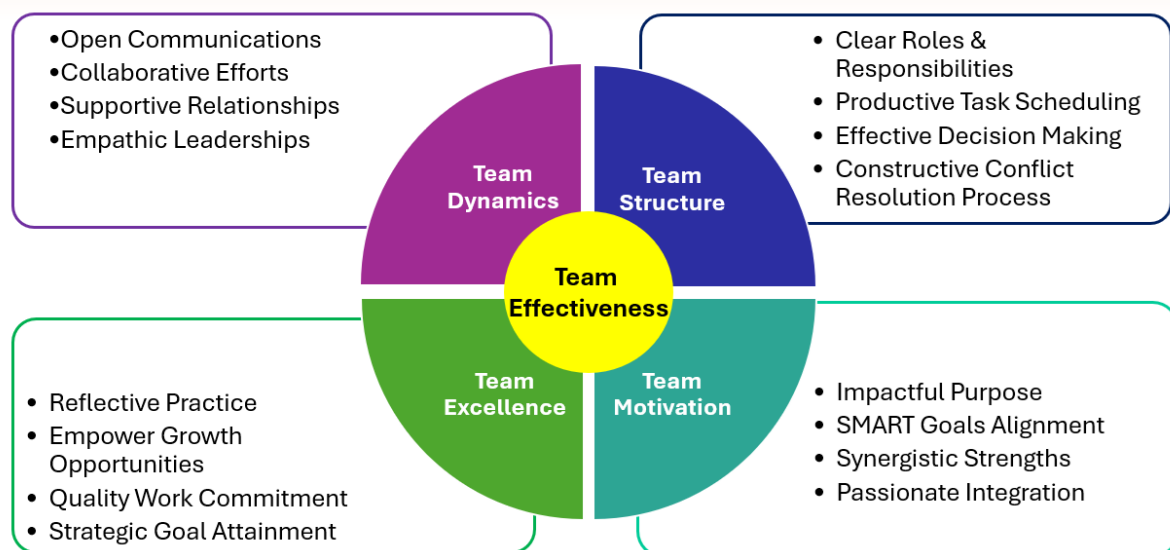


Figure 1: The Conceptual Framework of an Effective Team in PBL Settings

Figure 1 illustrates these dimensions and their subcomponents. The first dimension, TD, delves into the interpersonal interactions and relationships within the group that foster a positive and collaborative team culture. Effective collaboration depends on open communication and mutual support among team members. Team members who can share relevant information, expressing their opinions and feelings, offering active listening and constructive feedback would also respect and appreciate each other's diverse perspectives, needs, and emotions to create a supportive and trusting environment. The second dimension, TS, explores the organisational aspects of the team that facilitate optimal performance. These aspects involve defining clear roles and responsibilities, facilitating productive task scheduling, establishing effective communication channels, making decisions, and resolving conflicts constructively. A well-structured team assigns tasks based on members' strengths and preferences, coordinates efficiently to meet deadlines, makes decisions that reflect the team's consensus and goal directives, and manages disagreements and conflicts in a respectful and positive way, focusing on issues rather than personality differences and seeking win-win solutions. It conveniently leverages on e-platforms (e.g. WhatsApp, Telegram, and Google Doc) and regular meetings for facilitating group discussions. The third dimension, TM,

examines the factors that would inspire team members to engage in the project. These factors include having a clear and meaningful purpose that aligns with the team's values and interests, identifying and synergise the diverse strengths and skills of the team members in the facilitation of shared SMART (Specific, Measurable, Achievable, Relevant, Time-bound) goals. The passionate integration of the team members is manifested in their enthusiasm, passion, and dedication for the project. The final dimension, TE, is envisioned to be adopting a growth mindset that leads to high-quality innovation and improved student learning outcomes through reflective practice, opportunities for growth and commitment to quality work. While achieving the strategic goals, teams are capable of self-monitoring, recognising strengths and weaknesses and using feedback or mistakes as learning opportunities. Teams are also dedicated to continually improving their skills and producing high work standards.

