

## RETHINKING ASSESSMENT AND TEACHING IN RESPONSE TO GENERATIVE ARTIFICIAL INTELLIGENCE: UNPACKING THE IMPACT OF TECHNOLOGY-MEDIATED TEAM-BASED LEARNING

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### ABSTRACT

**Background and Purpose:** This study explores the implementation of Team-Based Learning (TBL) within a clinical reasoning module at a medical school. The objective is to assess the impact of TBL on student learning experiences and address the potential to mitigate assessment challenges heightened by Generative Artificial Intelligence (GAI) advancements.

**Methodology:** The study employed a mixed-methods approach, combining qualitative and quantitative analyses. Data were collected through surveys from students (n=31) who took a Clinical Reasoning module at a medical school. The university where the study was conducted is an international institution, hosting students from diverse cultural and ethnic backgrounds, including representation from the Asian continent. The Learning Activity Management System (LAMS) was used for module delivery. A thematic analysis was performed on the qualitative data, and descriptive statistics were applied to the quantitative data.

**Findings:** Findings indicate that TBL significantly enhances the learning experience by promoting active engagement, collaborative learning, and the development of critical thinking skills among

medical students. Students reported positive experiences with teamwork, peer evaluation, and the structured nature of TBL sessions. The study also highlighted the role of TBL in maintaining assessment integrity amidst the rise of GAI tools like ChatGPT.

**Contributions:** TBL presents a viable framework for enhancing student engagement and maintaining the authenticity of assessments in an era increasingly dominated by Generative AI. The study advocates for the thoughtful integration of TBL in education, emphasising its potential to foster a deeper understanding of the subject matter and address evolving challenges in academic assessments.

**Keywords:** Team-based learning, medical education, assessment integrity, generative AI, collaborative learning, higher education.

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## 1.0 INTRODUCTION

The digital revolution continually shapes teaching and learning methodologies to keep pace with technological advancements. Augmented with digital platforms, team-based learning (TBL) has emerged as a teaching and learning approach among these innovative approaches. This instructional strategy, centred around active learning and student accountability, has been embraced by diverse fields, with significant adoption by medical schools. This case study at Lincoln Medical School provides in-depth insights into students' perceptions of this method, the challenges encountered, and the unique opportunities it presents, particularly in assessments.

TBL is an approach that aims to foster collaborative learning, critical thinking, and improved academic outcomes (Sterpu et al., 2024). The structure of TBL - comprising the phases of preparation, testing, and application exercises - stimulates students to understand complex, real-world problems and develop solutions collectively, so the interactive nature of TBL encourages learners to be responsible for their understanding and contribute to their peers' learning (Sterpu et al., 2024). With the advent of AI-driven platforms such as ChatGPT, Google Gemini and Claude, traditional assessment methods face new challenges in higher education. The emergence of generative AI (GAI) tools threatens the integrity of assessments, as students may use these tools to bypass the learning process and produce work that would not help them prepare themselves for real-world practices, particularly in medical settings. Students adopting

such approaches may pose a significant risk to patient safety. TBL presents a potential alternative to this assessment crisis. By implementing in-classroom assessments and emphasising active engagement, collaboration, and accountability, TBL might limit the use of GAI tools and ensure the integrity and value of assessments.

## **2.0 LITERATURE REVIEW**

### **2.1 Team-Based Learning**

The implementation of TBL involves key elements such as team formation, readiness assurance, immediate feedback, and structured in-class problem-solving. This structure has been shown to be helpful in promoting engagement, a deeper understanding of concepts, and responsibility towards teamwork (Hosny et al., 2019). One of the core aspects of TBL is fostering teamwork. Through structured activities and immediate feedback, TBL encourages students to collaborate and engage in critical thinking, which is essential for clinical settings. Studies show that students recognise the value of TBL in improving their teamwork and problem-solving abilities, suggesting its effectiveness in enhancing essential medical competencies (Sterpu et al., 2024).

In a recent study, Cunningham et al. (2022) explored a novel team-based learning model using clinical vignettes. The course employed clinical cases to teach advanced physiology and introduce pathology, pharmacology, and interprofessional collaboration. The students found the course, facilitated by medical student teaching assistants, to be unique, engaging, and relevant to their future careers. Saudek and Treat (2015) demonstrated the positive effects of team-based learning (TBL) on third-year medical students' performance in pediatric blood disorder topics, revealing that students' exam scores improved significantly post-TBL implementation, with institutional scores surpassing national averages. Similarly, Guraya et al. (2023) explored using express team-based learning (e-TBL) to teach medical professionalism. Their qualitative analysis revealed that e-TBL facilitated transformative learning experiences, improved understanding of professionalism, and supported the formation of a new professional identity among students. In a mixed-methods study, Pany (2021) assessed pharmacy students' perceptions of face-to-face versus virtual TBL in the didactic curriculum. The results indicated a preference for face-to-face TBL, although both formats effectively promoted engagement and collaborative learning.

In another study, Subedi et al. (2022) focused on implementing and evaluating online team-based learning (TBL) for teaching medical ethics. The study, involving 29 medical students, found that online TBL was effective and positively received. It was stated that the

Team Readiness Assurance Test (tRAT) scores were significantly higher than Individual Readiness Assurance Test (iRAT) scores, indicating effective cooperative learning. Students also reported positive experiences and satisfaction with the TBL sessions.

Integrating TBL with problem-based learning elements, Hosny et al. (2019) found significant improvements in student engagement, satisfaction, and performance in undergraduate medical education. Similarly, Carrasco et al. (2019) highlighted TBL's positive impact on student involvement and academic performance in new medical institutions, emphasising the benefits of combining TBL with problem-based and case-based learning to enrich medical education. Rezende et al. (2020) demonstrated that while TBL and traditional lectures are comparable in knowledge acquisition, TBL significantly enhances student engagement, satisfaction, and motivation, particularly in complex subjects like neuroanatomy. This suggests that TBL fosters greater student interaction and effectively integrates clinical and basic sciences. Additionally, Burgess et al. (2020) noted that TBL promotes active learning, inter and intra-team discussion, and peer learning. However, challenges such as limited problem-solving time and adjustments to the student-centred approach remain. Together, these studies highlight the potential of TBL to transform medical education by enhancing student engagement and learning outcomes.

## **2.2 Adapting Assessments in the AI Era**

The literature shows that TBL differs from traditional teaching methods, particularly how assessment is run. In the current climate of higher education, large language models (LLMs) such as ChatGPT4, Google Gemini, or Claude will inevitably be discussed in relation to the assessment crises higher education faces today (Luo, 2024). The transformative potential of GAI in assessments necessitates a departure from conventional assessment forms, prompting the exploration of assessment strategies that are fundamentally different from traditional methods (Milano et al., 2023).

