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Enhancing students' academic performance through hybrid team-based case-based learning

Galvin Sim Siang Lin¹, Wen Wu Tan², Yook Shiang Ng¹ & Kelvin I. Afrashtehfar³

¹Department of Restorative Dentistry, Kulliyah of Dentistry, International Islamic University Malaysia, Malaysia; ²Department of Dental Public Health, Faculty of Dentistry, Asian Institute of Medicine, Science and Technology (AIMST) University, Malaysia; ³Evidence-Based Practice Unit, Clinical Sciences Department, College of Dentistry, Ajman University, United Arab Emirates

I. INTRODUCTION

The landscape of health profession education, particularly dental education, is evolving to equip students with essential contemporary knowledge and skills for competent dental practice. Within this context, dental materials science plays a pivotal role in undergraduate dental programs, providing the foundation for understanding the materials used in clinical dentistry. However, traditional teaching approaches relies on didactic lectures, often rendering this multidisciplinary subject seem dry and challenging (Soni et al., 2021). Students also face difficulties in grasping the practical applications of materials science in clinical dentistry within the confines of passive didactic lectures.

Recognising these limitations, there is a growing need for innovative pedagogical strategies shifting from teacher-centred to student-centred approaches, fostering active learning. Problem-based learning (PBL), case-based learning (CBL), and team-based learning (TBL) emerge as alternatives. While PBL involves open-inquiry scenarios, it can be time-consuming. CBL, a guided inquiry method, recreates clinical settings, with the teacher as a facilitator. Meanwhile, TBL, introduced in the 1970s, is a teacher-centred approach fostering active learning through student engagement (Michaelsen et al., 2004). Despite their efficacy, their application in dental materials science courses remains

underrepresented. This gap represents a significant deficiency in dental education, especially given the critical role of dental professionals in selecting and justifying the use of appropriate materials in clinical cases. This study addresses this gap by comparing the academic performance of undergraduate dental students in dental materials science courses, utilising a hybrid TBL-CBL approach against traditional didactic lectures.

II. METHODS

The study received approval from the local institutional ethics committee (approval code AUHEC/FOD/2022/28). The preclinical course comprised four modules taught over two semesters (One academic year consists of 2 semesters). A quasi-experimental design involved 74 second-year dental students, comparing continuous assessment scores between didactic lectures (pre-test) and hybrid TBL-CBL (post-test) introduced in the third module. Excluding the first module and final assessment in the fourth module, only scores from modules 2 and 3 were compared. Content validation involved group discussion and consensus among faculty members ensuring question difficulty alignment with learning outcomes. Hybrid TBL-CBL was conducted in seminar rooms with students randomly assigned to groups. Pre-reading materials, including PowerPoint slides from prior lectures were given. The process encompassed a 15-minute introduction, Readiness

Assurance Process (iRAT and tRAT), application activities, and a debriefing session. Data collection involved an unbiased faculty member anonymously obtaining consent for module 2 and module 3 assessment scores, evaluated against grading criteria. Descriptive statistics analysed demographic background, while the Wilcoxon test assessed academic performance using IBM SPSS software with a significance level set at 0.05.

III. RESULTS

54 females (73%) and 20 males (27%) consented to assessment score collection. Mean scores increased

significantly ($p=0.001$) from 61.89 ± 15.67 to 67.35 ± 12.57 after hybrid TBL-CBL, with both female and male scores rising. However, male academic improvement was not statistically significant ($p=0.130$). Following hybrid TBL-CBL, 13 initially failing students in traditional lectures passed ($p=0.020$). Assessment grades depicted a notable increase in 'A' grades (8.1% to 20.3%) and a decrease in 'D' and 'F' grades (23.0% to 6.7%). These findings underscore the positive impact of hybrid TBL-CBL on academic outcomes and the successful remediation of initially struggling students.

