Using team-based learning in a problem-based learning medical course to improve transition from a pre-clinical to clinical learning environment

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Many medical schools choose between using either a problem-based learning (PBL) or a team-based learning (TBL) approach to curriculum to teach pre-clinical students the foundational sciences needed to understand disease processes. This study explores whether it is possible to combine the strengths of both approaches to better prepare medical students for the transition from a pre-clinical to a clinical learning environment. While PBL allows students to identify gaps in learning and then apply new knowledge to an established problem, TBL gives students the opportunity to apply their learning to multiple new clinical problems thus providing opportunities for knowledge transfer. We used the Learning Activity Management System (LAMS) to run modified TBL sessions that were designed to fit within the normal lecture program. Iterative development of the intervention over five years based on staff and student feedback has delivered positive educational outcomes.

Keywords: Team based learning, knowledge transfer, medical curriculum

Introduction

At Western Sydney University (WSU), the five-year undergraduate medical degree implements a problem-based learning (PBL) curriculum across the first two pre-clinical years. PBL has been rolled out in many medical programs since its' inception at McMaster University Medical School 50 years ago (Servant-Miklos, 2019). It is favoured in medical degrees as a student-centered approach to stimulate learning of basic sciences and clinical knowledge around a problem scenario (Hmelo-Silver, 2004). The pedagogical advantages of PBL stem from students initially identifying gaps in their knowledge and using these gaps to generate topics for self-study. Students then return to their small groups and apply their new knowledge to solve the pre-set problem (Dolmans, 2014). This process of investigation, explanation and resolution of the problem is important for improving student self-directed learning skills and learning the cognitive skills needed for problem solving and collaboration. Thus PBL is explicitly designed to prepare students for clinical learning where every new clinical scenario is an opportunity to identify knowledge deficits and seek out resources to continue their learning experience (Taylor & Miflin, 2008).

Increasingly, however, medical schools have been turning away from PBL and starting to use a different instructional approach called team-based learning (TBL). The reasons for this range from avoidance of the more resource intensive and thus costly PBL (Burgess, Ayton & Mellis, 2016) to disenchantment with the PBL process itself at achieving its educational goals (Miflin, 2004). TBL lessons are comprised of pre-session individual preparation in the form of readings or lectures, an individual readiness assurance test (iRA), a team readiness assurance test (tRA) comprised of the same questions as the iRA, and application exercises (McMahon, 2010). TBL does share some pedagogical features with PBL. The learning theories are both centered around problem solving in small teams and applying the new learning to that problem. TBL differs in other ways, for example, in TBL multiple small groups are run simultaneously in a large room, rather than each group working in a small room with their facilitator. Also, in TBL, students are given pre-class work, whereas in PBL students develop their own understanding of what learning they need through initial classroom discussion. Finally, in TBL students are given immediate feedback on their answers and reasoning through content expert facilitation, whereas in PBL there are no specified questions and the facilitator is encouraged not to provide academic content, but to rather guide the self-study process.

Dolmans and colleagues (Dolmons, Michaelsen, van Merriënboer & van der Vleuten, 2015) have asked if there could be 'benefits to be gained from combining these approaches' unique strengths?' and if so, 'how can the two approaches be combined?' At WSU, we have been exploring similar issues, and through five years of iterations

of our teaching strategies, we have found there is a definite place for TBL in a PBL-centered course, particularly when it comes to helping students transition from a pre-clinical to clinical stage of their course.

A 2016 systematic review (River et al., 2016) concluded that blending technology with TBL, ranging from video-conferencing, online quizzes and social media did not necessarily correlate with positive student perceptions or outcomes. However, their study did not examine the currently available purpose-built software platforms that are used to run TBL in large courses. To date there is limited research comparing these technologies (e.g. OpenTBL, InterDash and LAMS) but the following paper shows how the use of technology has greatly facilitated the introduction of TBL to this course to minimize the impact on staff and students, and will be explained further below.

Case study: Infectious Diseases Clinical Classrooms

Context

As part of an initiative to improve student transition from pre-clinical to clinical learning in our medical program, we looked at ways that we could engage the students in more opportunities to apply their knowledge to clinical scenarios. Therefore, we sought ways to assess if students could transfer their knowledge outside of the PBL problem that they had participated in, to new cases that may not immediately present the same way as they had initially learned, but which shared an underlying scientific reasoning. The Infectious Diseases block, which occurs near the end of the second year of the medical degree (at the end of the pre-clinical section) was deemed an ideal place to attempt this intervention. A TBL approach was chosen as it provides multiple points for testing student foundational knowledge (through individual and group readiness assessment) and application of knowledge through team discussion and feedback in the more complex application exercises. These clinical classroom modules brought together clinicians, research scientists, educational designers and most importantly students to work together to develop, design, share and evaluate the content.

