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Balancing Engagement and Integrity: Rethinking Assessment Strategies in Team-Based Learning

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ABSTRACT

Team-based learning (TBL) has become a widely adopted approach for enhancing student engagement and assessment in medical education. Considering TBL as an assessment tool, maintaining academic integrity and ensuring assessment validity are crucial during TBL sessions. In this study, we examined the use of two assessment modalities—audience response systems (ARS) and computer-based testing (CBT)—in a newly established medical school. We explored student and faculty perceptions of these tools and their implications for academic integrity and assessment validity. Using a mixed-methods approach, we gathered data from 240 medical students (92.3% response rate) and conducted focus group discussions with the faculty. Audience response systems obtained a higher global score (34.3 ± 9.26) than CBT (28.3 ± 10.1; $p < 0.05$), yet no significant difference was noted in TBL performance scores between modalities (CBT = 8.58 ± 1.36; ARS = 8.83 ± 1.60). The results indicated that while student satisfaction was similar across both modalities, ARS were preferred for their ease of use and engagement. However, both students and faculty perceived CBT as a valid tool that is better suited to maintaining academic integrity by reducing opportunities for cheating. The faculty also favoured CBT for its cost effectiveness, technical reliability and reduced workload. These findings suggest that while ARS and CBT have their own merits, CBT may better align with institutional goals of ensuring fairness and rigour in assessments. This study provides insights that could inform broad discussions on the effectiveness and implementation of assessment tools in medical education.

***Keywords**:* TBL, ARS, CBT, Feasibility, Efficiency, Assessment tool

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INTRODUCTION

Over the past few decades, team-based learning (TBL) has emerged as a preferred, evidence-based collaborative teaching–learning strategy that balances the effectiveness of small-group learning with the feasibility of large-group instruction **(1-4)**. Team-based learning sessions integrate learning, assessment and application, providing a structured environment that enhances student engagement and promotes an in-depth understanding of course content. Application exercises in TBL are critical components that typically use real-world problems to promote high-order thinking, require teams to make specific decisions and involve simultaneous reporting to encourage discussion and accountability **(3)**. However, while TBL enhances learning outcomes, challenges remain in maintaining assessment integrity. As institutions increasingly rely on technological tools, such as audience response systems (ARS) and computer-based testing (CBT), for both formative and summative evaluations, ensuring fairness and security becomes crucial **(5)**.

At our institution, the College of Medicine employs TBL to anchor learning within an organ system–based curriculum. Each TBL session follows a structured cycle, including flipped learning, readiness assurance tests (RATs) at both the individual (Individual Readiness Assurance Test [iRAT]) and group (Group Readiness Assurance Test [gRAT]) levels and application exercises **(3,6)**. Application exercises include clinical case scenarios with problem-solving tasks and decision-making challenges in which teams must choose among clear alternatives and justify their reasoning. These sessions are strategically integrated at the end of each thematic week, encouraging students to apply core concepts to solve clinical problems, both individually and in teams. Importantly, TBL is also used as a key assessment tool, contributing to students' continuous assessment through grades.

The validity of assessments is a key element of educational evaluation, ensuring that assessments always measure what they are intended to assess. Previous research has made it possible to identify the impact of different assessment modalities on validity, particularly in relation to exam integrity and student performance **(7,8)**. However, the existing literature mainly focuses on comparisons between online and paper-based exams or on methods to improve the validity of online assessments, without a comprehensive analysis of how different digital assessment strategies compare in terms of maintaining validity **(9,10)**. Furthermore, while research confirms that cheating affects validity, few studies have been conducted to determine the extent to which different digital assessment strategies can reduce this risk.

Audience response systems have found their place in medical education because of their ability to promote active student-centred learning and engagement **(11,12)**. At our College of Medicine, ARS are the preferred tools for conducting TBL sessions. However, given that TBL assessments contribute to students' grades, maintaining academic integrity is paramount. The potential for cheating during assessments poses a significant threat to the validity of the assessment process **(5)**, particularly in high-stakes environments, such as medical education. This issue highlights the need for tools that not only enhance student engagement but also uphold academic integrity during assessments.