## **Literature Research**

PBL is a pedagogical approach that engages students in active and collaborative inquiry to solve authentic problems and acquire domain knowledge and transferable skills (Guo et al., 2020; Helle et al., 2006; Marinho et al., 2022; Sadjji et al., 2023; Žerovnik et al., 2021). PBL aims to develop the 21st century competencies in students with emphasis on problem-solving, critical thinking, teamwork and communication (Billah et al., 2019; Martínez, 2022; Yong & Saad, 2023). By working in small groups, students can tackle real-world issues that are relevant and meaningful to them and their communities. Several studies have shown the positive effects of PBL on student learning outcomes, motivation, and teamwork and collaboration (Andriyani & Anam, 2022; Hasan et al, 2023; Hussein, 2021; Johnsen et al., 2024; Le, 2018; Lee et al, 2015; Lou et al, 2004; Papanikolaou & Boubouka, 2010). Qualitative and quantitative research methods have been used to explore the effects and outcomes of collaborative learning in PBL settings. Qualitative studies have revealed how PBL fosters an inclusive and equitable culture that leverage on the diverse backgrounds of the group members to enhance their social and academic skills. In particularly, deep conceptual understanding and knowledge retention are important for Science and Technology education (Alharbi et al., 2018; Almulla et al., 2020; Dogara et al., 2020; Kim & Iwuchukwu, 2022; Konrad et al., 2021; Ma, 2022; Setyowidodo et al., 2020; Zhang et al., 2023). In contrast, quantitative studies complement the investigations by providing empirical evidence on the positive impact of PBL on student outcomes. Various measurement instruments of questionnaires, peer assessments, interviews, observations and self-reflection journals have been used to assess quality of the teamwork, efficacy and motivation in students (Andriyani & Anam, 2022; Guo et al., 2020; Zhang & Hwang, 2022). For instance, Andriyani and Anam (2022) showed that PBL can improve collaborative skills among Indonesian university students. Similarly, Guo and colleagues (2020) emphasised the importance of using multiple measurement methods to elicit students' experiences and perceptions. Moreover, Zhang and Hwang (2022) examined how peer assessment and problem-solving tendencies interacted to affect students' learning achievements and collaboration in a technology-enhanced PBL environment. However, challenges and barriers had been identified to hinder effective collaboration. Conflicts often emerge in teams due to poor communication, unfair task allocation, clashing values, lack of responsibility and communication skills among team members which can jeopardise the group's synergy. Other barriers may include the uncertainty about the project scope, process, and outcomes as well as inadequate competency or skills needed for the project. These challenges prompt the need for careful instructional design and intervention strategies to facilitate and sustain successful collaboration in PBL (Alharbi et al., 2018; Berta et al., 2020; Dogara et al., 2020; Hussein, 2021; Marinho et al., 2022).

## Methodology

Forty-five year two DPCS students (n=45) had been recruited for this study. They were divided into thirteen project teams, with six groups consisting of four students and seven groups consisting of three students. Each group was assigned a real-world project, sponsored by industry partners who provided the general project direction and requirements. The cohort was divided into six groups of four and seven groups of three. Each team with composition of diverse skills, interests, personalities and working styles, was responsible for working out the specifics and managing project to achieve innovative solutions using PBL. This approach encourages collaboration and helps students develop transferable skills of problem-solving, decision making and investigative abilities, in addition to acquiring relevant technical knowledge and skills.