GAI can generate competent answers and polished text, raising concerns about their use in writing essays and assignments and potentially affecting the integrity of assessments (Nguyen et al., 2023). This rapid advancement highlights the need for educational institutions to reconsider their assessment structures. The unique nature of GAI outputs, which do not directly trace back to a single source, makes detecting and enforcing academic integrity challenging (Smolensky et al., 2023). Some universities have already reverted to traditional pen-and-paper exams to mitigate AI-related academic misconduct; however, this approach faces limitations in its applicability and sustainability, especially in digital learning

environments. Moreover, while potentially beneficial, adopting GAI tools in education poses operational, financial, pedagogical, and ethical challenges (González-Calatayud et al., 2021).

The studies by Kebble (2023) and Smolansky et al. (2023) further elaborate on the important role of GAI in education, suggesting that while GAI can support certain aspects of learning and assessment, it requires careful integration and consideration to ensure it enhances rather than undermines the educational process. Schön et al. (2023) and Riedel et al. (2023) further explore how ChatGPT can be a supplementary tool in medical education, offering insights into its capabilities and limitations.

In response to the challenges posed by GAI, educators are exploring adapted assessments that assume GAI usage and emphasise critical thinking skills. However, student reactions to these changes are mixed, reflecting concerns about the loss of creativity and the shifting focus from learning outputs to processes (Smolensky et al., 2023). In this context, with its classroom-based assessments, TBL emerges as a potential alternative. It emphasises active engagement, collaboration, and accountability (Trill et al., 2024), potentially limiting the utility of GAI tools in assessments. We seek to answer the following research questions in response to this background:

RQ1: To what extent do students believe technology-mediated TBL facilitates teamwork?

RQ2: To what extent do students believe technology-mediated TBL support their clinical reasoning skills?

RQ3: To what extent can TBL be used as an alternative assessment method in the face of emergent generative AI tools?

### **3.0 RESEARCH DESIGN**

The module, Exploring Clinical Reasoning through TBL, was conducted at the University of Lincoln with a culturally diverse student body, including students of Asian ethnicity. Such representation of diverse ethnicities and backgrounds remains important as TBL encourages teamwork that requires students to work on their communication and collaboration skills in various contexts. The module involved 17 hours of contact time and began with an introductory lecture on Team-Based Learning (TBL) and the formulation of student teams (n=31). This was followed by the first TBL session, which was formative, and four subsequent summative TBL activities. 60% of the marks for the module came from iRAT and tRAT tests (40% iRAT/20% tRAT), with the remaining 40% of marks coming from a reflective account of the student's

response to one or more pieces of peer feedback received during the module. To understand the effectiveness of this learning strategy, the method of participant observation during the modules and a survey were conducted at the end of the term to gather students' feedback on their TBL experience. However, we centred our analysis on the students' experiences reflected by their responses to survey questions. The lead researcher (AD), who was not involved in delivering the module or marking assessments, performed the observation and analysed the survey responses, ensuring unbiased and confidential data collection.

An online platform called the Learning Activity Management System (LAMS) was used for module delivery. As seen in the below figures, the design and features of LAMS permit the smooth running of TBL sessions with iRAT questions being directly copied to the tRAT section, control of student flow through the activities by the use of permission gates, and a sophisticated dashboard whereby the session lead can monitor the progress of individual students and/or teams. LAMS also offers detailed data analysis regarding the students' individual and team performances and the time taken to complete the various elements of the session.

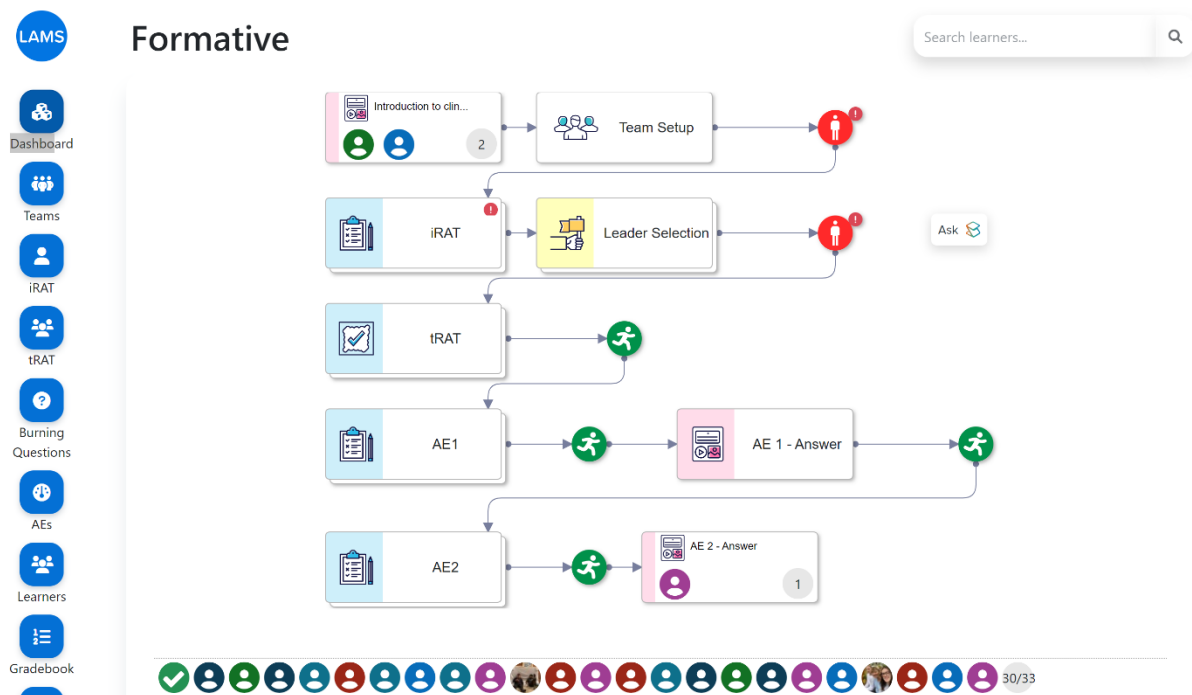


Figure 1: A screenshot of the LAMS dashboard illustrates the structure of a formative assessment and the students' progress