The CBT platform is used for both summative and formative assessments at the College of Medicine. Computer-based testing uses ExamSoft, a secure software that prevents cheating by locking down the exam taker's device, disabling Wi-Fi and randomising questions and answer sequences. Our medical school is in its early stages of adopting this technology and currently faces the challenge of conducting secure assessments using ARS for its growing student population **(6,13)**. In this scenario, we explored the use of CBT in TBL sessions to uphold academic integrity in RATs, particularly considering the increased potential for cheating during iRATs. Specifically, we explored the feasibility of administering iRATs in CBT format on ExamSoft.

This approach is essential for ensuring valid and secure assessments, which are crucial for maintaining the credibility of student evaluations. In TBL, in which collaboration is encouraged, the risk of cheating could compromise academic outcomes, making assessment integrity even more critical.

While previous research has highlighted the benefits of ARS for promoting student engagement **(11,14)**, fewer studies have compared ARS with more secure systems, such as CBT, in terms of maintaining assessment integrity. This gap in the literature points to the need for research that explores how different technological modalities influence both student performance and academic honesty.

This study aims to fill this gap by comparing stakeholder perceptions and student performance across ARS and CBT formats in TBL sessions. By exploring the feasibility of using CBT alongside ARS, we seek to provide insights into how these tools can best support both learning outcomes and academic integrity. Although this study focuses on a single medical school, the findings may have broad implications for educational policy and practice in other institutions and disciplines.

MATERIALS AND METHODS

Participants and interventions

This study included students enrolled in years 1, 2 and 3 of the medicine programme at the College of Medicine, United Arab Emirates. We introduced CBT for iRAT as an innovative approach for the College, a newly established school that is refining its assessment methods. Hence, the study was limited to internal participants to prevent external comparisons. Two consecutive TBL sessions differing in iRAT delivery formats (ARS vs. CBT) were designed and implemented in the Human Biology (year 1), Blood and Cardiovascular (year 2) and Neurosciences (year 3) courses. Both TBL sessions conducted for each cohort were based on topics from the same organ system. This structure was intentionally designed to ensure content uniformity and maintain consistency in the level of assessment difficulty. This approach helped control for potential confounding variables related to group dynamics and topic complexity. The students were already familiar with both tools—CBT as the standard for all assessments and ARS as tools

commonly used in lectures—thus limiting bias from previous experience. The study was approved by the Institutional Ethics Committee (Approval No: M-F-H-10-Apr).

TBL with ARS

During the first TBL in each of the courses, ARS were used to conduct the RATs.

1. Flipped learning: For the pre-class preparation, the TBL objectives and reading assignments contributed by the relevant subject matter experts were made available to the students early in the week via the learning management system platform (Moodle) (Supplementary files 1–2).

2. iRAT: This test consisted of a 10-item single-best-response multiple-choice questions shown sequentially in the classroom using a TurningPoint PowerPoint presentation. TurningPoint integrates with Microsoft PowerPoint as an add-in to incorporate interactive questions, audience responses from clickers and real-time data visualisation into standard PowerPoint presentations. The TurningPoint audience response system is a live polling system in which students respond to interactive questions in real time using response clickers working in tandem with TurningPoint software. The clicker transmits data via a radio frequency signal to the receiver attached to the instructor's computer, and the response is recorded against its unique ID in the software. The timer for each question is pre-set at 60 seconds. Students submit their answers to each of the MCQs using their clickers. They also have the option to change the answers within the allotted time, with the last answer selected being registered as the final response.

3. gRAT: All clickers are collected from the students, except from the assigned group leaders. The class breaks into their preassigned TBL teams and attempts the same MCQ-based quiz as a group—the gRAT. Once an MCQ is projected on a large screen for the entire class, the group members discuss and agree on an answer. The group leader then submits the answer on behalf of the group. After all groups have submitted their responses, the next MCQ is projected.

Feedback and discussion: In the discussion session that follows the gRAT, the iRAT response graphs generated by TurningPoint are displayed to review class performance. Subject matter experts who contributed to the items are on standby to discuss the questions that the students performed poorly on, review relevant topics and clarify any misunderstandings.

4. Application exercise: The student teams are presented with an application exercise consisting of a clinical scenario and four to five related questions. The teams are required to discuss, solve and submit a written response. The application exercise is then opened for a class-wide discussion.