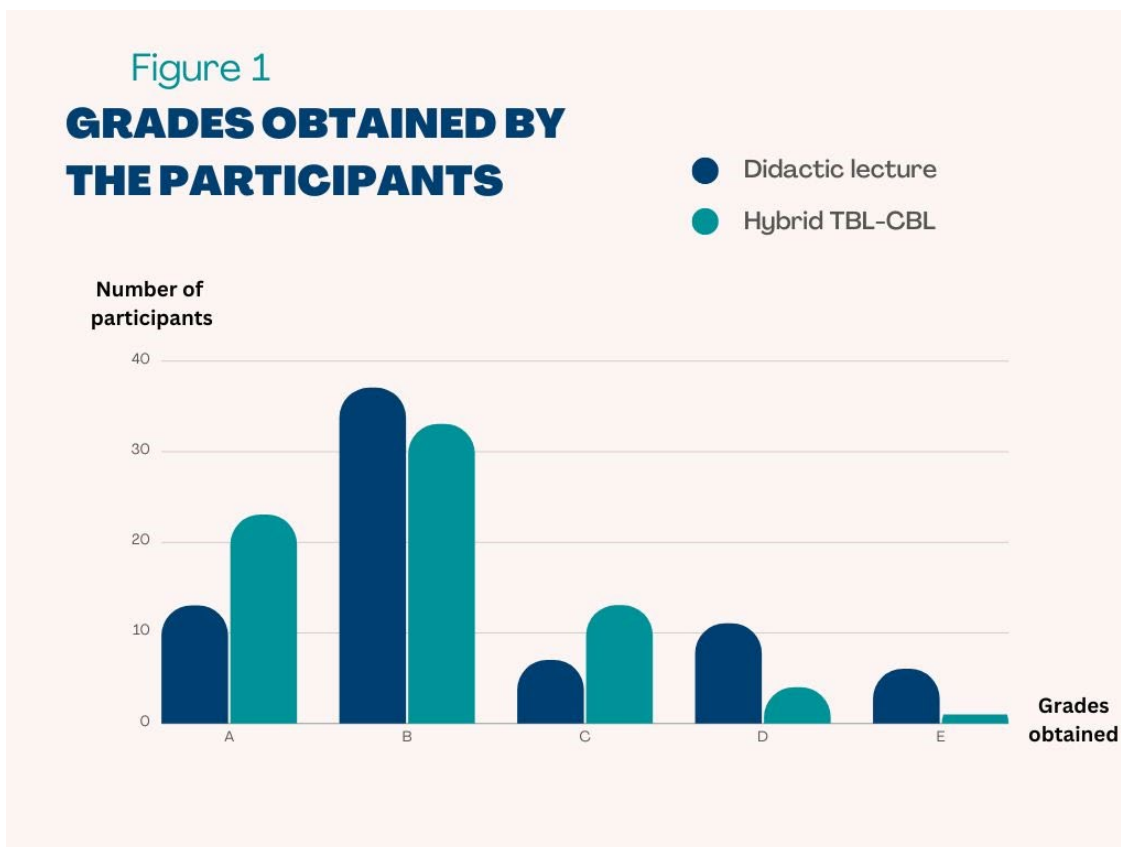


Figure 1. Assessment grades of students before and after the implementation of hybrid TBL-CBL

IV. DISCUSSION

In contrast to traditional didactic lectures, the hybrid TBL-CBL approach requires active student participation in group discussions, case analysis, and feedback sessions. After implementing hybrid TBL-CBL in module 3, significant improvement in students' comprehension of dental materials science was observed through higher assessment scores. This finding is consistent with other research suggesting that both TBL and CBL improve students' knowledge retention and learning experiences through active group learning, leading to better academic performance (Ulfa et al., 2021). Students are expected to participate more actively in group discussions and learn better from the prior knowledge they gained through pre-reading materials,

which helps them perform well in collaborative learning. Both TBL and CBL involve dividing students into small groups, which provides the opportunity to be more interactive and engage in discussion among each other. Unlike the passive nature of large lecture-based teaching, which often leads to "lecture ennui" among students due to one-way communication.

The current study revealed that both male and female students showed improvement in their mean assessment scores following the implementation of hybrid TBL-CBL approach. However, the improvement was not significant among male students. It is plausible that female students perceived the hybrid TBL-CBL sessions more positively, leading to increased engagement and

learning (Das et al., 2019). Conversely, male students frequently attend TBL sessions less prepared and feel that their assessment scores do not accurately represent their level of knowledge. Nevertheless, female students tend to learn in a collaborative, dependent, and participatory manner, whereas male students lean towards independent and competitive ways (Mahamod et al., 2010). Thus, the authors postulated that female students would benefit more from peer learning in hybrid TBL-CBL sessions than male students.

One limitation of the present study is that a comparison of assessment scores among higher-performing and low-performing students were not performed. Although there was no statistically significant increase in the academic performance of male students, it is important to note that this may be because there were fewer male students than female students, which may hinder our ability to detect significant differences. Since the present study utilised a one-group pre- and post-test research design, it is likely that students' interactions with teachers and learning styles may have an impact on their assessment scores. Moreover, the effectiveness of the present hybrid TBL-CBL would be further supported by randomised control research including a larger sample size in different institutions across the nation.

V. CONCLUSION

The hybrid TBL-CBL enhanced academic performance over traditional lectures, particularly benefiting female students. While promising for dental materials science education, future studies are needed to assess its efficacy across healthcare fields and diverse health professional student populations.

Notes on Contributors

Galvin Sim Siang Lin designed the study, performed data collection, drafted the manuscript and approved the final manuscript.

Wen Wu Tan performed data analysis, drafted and approved the final manuscript.

Yook Shiang Ng drafted, read and approved the final manuscript.

Kelvin I. Afrashtehfar gave critical feedback, read and approved the final manuscript.

Ethical Approval

The present study was approved by the Asian Institute of Medicine, Science and Technology (AIMST) University Human Ethics Committee (AUHEC) with ethical approval code AUHEC/FOD/2022/28.

Data Availability

The data supporting the findings of this study are available within the article, but raw data of this study are available from the corresponding author on request.

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Declaration of Interest

All authors have no conflicts of interest.

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- *Galvin Sim Siang Lin
Department of Restorative Dentistry,
Kulliyah of Dentistry,
International Islamic University Malaysia,
25200, Kuantan, Pahang, Malaysia
Email: galvin@iiu.edu.my