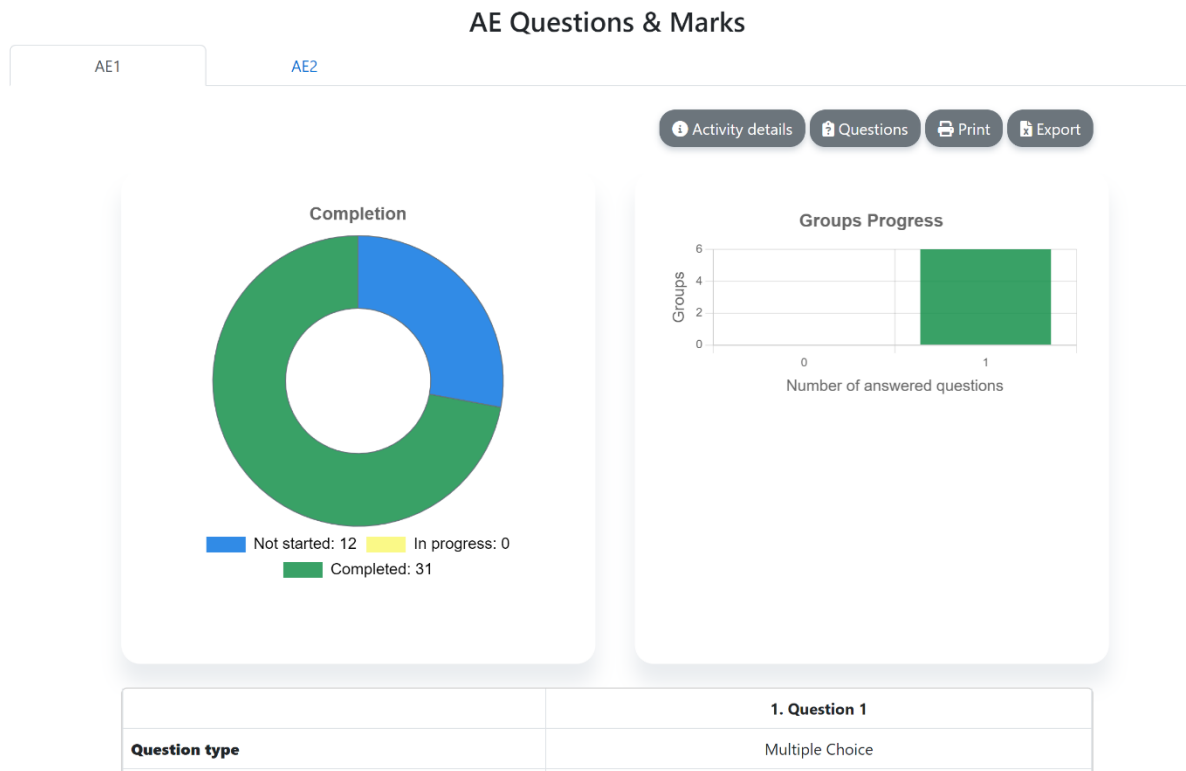


Figure 2: A screenshot of a different section of the dashboard displays the students' completion rate for application exercises and their responses to individual questions

LAMS has been used to support a range of pedagogies in medical education. For instance, within the Faculty of Medicine at Brunel University, LAMS is commonly employed in TBL. Similarly, this study uses the LAMS platform to design and implement activities and assessments within a classroom setting.

### 3.1 Data Collection

In developing the survey for our study, we shaped the questions to capture a comprehensive understanding of the student's experiences with TBL. Drawing from the works of Gallegos and Peeters (2011) and Woodcock et al. (2022), our survey was structured to encompass the nature of TBL and its impact on individual and group learning processes.

The survey was divided into five distinct sections to investigate various aspects of the TBL experience methodically:

1. Overall satisfaction with the team experience
2. The impact of teamwork on the quality of learning
3. Satisfaction with the peer evaluation process
4. The role of TBL in professional development
5. The influence of team dynamics on clinical reasoning skills

We incorporated open-ended questions in the survey to enrich our quantitative data. These allowed students to reflect on TBL and its integration with technology in the medical education setting. The open-ended format was inspired by the survey methodologies used in the study by Woodcock et al. (2022) and the teamwork perception measure developed by Gallegos and Peeters (2011).

### **3.2 Data Analysis**

In the data analysis phase, we employed a dual approach. For the qualitative data, we utilised Braun and Clarke's (2006) inductive thematic analysis method, which enabled us to identify, analyse, and report patterns (themes) within the data. This method provided a flexible and valuable research tool for identifying the qualitative responses. For the quantitative data, we conducted a descriptive analysis, summarising the basic features of the dataset and providing simple summaries. This approach allowed us to gather patterns from the quantitative responses, providing a statistical backbone to support the qualitative findings. By intertwining the outcomes of the qualitative and quantitative analyses, we crafted a narrative that reflects the dimensions of our study's findings. This mixed-methods analysis gave a comprehensive understanding of how TBL impacted students' learning experiences, fostering a data-driven discussion deeply rooted in the participants' experiences.

### **3.3 Ethics**

The Human Ethics Committee of the University of Lincoln provided ethical approval for the study (ref no. 10501). Participation in the study was voluntary. A URL link to the survey was sent to the students participating in the module. Survey data were collected and paired by the lead researcher (AD), who was not involved in the module's delivery or assessment. Therefore, the academic who delivered the module could not identify the study participants. The data collected from the surveys were not available to the module convener until the students had completed the module and received their final grades.



## 4.0 RESULTS

The survey responses included detailed and rich free-text responses and provided valuable insights into the impact of technology-mediated TBL on students' learning experience and their perceptions of the assessment method. The results will be presented under three main themes. The quotes in the following sections were selected to provide a balanced representation of all participants' responses, ensuring that the collective opinions of all participants are accurately reflected.

### 4.1 Enhancement of Interactive Learning Experience

Students appreciated the dynamic thinking and discussions fostered by TBL assessments. They found the cases less straightforward than others they had encountered in previous modules, prompting them to engage in in-depth discussions and apply critical thinking skills. The responses to the 5-point Likert scale survey questions indicate that students found working as part of a team in their classes to be a valuable experience. They recognised the contribution of their team members and felt respected within their teams. This positive team dynamic facilitated effective collaboration and fostered a sense of shared responsibility. Additionally, students reported that teamwork was a productive use of course time, indicating the efficiency and effectiveness of TBL in promoting active learning.