Modification of the TBL process

As our resources are currently centered around a PBL curriculum, this teaching intervention needed to be equivalent in resource use to our normal lecture program. For example, the same number of staff and hours would go towards the session and the time impact on students would be positive not onerous. To do this, the original TBL model was modified so as to maximise the time that the students spent with the content experts in the TBL session (which we named “Clinical Classrooms”). To accommodate this change, the original lecture content was shortened to videos of core concepts to free up space in the curriculum. The Clinical Classrooms sessions were 1 - 2h in duration, with one session held each week. Following the introduction of the main disease area in PBL where students identified their own gaps in knowledge and formed learning objectives, the students were introduced to supplementary online Clinical Classroom modules delivered through an online software system capable of implementing PBL and TBL (the Learning Activity Management System - LAMS). After several years of iterative development of our approach, our current modified TBL format consists of:

1. Assigned pre-work lecture content
2. Pre-Clinical Classroom individual readiness assurance test (iRA) with marks via LAMS
3. Start of Clinical Classroom face-to-face session of 60 students
4. Team formation of 3 to 4 students and leader selection through LAMS leader tool
5. Team readiness assurance test (tRA) using immediate feedback through LAMS
6. Application exercises in the form of four to five case studies. Teams complete questions in the form of short answers or ‘scratch card’ MCQs delivered through LAMS.
7. Content experts in the form of a clinician and a scientist answer student questions as they progress through the session

Iterative development of the Clinical Classroom process

An educational design research approach as originally outlined and then refined by McKenny & Reeves (2018) was applied to the development of this intervention. The steps taken to refine and develop the intervention were: (1) analysis of the problem (insufficient transfer of knowledge between clinical problems); (2) design of the intervention (modified TBL); (3) evaluation and reflection (a collaboration between students, researchers and lecturers), (4) repeat cycle.

The first phase of the intervention occurred in 2014 and involved pre-recording the lectures, creating iRA and application exercise questions and developing the structure and delivery of the components. The first iteration of the course used a different software platform from that outlined above, which was a combination of Blackboard for delivery of video content and NearPod for delivery of tRA and application exercises. In addition to this, the session had to be delivered in a lecture theatre. Ethics clearance was obtained, and feedback was sought from all stakeholders and involved both student surveys and staff interviews at the end of each session initially and then once a year as the modules matured. In addition, learning analytics tracking data revealed the student rate of progress, usage of the resources and scores on assessment tools both before and during the Clinical Classroom.

The survey instrument had eleven questions and used a 5-point Likert scale covering: pre-session video delivery, motivation to prepare, Clinical Classroom engagement, problem solving and an open-ended question about improvements. Feedback from both staff and students led to iterative development and modification of the Clinical Classroom to the final modified version as outlined above. In particular, the lecture theatre was deemed not suitable for small group work and the sessions were split across two sessions, each with a smaller number of students, so that we could make use of our technology-enabled teaching labs for group work. This allowed maximal beneficial interaction between students and content experts with respect to working through solutions while being able to answer tricky questions on the go. In addition, NearPod was found to be not suitable for self-paced group work as the lecturer is charge of the pacing of the content which led to student dissatisfaction, e.g.,

> Please give us more time to answer questions or give us warning when the questions are being taken down as sometimes we are in the middle of discussions when the questions are taken down.
> [Hepatitis Clinical Classroom using NearPod software, 2014]

We then chose to work with the open source LAMS software which had recently been adapted specifically to deliver a TBL style curriculum. We needed the technology to be flexible enough to deliver our modified TBL Clinical Classrooms and this software stood out from other purpose-built software options for this reason as LAMS is designed to run multiple different learning designs. From 2015 to 2019 we have evaluated and modified the modules to a point that student and staff satisfaction rates are good to very good. Key changes to the Learning Design of the Clinical Classroom have included changing the learning space to assist grouping and interactive ability, group size to maximise individual interactions within a group, placement of iRA as a pre-work task to allow students to assess their level of knowledge prior to entering the group work session, and importantly, improving alignment of expert content and questions. We have also brought a research student into the project team who originally participated in the Clinical Classrooms as a second-year medical student in 2016 and who has provided valuable insights into student motivations to learn and content for the project.

In the two examples below of the survey responses (Figures 1 and 2) it can be seen that the iterative development and improvement in the modules has led to improved student satisfaction in the use of online lectures (with iRA) and satisfaction in students perception that they can apply and transfer knowledge to new clinical scenarios.