TBL with CBT (ExamSoft)

The format of the subsequent TBL for each of the courses remained largely unchanged, except for the iRAT component. The students attempt the iRAT, comprising 10 single-best-choice MCQs, on the ExamSoft portal using their laptops. The iRAT session is set to a total duration of 10 minutes, with backward navigation disabled, preventing the students from returning to a question once an answer is submitted. Post iRAT, the class breaks out into their preassigned teams, the team leaders receive their clickers, and the groups proceed for gRAT on ARS. For the feedback and discussion sessions, the results of iRAT are extracted from ExamSoft. Unlike ARS, ExamSoft does not generate graphical response displays; instead, the results are presented as numerical values and percentages. The rest of the TBL steps remained unaltered. All sessions were delivered by the same facilitator to ensure consistency.

Focus group discussion and thematic analysis

The faculty members involved in TBL were randomly selected using Microsoft Excel. Six faculty members participated in a focus group discussion (FGD) in a meeting room, examining the benefits and drawbacks of ARS and CBT in iRAT. One researcher facilitated the discussion, while the other took notes. The session was audio-recorded and transcribed verbatim. Two researchers reviewed the transcripts independently and classified the responses as *benefits* and *drawbacks* of each tool. Any variation in categorisation was discussed to achieve consensus and accuracy. Member checking was conducted by presenting the categorised responses to the participants to enhance credibility and to validate and improve the categorisation. This ensures a rigorous qualitative analysis of faculty responses using a systematic approach, and it helps provide a clear understanding of the perceived advantages and limitations of ARS and CBT in TBL settings.

Data collection and analysis

A day after both modalities of the TBL session were completed, an electronic survey was administered to the students to document their views and opinions about the two modalities employed. Informed consent was obtained digitally on the first page of the questionnaire, in which the participants expressed their agreement to proceed or declined to participate (Supplementary file 3). The questionnaire included 14 items on a five-point Likert scale of 0–4, rating the preferred TBL delivery modality. The items were categorised into the following domains: promoting learning (three items), feasibility (two items), efficiency (three items) and test features (six items) (Supplementary file 4). The domain and global scores were estimated from the questionnaire. The questionnaire also had an option for free responses to assess what the students liked and disliked about each of the delivery modes. The iRAT results of the iRAT session for all six TBLs (two per course) were collated, and comparisons were made between the students' preferred modalities and their scores.

The questionnaire was reviewed and validated by experts in the field of medical education for its face and content validity. The revised questionnaire, based on the suggestions received, was sent to the experts for final approval. A pilot study was carried out among five students to finalise the questionnaire. Cronbach's alpha was used to check the reliability and validity of the questionnaire.

The Statistical Package for Social Sciences Version 22 (Armonk, NY: IBM Corp.) was used for the data analysis. Cronbach's alpha for the questionnaire was 0.74. As the data were not normally distributed, the Wilcoxon signed rank test was used to compare the TBL perception scores of the study population, the Mann–Whitney U test was applied to assess differences in perceptions and TBL scores between male and female students, and the Kruskal–Wallis test was used to assess perceptions and TBL scores across different years of study. A thematic analysis was conducted on the students' free responses and the faculty members' FGDs, with the key findings categorised and presented accordingly.

RESULTS

Sociodemographic characteristics

A total of 260 students were approached, of which 240 participated in the survey (92.3% response rate). Of the 240 students surveyed, the majority were female (70%). Students from years 1, 2 and 3 were almost equitable in distribution in the population sample. Year 1 students accounted for 38% (n = 91) of the total, year 2 = 31.5% (n = 76) and year 3 = 30.8% (n = 73). Audience response systems were the preferred TBL mode across all students at all programme levels. While the proportion of first-year students preferring ARS was high (91%), there was a decline in this proportion in later years in the programme (76% in year 2 and 61% in year 3).