### 9. Team impact on quality of learning

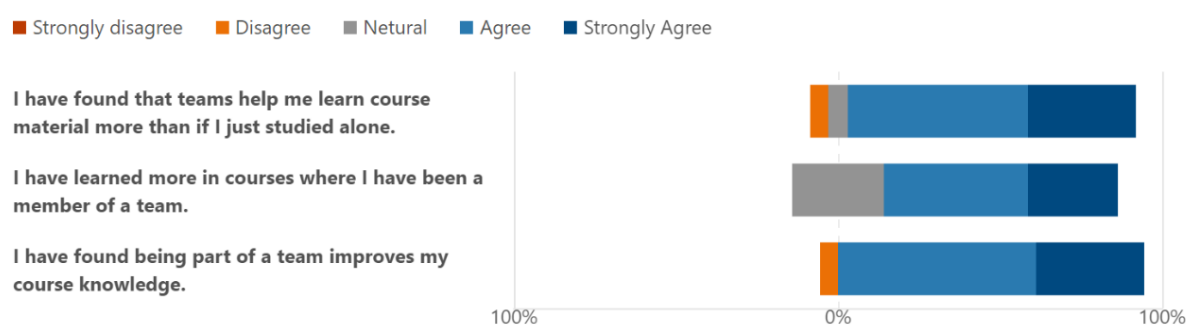


Figure 3: Team impact on quality of learning

A graphical representation of the degree of student agreement with several statements related to the impact of teamwork on the quality of learning. Blue (and deeper blue) colours represent a greater degree of agreement with the statement.

The efficacy of TBL in augmenting the quality of learning through collaborative efforts is reported. Figure 3 indicates a high level of agreement among students that teamwork significantly enhances their learning compared to solo study.

Students showed appreciation for the dynamic and interactive nature of TBL assessments. One student's reflection echoes the quantitative data, as they acknowledged the stimulating discussions, stating, *"I really enjoyed the discussions and the dynamic thinking that needed to be applied."* The TBL approach has been highlighted by another student as significantly enhancing the learning experience, particularly noting the dual benefit of solo and group assessments, *"Being able to complete an assessment alone and then within a team allows you to often improve and learn something new in discussions."*

This process not only solidifies one's knowledge but allows it to be expanded upon through the collective intelligence of the group. Another student's insight illustrates the practical support that teamwork offers. They wrote, *"Having a team is useful when you are struggling or have limited knowledge on something. Input from someone else on top of your own can be invaluable."*

This demonstrates how the collaborative nature of TBL assessments facilitates knowledge sharing, enhances problem-solving capabilities, and supports students in areas where they may face challenges. The student responses highlight the value of collaboration in TBL assessments. One student noted, *"I really enjoyed exploring the thought processes of others and my own to help improve my knowledge."* This indicates that engaging in discussions and considering different viewpoints fosters a deeper understanding of the subject.

Figure 4 represents students' overall satisfaction with their team experience in the module. A striking majority agreed or strongly agreed that working as part of a team in their classes was a valuable experience. This quantitatively substantial endorsement suggests that students perceive team-based interactions as an integral and beneficial component of their educational journey.

## 8. Overall satisfaction with team experience

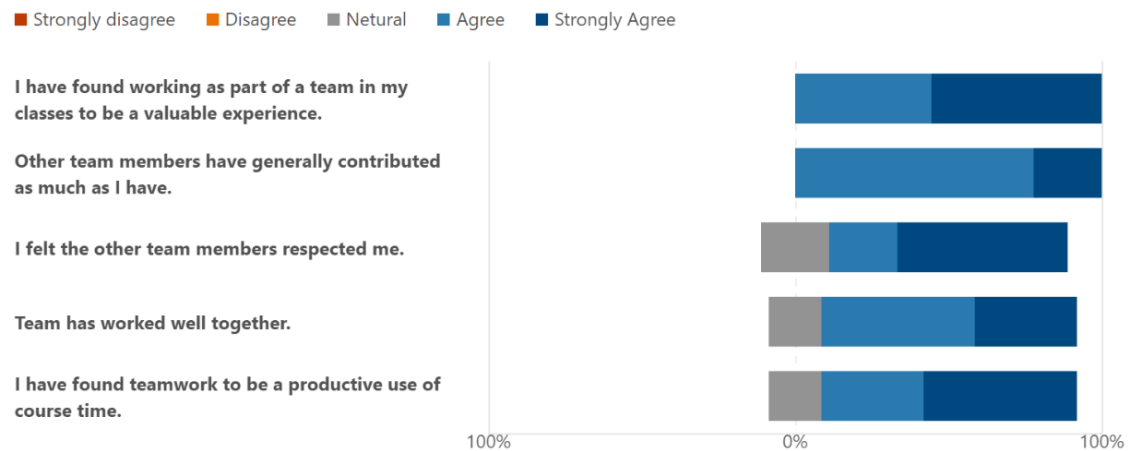


Figure 4: Overall satisfaction with team experience

A graphical representation of the degree of student agreement with several statements related to their satisfaction with the team experience. Blue (and deeper blue) colours represent a greater degree of agreement with the statement.

The responses lean positively in terms of equitable contribution within these teams, with most students feeling that their team members have generally contributed as much effort as themselves. This perceived contribution balance is a crucial element of effective team dynamics, indicating a sense of fairness and shared workload among team participants. The functionality of the teams is also reflected positively, with a significant number of students agreeing that their teams worked well together. This suggests a smooth and effective team operation, often leading to better learning outcomes and a more satisfying educational experience.

Furthermore, Figure 4 indicates that most students viewed teamwork as a productive use of course time. This perception is instrumental in validating the team-based approach, as it reflects a general consensus that the time invested in team activities is perceived not as an obligatory chore but as a valuable aspect of their learning process. Continuing from the qualitative data, it was seen that TBL assessments were perceived as an enhancement to the learning experience compared to other teaching methods. Students found TBL more structured and motivating, as they were prompted to complete preparatory work beforehand. A student stated that, “*TBL sessions had more of a structure compared to other case-led approaches. It motivated us to do the pre-work and therefore enhanced our learning during the session.*”

Including individual readiness assurance tests (iRATs) and team readiness assurance tests (tRATs) ensured that students learned the content individually before collaborating with their peers. The preparatory aspect of TBL is valued by students, who have recognised the importance of individual readiness as a precursor to effective team collaboration. A student remarked on this dual-phase learning process, *“I liked how there was a iRAT and tRAT, making sure I learned all the content, and then my peers could enhance it.”*

Such insights reaffirm the value of the preparatory work that TBL necessitates. Also, the interdependence between team members and the respect for one another’s contributions foster a healthy academic and social environment. TBL seemed to foster a deeper understanding of the material and allowed for knowledge enhancement through team discussions.