Figure 2 illustrates the five stages of PBL. They involve planning, organisation and monitoring, forming the key aspects in developing communication and collaborative teamwork skills. During the initial stage of 'Questioning', teams employed an inquiry-based approach to ignite curiosity and generate innovative ideas for their projects. By conducting SWOT analyses, teams leveraged on their strengths and opportunities while mitigating weaknesses and threats. Simultaneously, team members brainstormed and developed interview questions to gather consumer insights. These insights guided the team's strategic ideation process, leading to the 'Define' stage, where the team established the project's persona, needs statement, scope, roles and responsibilities designation and SMART goal setting. Establishing shared goals and ground rules within a team not only increased accountability and clarified expectations for each member, but also enabled the team to effectively plan and track project milestones with the use of Gantt charts. Prior to beginning experimentation, the 'Research' stage allows teams to gather relevant information from reliable sources, including books, journals, lecture notes, articles, and online materials. The teams then organised, analysed, synthesised, and made sense of the information to answer the driving questions. This led to knowledge sharing, collaborative learning, and peer feedback. During the 'Create and Improve' stage, teams engaged in prototyping activities such as setting interim goals, experimenting with formulations, testing, data collection, and other laboratory work whereby collaboration and communication skills are emphasised. Teams were given the autonomy to collectively manage resources as well as recommend improvements and solving problem-solving methods. Additional support from their project supervisors and industry partners were also rendered. A robust monitoring and feedback system is essential to track each member's progress, ensure resource availability, evaluate findings and facilitate efficient and effective decision-making. In the final 'Present and Evaluate' stage, team collaborated to achieve their goals, reflect on their findings and present their recommendations to an audience of lecturers, industry partners and professionals.

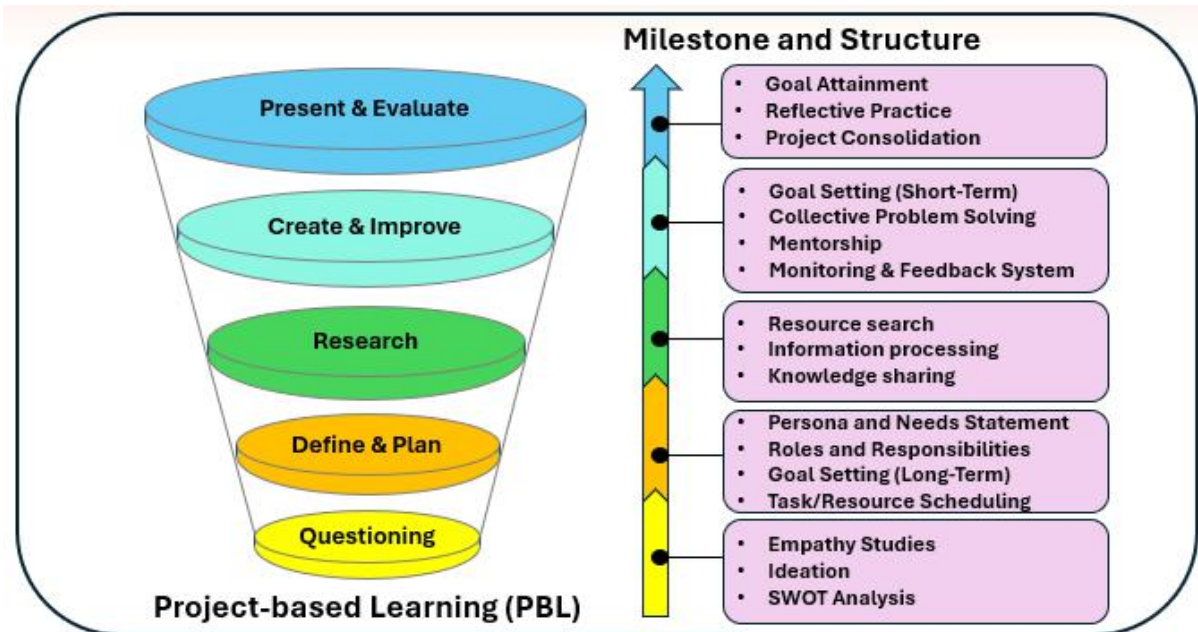


Figure 2: The Facilitation of Effective Teamwork in PBL Settings

To monitor the team effectiveness throughout the project, dialogue sessions were conducted in the first and third quarter of the semester. These sessions aimed to help the students reflect on their collaboration and communication skills beyond the project tangible outcomes. As a final evaluation, a questionnaire adapted from the Team Effectiveness Diagnostic by London Leadership Academy, National Health Service, was administered. The assessment tool used a five-point Likert scale - (1-Strongly Disagree; 2-Disagree; 3-Neutral; 4-Agree; 5-Strongly Agree) - to measure the students' perception of their team effectiveness based on four dimensions: TM, TS, TD and TE respectively. These dimensions capture the key aspects of team functioning that are considered crucial for successful PBL.