The global score for CBT was 28.3 ± 10.1, while ARS were rated higher at 34.3 ± 9.26. The students perceived ARS better than CBT in terms of enhancing student learning, test features and efficiency (Figure 1). However, they found TBL on CBT using ExamSoft to be more feasible, as indicated by the feasibility domain score (Figure 1). The Wilcoxon signed-rank test revealed statistically significant differences in global perception scores and several domain scores between the ExamSoft (ES) and Audience Response System (ARS) modes of TBL delivery. Specifically, significant improvements were observed in ARS over ES in the domains of Learning, Test Features, and Global Perception ($p < 0.05$). However, no significant difference was noted in Efficiency ($p = 0.10$) and Feasibility ($p = 0.61$), with a negative trend in feasibility scores for ARS compared to ES, particularly among first-year students. These findings are detailed in Table 1.

Table 1: Comparison of perception scores across different years of study

Domain		**Learning**		**Test features**		**Efficiency**		**Feasibility**		**Global perception**	
Mode of TBL		CBT	**ARS**	CBT	**ARS**	CBT	**ARS**	CBT	**ARS**	CBT	**ARS**
Year of study	1	3.85±3.33	9.43±2.92	9.26±5.96	16.2±5.15	6.11±2.19	7.19±1.69	5.28±2.12	3.3±2.23	24.5±9.37	36.1±7.68
	2	5.62±3.32	8.71±3.23	11.8±6.11	15.3±5.99	6.82±2.17	6.82±2.51	5.13±2.19	3.96±2.18	29.4±11.2	34.8±11.3
	3	6.34±3.06	7.93±3.12	13.4±4.59	12.8±4.29	7.09±2.06	6.36±1.92	5.05±1.71	4.45±1.68	31.9±8.19	31.5±8.21
χ^2		16.886	7.237	13.756	15.53	7.326	4.581	0.973	8.675	16.66	10.869
p		< .001	0.02	0.001	< .001	0.02	0.10	0.61	0.01	< .001	0.004

ARS: Audience response system, CBT: Computer Based Testing

Sociodemographic factors and perception scores

No significant difference was noted in the perception scores for ARS and CBT between the male and female students. The Kruskal–Wallis test (df = 2) showed that the year of study significantly affected all perception scores for both TBL modalities, except the feasibility of CBT and efficiency of ARS. Dwass–Steel–Critchlow–Fligner (DSCF) pairwise comparisons revealed significant differences in the perceptions of years 1 and 3 students towards ARS and CBT.

Preferred mode and TBL scores

While there was no significant difference in the TBL scores in both formats (CBT TBL score = 8.58 ± 1.36; ARS TBL score = 8.83 ± 1.60), the mean scores of those students preferring CBT were higher than those preferring ARS for both modalities of TBL (CBT session: 8.82 ± 1.35 vs. 8.50 ± 1.34; ARS session: 9.08 ± 1.18 vs. 8.76 ± 1.72).

Spearman's rank correlation was used to assess the relationship between TBL scores, and global perception scores revealed an insignificant correlation between the variables: TBL scores vs. CBT global perception scores, r (142) = .11, p = .196; and TBL scores vs. ARS global perception scores, r (142) = − .14, p = .10. These results, as shown in Figure 2, indicate no significant association between TBL performance and the students' overall perceptions of either assessment modality.

In the free response section of the questionnaire, the students were asked for additional comments on the benefits and drawbacks of each modality. The most frequently mentioned remarks are summarised in Table 2. Similarly, faculty perceptions of the benefits and drawbacks of each modality gathered through the FGD are detailed in Table 3, providing a comparative view of faculty perspectives on ARS and CBT. Thematic analysis of the qualitative responses from the students and faculty members regarding CBT and ARS categorised responses into five overarching themes—security and academic integrity, technical reliability, user experience and engagement, operational feasibility and pedagogical alignment. The findings indicate that while CBT is favoured for its security, efficiency and alignment with standardised assessment practices, it is hindered by limitations and execution constraints. Conversely, ARS improve interactivity and learner engagement but are restricted by technical instability and concerns about academic integrity. Faculty perspectives closely align with the student responses, emphasising the need for improved infrastructure, technical support and better-integrated assessment delivery systems.