#### **4.2 Collaborative Enhancement of Clinical Reasoning**

The impact of team collaboration on clinical reasoning skills presents a compelling narrative that resonates with the feedback from students. Analysing teams’ performances on the Readiness Assurance Tests, Figure 5 illustrates the performance differences between individual Readiness Assurance Tests (iRAT) and team Readiness Assurance Tests (tRAT) across six student teams. The yellow bars represent iRAT scores, indicating individual performance, while the blue bars represent tRAT scores, showing team performance. Across all six teams, there is an improvement in scores from iRAT to tRAT. This consistent enhancement highlights the significant positive impact of team collaboration on student performance.

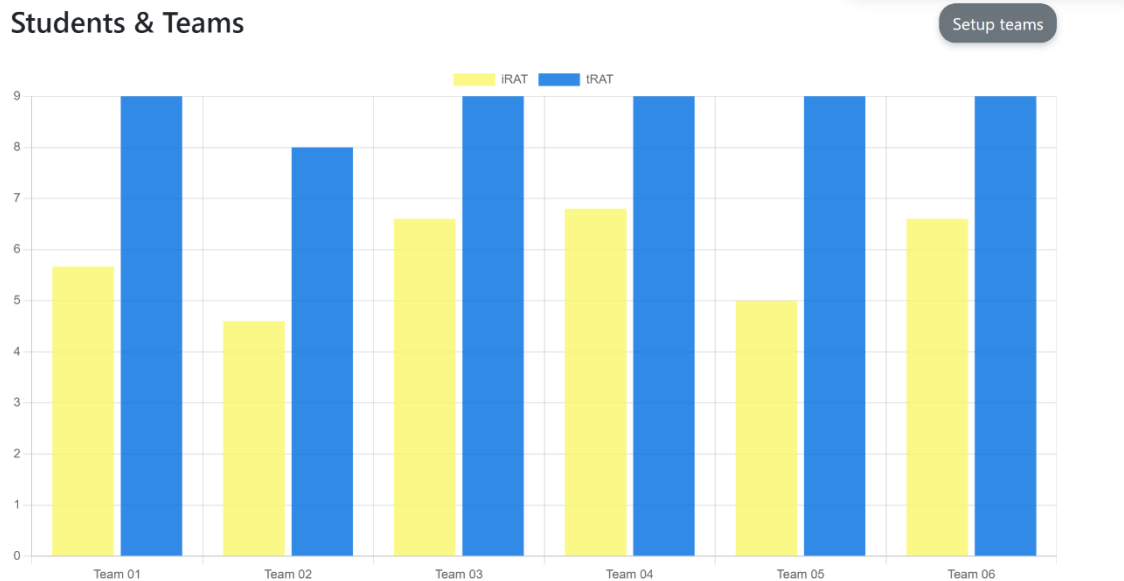


Figure 5: Comparison of individual and team performance on readiness assurance tests shows student performance improvement from individual Readiness Assurance Tests (iRAT) to team Readiness Assurance Tests (tRAT) across six teams

The students recognised the value of TBL assessments in stimulating their thinking processes and preparing them to tackle real-life clinical scenarios. As seen in Figure 6, most students agree that team discussions lead to more effective decision-making. This perspective aligns with a student's reflection on the value of TBL in clinical settings, *"I think it is useful for making us think through scenarios and what we would do as a clinician."*

This student's experience exemplifies the consensus that TBL's group discussions foster in-depth analysis and thoughtfulness, which individual study may not provide.

## 12. Team impact on clinical reasoning



Figure 6: Team impact on clinical reasoning

A graphical representation of the degree of student agreement with several statements related to the impact of teamwork on the development of problem-solving and clinical reasoning skills. Blue (and deeper blue) colours represent a greater degree of agreement with the statement.

Further, Figure 6 shows that participation in team-based activities is perceived to enhance problem-solving skills, a sentiment echoed by the accounts of students navigating complex clinical problems. A particular student's observation mirrors this data, emphasising that the TBL environment prepares them for real-world clinical practice, *"I think it teaches us to tackle problems like we will when we are on wards and taking part in interprofessional patient care."*

TBL has also been instrumental in presenting novel problem-solving techniques to students. One student shared their appreciation for this aspect:

*"I enjoyed the way of learning and being able to find out how other students would work through a problem to show me new ways of approaching scenarios that I would have never thought of myself."*

Exposure to diverse thought processes is invaluable in preparing students for the multifaceted challenges they will face in their careers. The students' recognition of the value of team-based learning reinforces that such collaborative engagements are not just an academic exercise but a rehearsal for their future roles in healthcare.

The student responses highlight the interactive and engaging nature of TBL assessments. They found it helpful to talk through problems, benefitting from the input and perspectives of their peers. As one student expressed, TBL assessments are “*far more interactive and engaging*”, creating an environment where everyone’s contributions are valued, and active participation is encouraged. Students’ feedback about the realism and relevance of TBL assessments reinforces this viewpoint. One student noted the similarity with their future professional practice, remarking, “*I found it more realistic in terms of how we will be practising in the future with others.*”

Learning through collaboration is particularly effective in reinforcing knowledge, as one student reflected, “*Everyone has different areas of knowledge, and it also helps to clarify what you know by having to justify it to other people, which confirms how well you know it.*” This social aspect of learning broadens understanding and confirms mastery through explanation and justification to peers. A student compared TBL positively against other teaching methods, saying, “*I find it more engaging than other styles of teaching and was more interested in the content.*”

TBL assessments also had a positive impact on students’ motivation and preparation. Students reported feeling more motivated to complete their work before the sessions to avoid letting their team members down. This sense of accountability within the team dynamic encourages students to learn proactively. As one student mentioned:

*“It genuinely helped me understand and navigate through the topics easier. It also motivated me to put my best effort as I did not want to let my team down.”*

The sense of communal responsibility fostered by TBL can be a powerful motivator, as another student also pointed out: “*I felt more motivated to do my work before the seminar, so I wasn’t letting my teammates down.*” This intrinsic motivation to not disappoint peers can lead to an enhanced commitment to the learning process.

The supportive aspect of team collaboration was also noted: “*Having a team for support - improved knowledge as contribution from peers allowed different views and added to things I already knew in a positive way.*” This reflects an appreciation for the diverse perspectives and shared knowledge that the technology-enabled TBL environment cultivates.

Moreover, students expressed that being part of a team enhanced their learning experience. They felt teams helped them learn course material more effectively than studying

alone. Most students also indicated that they prefer TBL over other case-led teaching approaches and would like to have had more TBL.

Figures 7 and 8 demonstrate that most students preferred the use of TBL to other case-led approaches and would have liked TBL to have featured more heavily in the programme of study. This finding is perhaps surprising since TBL requires more preparation and interaction than other more passive case-led approaches, and it may indicate that it has greater face validity than these other approaches.