## Results and Discussions

The reliability of the questionnaire was first assessed by calculating the Cronbach alpha ( $\alpha$ ) for each dimension of team effectiveness. This parameter is a measure of internal consistency that indicates how well the questionnaire items in a scale are related to each other. With reference to Table 1, the data reflected that all the dimensions had high reliability, with  $\alpha$  values ranging from 0.972 to 0.980. This indicates that the questionnaire items were consistent and coherent in measuring the different aspects of team effectiveness in PBL. A Spearman correlation analysis was subsequently conducted to examine the relationships between the four dimensions of team effectiveness in PBL settings. The results in Table 1 showed that all the dimensions were positively and significantly correlated at 95% confidence level, signifying that they were mutually reinforcing and collectively contribute to the overall team performance. A matrix plot was used to graphically represent the data in Figure 3. The upward trends observed in all the plots validate the analysis with strong correlations with  $\rho$  values of 0.934, 0.922, and 0.909 between TS and TD, TS and TM, and TD and TM respectively. These findings suggest that the quality of team interactions and relationships has a direct impact on the formation of team structure and motivation. A well-defined team structure emerges from effective communication, trust, and collaboration among team members, who can clarify their roles and responsibilities, allocate tasks, and make decisions efficiently. Similarly, team motivation is enhanced by clear team goals that minimise

ambiguity and uncertainty, which are potential sources of stress and demotivation. When team members have a shared understanding of what is expected from them and how their individual contributions align with the team's outcomes, they are more likely to perform their tasks competently with a sense of accomplishment. This positive feedback loop is strengthened by fostering a culture of sharing and learning among team members, which further improves the quality of interactions and facilitates the development of a structure that supports coordinated, communicative, and collaborative work. The learning environment becomes a motivating one where team members feel respected, challenged, confident in their ability to contribute and excel, leading to enhanced performance and ultimate team success.

Table 1: Spearman's Coefficients ( $\rho$ ) and Cronbach's Alpha ( $\alpha$ ) Values.

Spearman Coefficient ( $\rho$ )	Team Motivation	Team Structure	Team Dynamics	Cronbach's Alpha ( $\alpha$ )
Team Motivation				0.9799
Team Structure	0.922			0.9724
Team Dynamics	0.909	0.934		0.9776
Team Excellence	0.839	0.884	0.832	0.9794
			Overall	0.9829