Table 2: Thematic Categorization of Student Responses on CBT and ARS

Theme	CBT	ARS
Security and Academic Integrity	- Fairer - Less chance of cheating	- Easy to cheat
Technical Reliability	- Downloading errors - Laptop malfunction	- Technical glitches - Signal issues - Responses not registered
User Experience and Engagement	- Better presentation with highlighting	- More interactive, convenient, appealing, and interesting - Easier to use
Operational Feasibility	- Transition from iRAT to gRAT is hectic and disorganized	- Clickers are messy - TBL sessions become chaotic
Pedagogical Alignment	- No worries about answers being registered	- Each MCQ is timed appropriately, unlike CBT

ARS: Audience response system, CBT: Computer Based Testing

Table 3: Thematic Categorization of Faculty Responses on CBT and ARS

Theme	CBT	ARS
Security and Academic Integrity	- Hard to cheat	- Seating arrangements needed to prevent cheating
Technical Reliability	- Login issues - Laptop crashes - Difficult transition from iRAT to gRAT	- Signal issues - Weak batteries - Answer registration failures - Technical expertise required
User Experience and Engagement	- Good practice for international tests (encourages familiarity and confidence)	- Students find the sessions more enjoyable
Operational Feasibility	- Switching formats between iRAT and gRAT is problematic	- Increased workload on the assessment office - More staff needed - Expertise needed for setup
Pedagogical Alignment	- Learning objectives can be tagged - Richer feature set for assessment design - Practical for test execution	- Ability to customize the time for each question

ARS: Audience response system, CBT: Computer Based Testing

DISCUSSION

With the growing integration of technology into medical education, institutions are increasingly adopting digital platforms to enhance both learning and assessment. However, the choice of technology must consider not only logistical feasibility but also its impact on learning outcomes, academic integrity and student experience **(15)**. The feasibility of conducting ARS with CBT has been previously tested and reported by many researchers **(16-18)**. In this study, we switched the method for conducting iRAT sessions from ARS to CBT in an attempt to maintain assessment validity without compromising its acceptance and the ability of the sessions to achieve their intended educational outcomes. This study aimed to compare students' perceptions of ARS and CBT with ExamSoft during TBL sessions and to assess whether changing the modality affects student performance.

While most of the students expressed a preference for ARS over CBT, their perceptions were largely shaped by the interface, engagement level and user experience associated with each modality. The students found ARS to be more conducive to interactive learning and favoured their graphical display of real-time responses, which likely fostered greater engagement. This finding is consistent with research showing that immediate feedback and visual reinforcement in learning environments can enhance student motivation and retention of material **(19,20)**. The students perceived ARS-based TBL sessions to be more structured and convenient. In the case of our CBT-based TBL, after the CBT in the iRAT session, the students needed to switch to ARS for their gRAT. This switch could be the probable reason why the students perceived CBT-based TBL to be disorganised, causing inconvenience. The same concerns were reiterated by the faculty. A very plausible approach to this problem would be to conduct the gRAT also in CBT format. This transition incurs no additional cost, as the students already have access to the computers used for iRAT. Therefore, there is no need to invest in clickers. Faculty feedback also emphasised that using a consistent modality for both iRAT and gRAT (e.g. conducting both via CBT) could mitigate the perceived disorganisation associated with switching technologies mid-session. This suggestion aligns with best practices in assessment design, which advocate consistency and clarity in the delivery of assessments to minimise cognitive load and improve the student experience **(18)**.

Moreover, the ability to prevent backward navigation in CBT, while potentially stressful for some students, is intended to reduce the likelihood of dishonest behaviours, such as sharing answers. This underscores a key tension between designing assessments that are secure yet do not overburden students with anxiety. Previous research supports the idea that balancing these concerns is essential to ensuring both the validity and reliability of assessments in educational settings **(21)**.

However, from an assessment validity perspective, the adoption of CBT using ExamSoft was viewed more favourably by both the students and faculty for its potential to uphold academic integrity. Given that maintaining fairness and reducing opportunities for academic dishonesty are critical components of assessment design, the randomised questions and answer choices in ExamSoft provided a more secure testing environment. This aligns with research indicating that secure testing environments promote more reliable assessment outcomes, particularly in high-stakes examinations **(5,13)**. This distinction is particularly relevant to institutions grappling with growing class sizes and the logistical challenges of maintaining secure, valid assessments in collaborative learning environments.