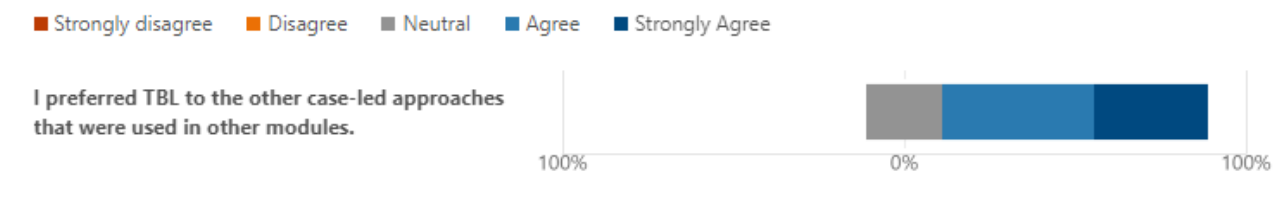


Figure 7: Preference of TBL over other case-led approaches

A graphical representation of the degree of student agreement with a statement related to students' preference of the TBL approach versus other case-led approaches.. Blue (and deeper blue) colour represents a greater degree of agreement with the statement.

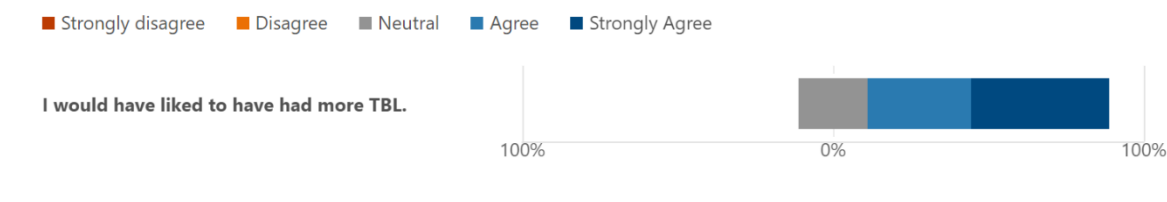


Figure 8: Desire for more team-based learning

A graphical representation of the degree of student agreement with a statement related to students' desire for more TBL in the programme of study. Blue (and deeper blue) colour represents a greater degree of agreement with the statement.

Students expressed that TBL assessments were a powerful learning motivator and encouraged active team participation. One student highlighted, *"It was a really good way of motivating me to learn more content so I could be a valued member of the team."*



This response emphasises how TBL assessments allow students to delve deeper into the content and contribute to their team’s success. The sense of accountability within the team dynamic encourages students to show their best effort, ensuring they can actively participate and contribute.

### 4.3 The Dual Edge of Peer Evaluation: Benefits and Challenges in Team-Based Learning

In the Team-Based Learning (TBL) environment, peer evaluation is a pivotal feedback mechanism that garners mixed reactions, as seen in Figure 9. Students widely recognise the value of this process, with one noting, *“So that you know how you can better help the team but also motivating when they give positive comments.”* This statement summarises the dual role of peer assessment in providing personal insight and encouragement.

#### 10. Satisfaction with peer evaluation

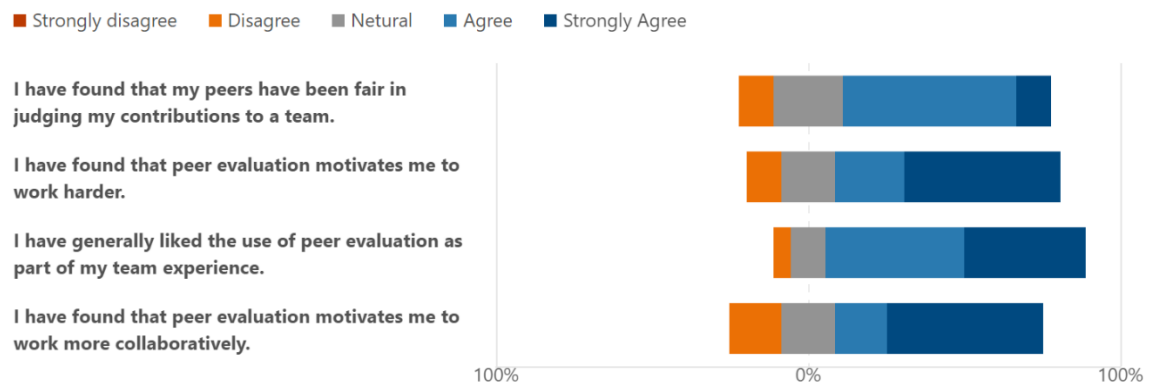


Figure 9: Satisfaction with peer evaluation

A graphical representation of the degree of student agreement with a series of statements related to students’ satisfaction with peer evaluation within TBL. Blue (and deeper blue) colours represent a greater degree of agreement with the statement.

A student highlighted the importance of this feedback mechanism in maintaining team accountability, *“It is a safe and professional way to let other teammates know if they aren’t pulling their weight.”* This comment underlines peer evaluation as a tool for upholding a team’s integrity and performance. Team members are positioned uniquely to observe one another’s contributions, which is essential for accurate and constructive feedback. *“If you’re working within a team, the best people to ask about your performance will be part of the team,”* reflects

the sentiment that peers can provide the most relevant insights into an individual's team performance.

The anonymity of the evaluation is particularly noted for its effectiveness. One student remarked,

*"It allows other team members to pick up on the strengths and weaknesses of members and highlight these anonymously to other members, giving them a chance to reflect and improve."*

This process can lead to personal growth, allowing individuals to digest feedback without the pressure of face-to-face confrontation. A student's reflection on peer evaluation points out its self-examining value, *"Peer evaluation is a valuable part of TBL because it allows people to see how they work in a team, because you cannot judge yourself on this."* Here, the introspective nature of peer evaluation is acknowledged, offering a mirror to one's interpersonal skills within a group setting. Some students felt the motivational push of peer evaluations to perform better and contribute more significantly to the team. *"The peer evaluation motivated me to put in the work. All the constructive criticism helped me achieve a higher efficiency,"* a student shared, illustrating how peer feedback drives improvement.

However, Figure 9 also indicates that while many students find peer evaluations helpful, a notable portion remains neutral or dissatisfied, suggesting room for improvement in how peer assessments are conducted. The issue of honesty in evaluations was raised by a student who expressed, *"Good to know how you come across, in ways you may have not initially thought. Though people probably aren't 100% honest in them."* This hints at a possible avoidance of conflict that may limit the usefulness of the feedback. Another student echoed a similar sentiment:

*"When people did constructive feedback it did help me to see how I needed to improve. Sometimes it felt like people weren't putting a lot of effort into the feedback, and were just being nice for the sake of it, which wasn't entirely helpful."*

Peer evaluations also serve as a reflective tool for both the reviewer and the reviewee. A student insightfully noted, *"I think it betters the individual you're feeding back to, but also allows you to think and reflect on how you contributed to the team yourself."* Such self-reflection is crucial for the ongoing development of effective team players.