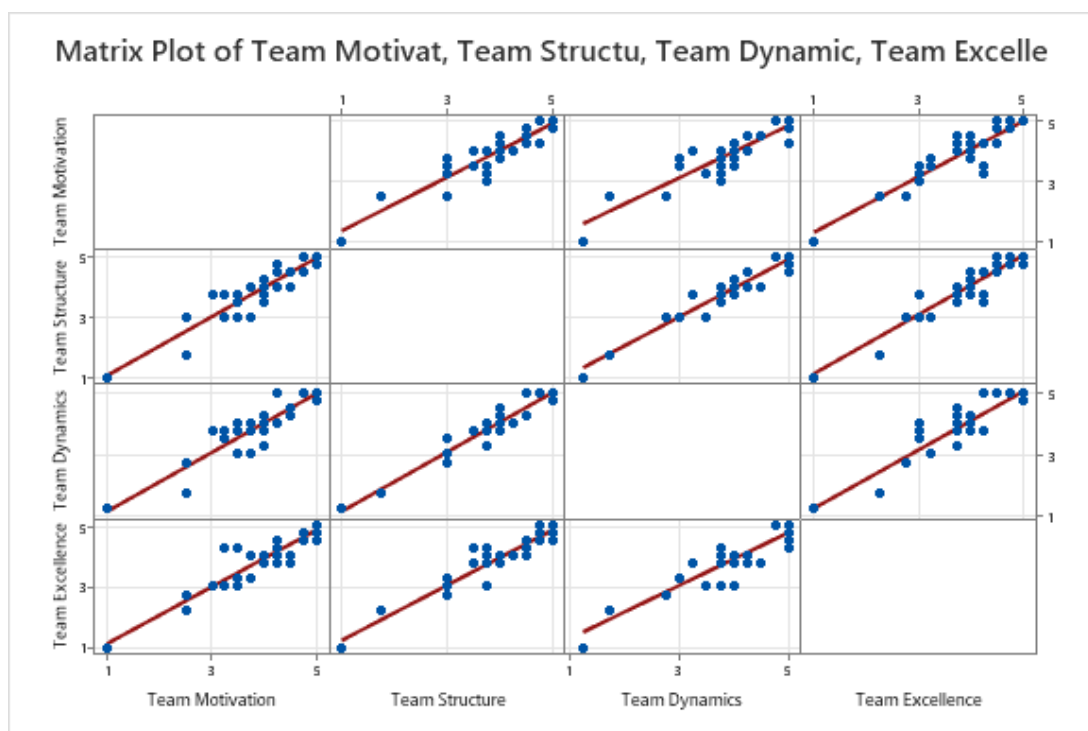


Figure 3: The Matrix Plot Comparison of the Measured Variables

In this section, we posit a team effectiveness model in PBL settings that integrates the four dimensions. The proposed model, depicted in Figure 4, represents the sequential relationship between these four factors that influence and support one another. The innermost layer (TD) is the foundational condition that affects the quality of team interactions and sets the stage for team activities in relation to group dynamics. It involves the development of positive interpersonal relationships, trust, cohesion, communication and conflict resolution among team members. The second layer (TS) is the mechanism that guides and regulates team interactions towards productive outcomes. It involves the implementation of a structural system that the team establishes and adapts to changing conditions and encompasses the

process of defining and assigning roles, responsibilities, tasks, setting milestones, monitoring progress and performance, and providing feedback and support. The third layer (TM) is the driving force that energises and directs team interactions towards shared goals. It involves the alignment of team vision, values and purpose as well as encompasses the intrinsic and extrinsic factors that motivate team members to participate, contribute and collaborate in the team. The outermost layer of the model (TE) is the mindset that shapes the team's attitude and approach in addition to a collective belief in the team's capabilities and potentials. It involves fostering a culture of growth, improvement and resilience in the pursuit of excellence. For example, positive team dynamics can facilitate the adoption of an effective team structure, which in turn can enhance team motivation and team excellence. Conversely, negative TD can hinder the establishment of a clear TS, which in turn can affect TM and TE subsequently.

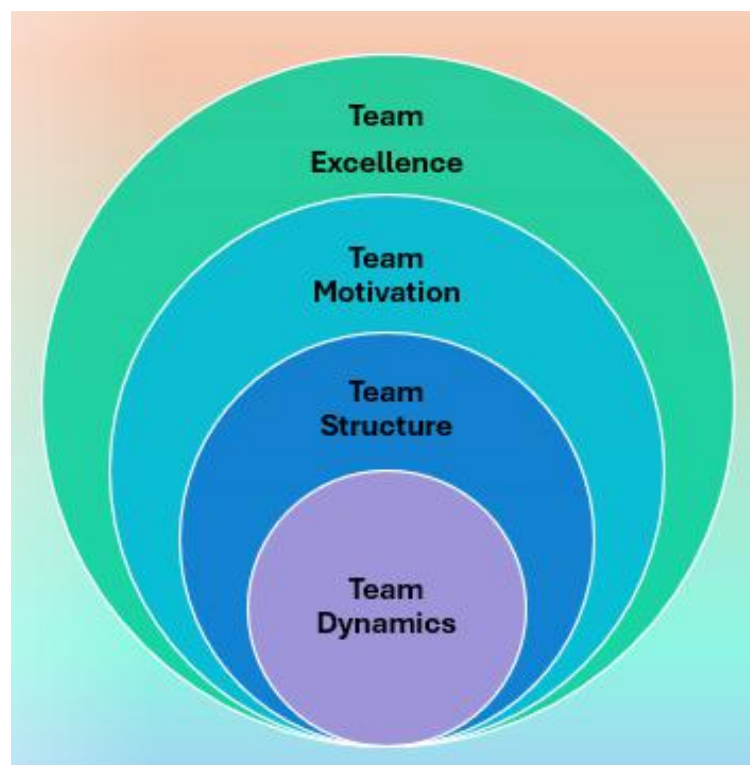


Figure 4: The Conditions and Mechanisms That Optimally Enhance Team Effectiveness in PBL Settings