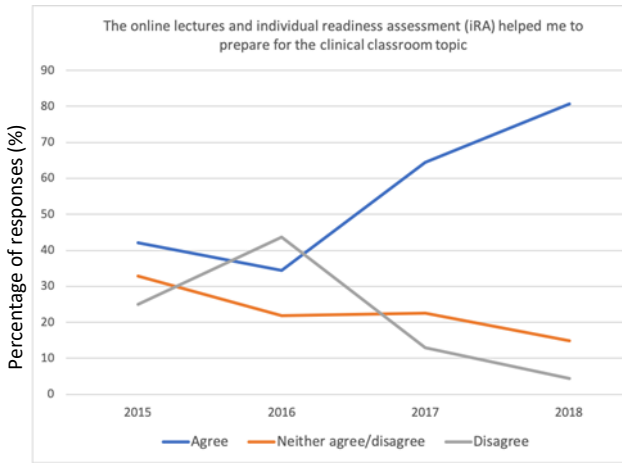

Figure 1: Student responses to having lectures online with iRA

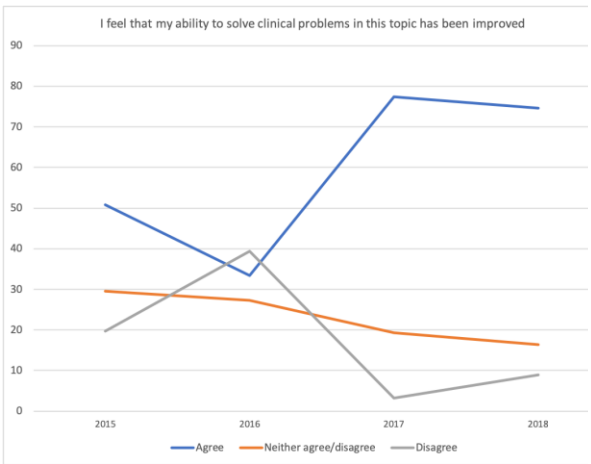

Figure 2: Student response to transfer of knowledge to new clinical scenarios

There were also improvements with motivation to prepare for class, engagement with the content and team discussion and a request for more Clinical Classrooms in the future

Table 1: Student response expressed as agree or strongly agree for Clinical Classroom feedback

Survey question	2015 (n = 61)	2018 (n = 67)
Online lectures and individual readiness assessment (iRA) motivated me to prepare for class	44% agree or strongly agree	81% agree or strongly agree
Team discussion activities in the Clinical Classroom helped me engage more with the content than in a normal lecture	40% agree or strongly agree	88% agree or strongly agree
I would like more Clinical Classrooms in the future	33% agree or strongly agree	81% agree or strongly agree

Positive student feedback included: "The group discussion with tutors coming around to help us was very effective and helped with my understanding (student feedback, 2017)" and "very good way to learn ID, could probably even work for other blocks like neuro (student feedback, 2018)". Based on the Clinical Classrooms being well received it was decided to roll out a new Clinical Classroom for the Oncology block in 2018 – this has subsequently been positively received by students "i wish u've done this every week in onco. make it a little bit shorter though like id ccs" and "Overall really good for consolidating learning" (student feedback Oncology Clinical Classroom, 2018).

Conclusions and next steps

Our design research approach has been valuable for iteratively designing a practical way to include TBL in our PBL oriented course. This has allowed us to combine the exploration of ideas and promotion of self-directed learning components of PBL with the application of learning to alternate scenarios and challenging of students assumed level of learning aspects of TBL. Use of the LAMS software has made the intervention possible with a relatively small team as there is no need to hand out scratch card, there is automated selection of leaders and groups and student progress through the session can be monitored in real-time to quickly catch struggling students. The software has also been integrated into our LMS to allow for single sign on for students.

While PBL allows students to apply new learning to an already established problem, TBL allows students to transfer and apply their knowledge to multiple professionally relevant, clinical problems. We see this as very desirable in identifying gaps in deeper understanding on topics and as a way of developing thinking and reasoning skills. The scientific understanding of the underlying mechanisms (pathological changes to structure and function) provides the basis for understanding disease process, no matter what the condition. This allows us to highlight the important linking concepts between conditions, rather than just the presentation of the conditions themselves.

Future directions include a roll out of the modified TBL Clinical Classrooms into other parts of the course including in Year 1. Our program is undergoing significant change to adapt to a new partnership with a rural medical school and ongoing feedback from students to move away from face-to-face lectures and to flexible online delivery. Advancing the use of TBL in our course is a positive way to address these diverse issues. Our research contributes to a gap in the literature showing how PBL and TBL can be delivered in the same medical course and in the process, we have adopted an innovative approach to improve transition from a pre-clinical to clinical learning environment.

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Declaration: The first author in this paper is related by marriage to the creator of the Learning Activity Management System software used in this study.

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