In summary, peer evaluations within TBL are viewed as a crucial element for personal and team development, with students valuing the direct and anonymous nature of the feedback. While many are satisfied with this aspect of TBL, a noticeable portion of the student cohort might want to see a more authentic feedback mechanism.

#### **4.4 The Role of Technology and its Reception**

Integrating the Learning Activity Management System (LAMS) into TBL has been met with commendation from students who have found value in the platform's efficiency and structured approach. Its utility in facilitating collaboration was particularly noted, with the system allowing team members to engage and contribute using their devices. This aspect of technology enhanced the interactive experience, enabling a smooth transition from individual learning to team-based activities.

One student emphasised the eco-friendly aspect and the smooth operational flow, saying, *"Smoother transitions through tasks (once it's working) and less paper waste"*, highlighting the environmental benefit and the streamlined process that the technology facilitates. Another student pointed out the digital platform's clarity: *"It was very straightforward and hard to get confused by where on paper I think it could've gone wrong by ruining the answer sheet or something."* This comment underlines technology's reduction of potential human error, making the learning process more foolproof.

Further emphasising the ease of use, a student appreciated the inclusive visibility of the sessions: *"I enjoyed being able to keep up with the progress even if I'm not the leader. It was helpful that we could all edit at the same time."* The ability for multiple students to engage with the material simultaneously fostered a sense of collective participation.

Students also commended the immediate feedback and accessibility of the system, with one remarking on the convenience it provided to a team member who needed to contribute remotely. The user-friendly nature of the platform was repeatedly mentioned, with one student describing it as *"easily accessible and easy to understand,"* thereby reducing anxiety during assessments and contributing to a more relaxed exam experience. The structure and flexibility of the technology were highlighted as well: *"Being able to answer questions in any order, this was good as we answered questions we were most confident on first"*, showing how technology can adapt to the students' strategic approaches during assessments. The anonymous feedback mechanism within the system was also appreciated for its contribution to a constructive learning environment, even though it presented challenges when the effort in feedback was not reciprocated equally.

Feedback processes were streamlined through the technology. As one student detailed, *“The weekly feedback from my team, the technology aspect means completion can be easy and fast, and you get the opportunity to practice speaking in a group.”* Furthermore, the visibility of progress for all team members, not just the team leader, was recognised as a positive attribute, ensuring all team members were synchronously engaged. Lastly, the simplicity and intuitiveness of the platform were valued, with students describing it as *“simple, quick, easy”* and *“Really easy to use with an intuitive interface,”* which not only made peer review easy to manage but also supported their essay writing process.

#### **4.4.1 Challenges**

Despite these positives, students encountered challenges, including the need for a strong and reliable Wi-Fi connection. *“Wi-Fi problems, the issue of members being left out, and peer pressure cause you to feel further anxiety about performance,”* a student mentioned, highlighting that consistent internet access is critical for the uninterrupted operation of technology-based learning. LAMS’s functionality and user experience were also areas where students saw room for improvement. Suggestions included providing pre-session access to the software and the learning objectives. One student elaborated, *“Maybe having a part of the software where you could share your self-study notes or resources with the rest of the team after each session?”* This reflects a desire for an integrated platform where information can be updated and shared, ensuring all team members are on the same page with current and correct information.

Operational enhancements were also suggested to improve the interactive components of the software. A student noted the potential for a better collaborative experience: *“If all team members could contribute to the answer box in the application exercises, as the one person that could write got very overwhelmed.”* This feedback calls for a more distributed workload and shared responsibility during problem-solving exercises. Additionally, students noted the system could benefit from safeguards against accidental assessment selections. *“Some sort of confirm, or are you sure button when clicking answers in the iRAT and tRAT,”* was a specific improvement mentioned to prevent the ease with which incorrect answers could be inadvertently submitted.

Technical reliability was another concern, with reports of the system occasionally lagging. However, the overall sentiment remained positive, with one student expressing complete satisfaction, *“I can’t think of any improvements. It was perfect.”* These insights from students indicate that while the technology-mediated TBL approach is well-received and

provides a strong foundation for collaborative learning, there is potential for further technological enhancements to maximise its effectiveness and user-friendliness.

## **5.0 DISCUSSION**

In the following discussion, we explore the findings of our study under three distinct yet interrelated thematic titles: “Beyond Individual Achievement: Cultivating Collective Experience and Accountability through Team-Based Learning”, “The Potential Role of Team-Based Learning in Upholding Assessment Integrity in the AI Era” and “Enhancing Learning through Technology: The Role of Technology in TBL”. We extend our exploration to consider the evolving landscape of higher education assessments in the face of rapid advancements in generative Artificial Intelligence (AI). This connection highlights the inherent strengths and potential challenges associated with TBL and scrutinises its role amidst the expanding influence of AI technologies.

### **5.1 Beyond Individual Achievement: Cultivating Interactive Experience and Accountability**

Our findings highlight the significant impact of Team-Based Learning (TBL) on enhancing individual learning outcomes and the collective learning experience, especially in disciplines requiring high collaboration and critical thinking, such as healthcare. The theme “Beyond Individual Achievement: Cultivating Collective Experience and Accountability through Team-Based Learning” emphasises TBL’s potential to foster a learning environment that encourages active engagement and mutual accountability.

TBL transitions the focus from solitary knowledge acquisition to a more dynamic, interactive process of learning that capitalises on the diverse strengths and perspectives within a team. In doing so, TBL contributes to a deeper, more holistic understanding of the subject matter, enhances critical thinking skills, and prepares students for the collaborative nature of professional practice. Integrating TBL into various educational settings has demonstrated its efficacy in enhancing student learning experience and outcomes across disciplines (Trill et al., 2024). This collective insight from multiple studies underlines the versatile benefits of TBL, particularly in fostering active engagement, collaborative learning, and the development of critical thinking and clinical reasoning skills.

TBL within clinical education has the capacity to elevate student engagement and satisfaction in undergraduate medical training (Sterpu et al., 2024). This aligns with the findings from our research, where TBL was similarly praised for fostering active learning and

critical thinking, significantly benefiting students' preparation and participation in clinical scenarios. Additionally, the aspect of peer evaluation in TBL was found to be favourable among students, contributing to a reflective learning process and emphasising the importance of constructive feedback.