On the other hand, the model should also consider the diversity and complexity of PBL settings and allows for flexibility and adaptability in its application. Therefore, it does not prescribe a fixed or universal set of conditions and mechanisms for optimal team performance but rather provides a flexible and adaptable framework that can be applied and adjusted according to different situations and needs. Consequentially, the team performance model is not a static outcome but a dynamic process that evolves over time and responds to multiple contextual factors such as the nature of the problem, the characteristics of the learners, the role of the facilitator, and the institutional environment.

In PBL settings, one of the key factors is the role of the project supervisors from academia and professional. They are instrumental (Alharbi et.al., 2018; Kokotsaki et.al., 2016) in enhancing the team's performance, learning and satisfaction by facilitating teams to establish and maintain a clear and coherent team structure that is consistent with the team objectives

and project demands. They also monitor and evaluate team's progress and performance, steer teams towards the desired direction, provide constructive feedback and timely support to address challenging issues such as constructive feedback and support to address challenging issues that exceed students' control, such as technical difficulties, ethical dilemmas or interpersonal conflicts. Furthermore, project supervisors can alleviate students' anxiety by ensuring that the team has adequate and reliable resources, such as information, tools, materials and facilities, that enable them to accomplish the project successfully. While they can stimulate team members to reflect on their learning processes and outcomes periodically, they can also promote team motivation by recognising their accomplishments and progress.

Table 2 summarises the qualitative data collected from self and peer reflections on teamwork performance. The qualitative data revealed the team dynamics in terms of communication, collaboration, coordination and conflict resolution skills that affected the team outputs' quality, efficiency, and creativity, as well as the team members' satisfaction and motivation. The analysis identified various factors that influenced the level of team effectiveness, which are categorised into three levels of high, moderate, and low efficacy. The teams with high efficacy established a positive and supportive team culture that fostered mutual trust, respect and morale. Each member communicated clearly and consistently to ensure alignment with their team goals. The members showed high levels of motivation and accountability to provide constructive feedback and innovative solutions. The teams with moderate efficacy displayed some strengths and weaknesses in different aspects of team effectiveness, but they could improve by addressing their gaps and challenges. On the opposite end of the spectrum, the teams with low efficacy encountered significant difficulties in their fundamental issues such as ineffective leadership, personality clashes and lack of trust that hindered the teams to have clarity about their team goals and roles and responsibilities, leading to the escalation of internal conflicts. Due to an absence of a proper execution of the team mechanism, the 'free riders' persisted to lack initiative. The unequal work distribution and contributions from the team members resulted in low team morale and manifested in their poor feedback and creativity skills.

Table 2: The Qualitative Evidence of the Key Team Characteristics Associated to Various Level of Team Effectiveness.

Level of Team Effectiveness	Team Assessments
High	<ul style="list-style-type: none"> <li>- Contribute proactively and significantly to goal attainment by conducting extensive research, sharing of knowledge, seeking feedback regularly and striving for continuous improvement</li> <li>- Exhibit strong role/goal alignment, set detailed plans and follow timelines</li> <li>- Actively engage in problem-solving and provide valuable recommendations and constructive ideas</li> <li>- Develop comprehensive action plans and apply effective strategies collaboratively</li> <li>- Demonstrate high cooperation and strong mutual support in a blame-free environment by actively, acknowledge feelings, maintain optimism and spread positivity, show appreciation, and maintain mutual respect that foster high team morale</li> <li>- Demonstrate effective communication and leadership qualities</li> <li>- Demonstrate strong responsibility, remarkable dedication and adaptability</li> </ul>