The only domain in which the students rated CBT better than ARS was in terms of feasibility. Computer-based testing leverages existing technology (student laptops), which enhances its feasibility for widespread use. With ExamSoft as the official assessment portal for the college, all students can access the RAT through their personal laptops. Conducting TBL with CBT does not demand any additional prerequisites. By contrast, ARS sessions require the purchase of clickers and software licenses. The students are required to store the clickers in safe custody and are accessible for each TBL session. While ARS offered a more engaging and user-friendly experience, the technical and logistical challenges associated with their use, such as potential clicker malfunctions and the need for consistent maintenance,

were highlighted by both the students and the faculty members. The fact that ARS sessions require additional equipment and setup may limit their scalability for larger cohorts or institutions without sufficient resources. Similar responses were reported from a students' survey by Shaikh AA et al. **(22)**. In addition, the faculty felt that they needed additional training to use TurningPoint software, which further increased their workloads.

The domain scores for learning and test features of year 3 students were significantly different from those for year 1 students, with the senior students giving higher scores for CBT than for ARS. This difference could be due to two reasons. As suggested by Petrak and Bartolac **(23)**, senior students are more honest and less likely to cheat than freshmen students, hence their preference for interventions that prevent cheating. While the format of the ARS session seems more novel and interesting for freshmen, the format of iRAT on CBT is similar to international computer-based exams, which the senior students are looking forward to, thus explaining the rating. The faculty also felt that CBT TBL offers students good practice for international exams.

The absence of significant differences in performance between ARS and CBT in our study suggests that the effectiveness of TBL in promoting learning may be independent of the specific technology used to deliver assessments. This finding is consistent with previous research indicating that the pedagogical approach itself—rather than the tools used to assess it—plays a key role in student outcomes **(17)**. However, the significant differences in perceptions between students and faculty regarding the feasibility and academic integrity of ARS and CBT suggest that the choice of technology can still affect the educational experience. It is important to note that students preferring CBT with ExamSoft tended to have slightly higher TBL scores, suggesting that students with stronger academic integrity or achievement-oriented motivations may gravitate towards more secure assessment methods. This trend is consistent with literature suggesting that high-achieving students are less likely to engage in dishonest practices and may value the fairness and security that such systems provide **(24)**. Computer-based testing offers a controlled environment that helps reduce distractions and opportunities for cheating from peers. In comparison, although ARS are fun and popular among students, they may be considered less secure and less fair. High-achieving students may also have more confidence in their skills and hence prefer assessments that are less influenced by other factors. Consequently, although interaction is seen as a benefit of ARS, students with higher TBL scores prefer security and fairness, making CBT their preferred choice.

These findings have broad implications for medical schools and other higher education institutions implementing TBL. Although students may prefer ARS for their ease of use and engagement features, the benefits of CBT in preserving assessment validity cannot be overlooked. In contexts in which cheating is a significant concern, educators may need to weigh student preferences against the need for secure, reliable assessments.

Team-based learning offers a tremendous advantage in terms of recording and archiving session data, which can be used in later research. This would include determining team- and student-level opportunities and challenges to make more informed educational decisions to improve learning. As noted by Koh et al. **(25)**, the success of collaborative learning strategies, such as TBL, often hinges more on the design of the learning process than on the tools used to facilitate it.

In the Gulf Cooperation Council region, our research provides useful insights into the comparative efficacy of ARS and CBT for TBL. Despite targeting all medical students in their first three years of medical school, the study is limited by its small sample size. Nevertheless, the findings can provide insight into the common challenges faced by institutions with similar pedagogical approaches. Future studies should explore these dynamics across larger and more diverse student populations to determine the generalisability of the results. The long-term impact of these modalities on learning outcomes, particularly when the novelty effect of new technology wears off, should also be investigated to provide a clear understanding of their effectiveness.

Ultimately, while ARS may be more engaging in the short term, institutions must weigh the benefits of engagement against the need for secure, valid assessments. For institutions transitioning from ARS to CBT, proper planning is required. Educators should be trained in effective TBL design using CBT platforms and suitable proctoring strategies. Institutions must invest in adequate infrastructure, including proper testing software, secure network systems and contingency plans in case of technical disruption.

As medical education evolves, further research is needed to identify the optimal balance between engagement and integrity in assessment integrity, ensuring effective and sustainable transitions. This study could be extended through longitudinal research to explore the long-term effects of different assessment modalities on learning retention.

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