The findings of this study highlight the importance of fostering a supportive team atmosphere and the proactive role of peer evaluation. Ulfa et al. (2024) provide further evidence of TBL's adaptability in diverse educational landscapes. Their implementation research underlines TBL's potential as a scalable model in low-resource settings, reinforcing our findings on the active learning experiences and collaborative clinical reasoning fostered by TBL.

However, challenges regarding the reliability of peer evaluations were noted. Some students perceived peer assessments as superficial, reflecting similar challenges noted in previous research. Addressing these issues is essential to improve the effectiveness and fairness of peer evaluations in TBL settings (Kweon & Park, 2023; Lin et al., 2023). Our study reveals that while peer evaluation is generally seen as beneficial for the learning process, there are concerns regarding its reliability and utility. Some students expressed dissatisfaction with the peer assessment, noting that their peers were often "just being nice" or engaged in the process superficially, "doing it for the sake of it." This feedback mirrors the wider concerns to address regarding the need for reliable and meaningful peer evaluation mechanisms within TB (Kweon & Park, 2023; Lin et al., 2023)

In summary, TBL significantly enhances student engagement, critical thinking, and collaborative learning. Integrating TBL into educational settings can improve learning outcomes and better prepare students for professional practice. To fully realise TBL's potential, it is essential to address the challenges related to peer evaluation reliability, ensuring that TBL remains a robust and effective educational strategy across various contexts.

## **5.2 The Potential Role of Team-Based Learning in Upholding Assessment Integrity in the AI Era**

The student feedback and observed outcomes indicate that technology-mediated TBL holds significant promise as an alternative assessment method in the face of the AI revolution. By promoting active learning, collaboration, and accountability within the classroom, TBL limits the use of AI tools to bypass assessments. Students' positive perceptions of TBL as an engaging and effective learning experience highlight its potential as a solution to the assessment crisis faced by higher education institutions.

As evident in the literature and our findings, TBL assessments motivate students to learn and contribute actively and prepare them for real-world practice (Gong et al., 2022; Imran et al., 2022; Shimizu et al., 2022). TBL's collaborative learning environment, reflective practices, and realistic assessment approach align well with the needs of healthcare professionals. As AI advances, TBL assessments could offer an engaging alternative that promotes critical thinking, teamwork, and adaptability.

While this study was not mainly set up to test whether TBL can challenge AI language models, it can still be considered an alternative assessment method in response to the emergence of AI tools such as ChatGPT. Such tools primarily provide information or answer questions without the same level of interactive and collaborative engagement. While AI tools can be valuable resources for learning and information retrieval, they may not fully capture the depth of understanding and critical thinking skills developed through team-based assessments like TBL.

Amidst these concerns, Thanh et al. (2023) provide an essential perspective on the limitations of AI in handling tasks requiring higher-order cognitive skills, suggesting that despite AI's advancements, nuanced critical thinking and creative problem-solving cannot be easily replicated. This limitation of AI, as also discussed by Morreel et al. (2023), emphasises the continued relevance of TBL in cultivating essential skills that go beyond the reach of current AI technologies.

Farazouli et al. (2023) and Kumar et al. (2024) examine AI's potential to enhance pedagogical innovation while cautioning against the threat that such technologies may pose to academic integrity. This duality resonates with the findings of Lacey and Smith (2023), who emphasise the critical need for AI literacy among educators and students to navigate these challenges effectively. The sentiment is echoed by Sweeney (2023), who discusses the ethical dilemmas and challenges of academic dishonesty, further complicated by AI's capabilities. These studies urge higher education to call for a critical examination of current assessment methods.

Our study finds a complementary narrative in these discussions, highlighting the critical role of TBL in upholding assessment integrity amidst the rise of generative AI. While AI presents new opportunities for innovation in education, TBL's interactive, collaborative nature ensures a depth of learning and assessment beyond what AI can currently achieve. TBL's emphasis on active engagement, critical thinking, and peer feedback fosters an educational environment that prepares students for the complexities of their fields. However, it is important

to note that students should be encouraged to work with AI to prepare for classroom discussions, allowing AI to be integrated into their learning journey.

In conclusion, the collective insights from these studies and our findings point out the importance of innovative, informed approaches to education that harness the strengths of both TBL and AI. By critically evaluating and integrating these methods, educators should ensure that assessments evaluate knowledge and foster the development of essential skills and ethical integrity in the AI era.

### **5.3 Enhancing Learning through Technology: The Role of Technology in TBL**

Integrating the Learning Activity Management System (LAMS) into team-based learning (TBL) has enhanced the educational experience by fostering collaboration and streamlining processes, as also confirmed by Antonis et al. (2023). Students have praised LAMS's structured, user-friendly interface, which reduces anxiety and facilitates seamless transitions between individual and group tasks. Notably, the platform's eco-friendly nature and real-time feedback capabilities have been highlighted as significant advantages. However, challenges such as dependence on stable internet connectivity and occasional system lags have been reported. Addressing these concerns could further improve the effectiveness of technology-mediated TBL.

### **5.4 Limitations**

First, the application of TBL was confined to a single term. This limited exposure might not allow for a comprehensive assessment of TBL's long-term effects and sustainability in enhancing learning outcomes, student engagement, and critical thinking skills over time. Second, TBL was applied within a specific academic module, which may not fully capture its potential or challenges across different disciplines or more extensive curricular structures. The findings might thus reflect the peculiarities of the module's content, student dynamics, or instructional design rather than TBL's inherent qualities.

## **6.0 CONCLUSION**

This study highlights the potential of Team-Based Learning (TBL) in teaching and learning assessment. Through fostering collaboration, critical thinking, and student accountability, TBL demonstrated significant enhancements in student engagement and learning outcomes. The structured phases of TBL, complemented by technology-mediated tools such as the Learning



Activity Management System (LAMS), provided an efficient and interactive learning environment that students appreciated.

Importantly, this research highlights TBL's capacity to address emerging challenges in assessment integrity amidst the rise of generative artificial intelligence (GAI). By embedding active, classroom-based assessments within collaborative frameworks, TBL mitigates the risks associated with GAI misuse, such as bypassing critical learning processes. The positive reception of peer evaluation and the dual-phase learning process further reinforced TBL as a reliable assessment strategy for preparing students for real-world practices.

However, the findings also point to areas requiring further attention, including enhancing the reliability of peer evaluations and addressing technical challenges associated with digital platforms. Future research should explore the long-term impacts of TBL across diverse disciplines and its integration with AI-driven tools to augment, rather than undermine, educational practices.

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