Moderate	<ul style="list-style-type: none"> <li>- Inconsistent leadership style and role alignment</li> <li>- Occasional lapses in shared goal setting (prioritise personal goal), task delegation, communication, commitment and contributions, resulting in struggles to meet some of the deadlines</li> <li>- Selective listening and acceptance of criticisms</li> <li>- Moderate efforts in providing innovative ideas</li> </ul>
Low	<ul style="list-style-type: none"> <li>- Ineffective leadership style and role alignment</li> <li>- Inability to overcome personality differences that hinders team dynamics</li> <li>- Failure to understand team goals</li> <li>- Lack of initiative/proactiveness/urgency and commitment, requiring for close supervision</li> <li>- Unequal/minimal contributions</li> <li>- Low team morale resulted from inconsistent support and communication issues</li> </ul>

### **Limitations and Recommendations**

There are several limitations in this preliminary study that suggest possibilities for future research. One of them was the short span of a 15-week semester, which might not capture the full development and outcomes. A longitudinal design will offer a more holistic and dynamic evaluation of the team characteristics and their impact on the PBL process. Another limitation lies in the customisation of the intervention strategies that can address the specific needs and challenges of each team, rather than applying a uniform strategy. Extensive studies on various factors such as team leadership, conflict management, and peer evaluation, as well as faculty support in terms of coaching, mentoring, or scaffolding techniques, can reveal how they affect team performance and satisfaction in relation to different levels of team efficacy. They can also help to tackle fundamental issues such as social loafing and blocking in self-selected teams and enhance the team characteristics such as goal clarity, feedback mechanisms, interpersonal relationships, trust, commitment, communication, and respect etc. Furthermore, regular reflections by the team members will lead to more realistic assessment of the strengths and weaknesses of their team composition, process, dynamics and behaviours, and how they influence their overall performance and satisfaction with the projects. This would enable teams to make the necessary adjustments along the way and guide the design, implementation and recommendations of future PBL activities for improving team skills and competencies among students. A third limitation was the focus on one course and subject area, which might limit the relevance and generalisability of the findings to other courses and subject areas. A comparative study of different courses and subject areas, as well as different modes of delivery, such as online or blended learning, could examine the similarities and differences of the team characteristics and outcomes across different contexts and settings.

### **Conclusion**

This study proposes a model of team characteristics that can optimise the benefits of PBL through effective teamwork. PBL is a pedagogical approach that engages the DPCS students in authentic and meaningful projects that require collaboration, communication, creativity, and critical thinking skills. It can effectively enhance the students' learning outcomes and experiences, especially when the team characteristics are well-developed and aligned. The empirical findings indicate that the four dimensions of team effectiveness (TD, TS, TM and

TE) are strongly correlated and mutually reinforcing ( $\rho > 0.82$ ), creating a trajectory of positive PBL experiences. The team characteristics serve as indicators to evaluate team performance. The key to a highly effective team is a cohesive TD that lays the foundational condition for an effective implementation of TS to meet the project requirements and expectations. A clear and strategic structure should guide students' actions and facilitate their project coordination. This clarity of the mechanism drives TM. The high level of enthusiasm and commitment in teams leads to TE, which involves the development of a growth mindset of continuous improvement on the learnings and challenges encountered throughout the PBL process. The strive for excellence continues to promote a collaborative team culture, strengthen team structure, and boost motivation. This cycle of reinforcement is further supported by project supervisors who play a vital role of a facilitator in creating a positive and productive learning environment and providing timely guidance and support in the development of students' technical and soft skills. They also offered opportunities for reflective practice so that teams could evaluate their progress and performance at strategic intervals. In conclusion, this study provides an alternative perspective on how to optimise the benefits of PBL through effective teamwork.

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During the preparation of this work the author(s) used ChatGPT, Gemini, Copilot and Perplexity AIs for drafting, language polishing, and content enhancement. These tools were utilised to streamline the writing process, enhance clarity, and ensure coherence. After using these tools/services, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

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