International Conference NEW PERSPECTIVES in SCIENCE EDUCATION

Problem-Based Tuition in Blended Environments

Sarah Gretton[1], Dylan Williams[2] & Derek Raine[3]

[1]University of Leicester, UK
[2]University of Leicester, UK
[3]University of Leicester, UK

Abstract

Problem-Based Tuition is a scaffolded form of PBL that we have developed over the past 15 years to deliver an interdisciplinary science (Natural Sciences) degree. We discuss the issues arising in adapting the novel features of the program to a blended delivery in response to the COVID19 pandemic. One of the key features of the program is the use of structured guided reading, which carries over smoothly to the on-line environment. Others such as the lectures and group facilitation require adaptation. Rather than their use for Q&A following self-study, the previously interactive lectures were repurposed as pre-recorded introductions to the guided reading. Students then have these available for review. We found it important to provide extensive initial practice in the use of the relevant software for group discussions (Blackboard Collaborate and OneNote). The issues arising in the adaptation of group peer-marking will be discussed. We compare our experience with the adaptation to blended learning of a PBL module in a Chemistry degree.

Keywords: *Problem-Based, Interdisciplinary Science, Blended Learning*

1. Problem-Based Tuition

Problem-based tution (PBT) is our term for a strongly scaffolded version of problem-based learning (PBL) developed for an interdisciplinary science programme (biology, chemistry and physics) at the University of Leicester in the UK [1]. The programme was first presented in 2004 [2] and significantly revised in 2018. The apsects discussed here are common to both implementations. We begin by describing the innovative features of the programme. We then discuss the adaptation to much reduced face-to-face interaction brought about by the COVID19 pandemic. We compare our experience with that of colleagues delivering PBL in a chemistry degree.

In PBT each module is based around a problem or project, here of an interdisciplinary scientific nature. An example might be to investigate the limits to the speed at which a human can run which include physical (heat and chemical transfer, for example) and biological (metabolism, muscle action and so on) and to write this up in an authentic assessment in the form of a report for an athletics governing body. The scaffolding consists of directed reading, and a series of lectures, workshops (classes with problems for group discussion) and individual exercises that frame the student learning. Four core science modules run one at a time in sequence over the academic year. In parallel there are support modules for mathematics, computing and professional skills which are not taught by PBT and for which the adaptation to online is considered briefly at the end.

By contrast, in the School of Chemistry, PBL is integrated into the lecture-based teaching of a number of core modules throughout the curriculum [3]. Students are assigned to small teams (typically around six members per team) to work on open-ended problems in which they apply their subject understanding to problems with broad societal significance such as environmental, financial and social impact. In one example, year two students have to advise the government of a small European nation on the development of a sustainable energy strategy. Here students communicate the key outcomes of their strategy through (i) a review paper providing evidence-based scientific justification for their proposed course of action and (ii) a press conference presentation addressing the social impact. Students work on PBL problems in weekly facilitation sessions. Support is provided in the form of lectures and workshops (related to the scientific principles and the key transferable skills), directed reading and individual reflective activities.

2. Adaptation to online learning

The adaptation of a course of lectures to delivery online is straightforward, to the extent that it is surprising that it has taken a pandemic to drive this change. It is possible to learn from the experience of MOOCs here to make this adaptation a more interactive experience. In theory, adaptation of a problem-based pedagogy to online learning can be accomplished through virtual group work and virtual workshops. In practice we discover pitfalls in this approach. We discuss these in the context of the two programmes.

2.1 Lectures

The facility to record live lectures (as voice over slides) already exists in all of the university theatres using Panopto software. In PBT these recordings were used previously to address issues of accessibility, to provide students with revision material or as (rather poor) alternatives to attending the live sessions. In the programmes described here lectures were not the prime mode of delivery of discipline content. In chemistry PBL they are used to support the pedagogy (see section 4) and in PBT science we use them to guide the content learning. Nevertheless, although these recordings exist, we did not consider them to be of sufficient quality to substitute for face-to-face sessions.

We have therefore made use of Panopto to generate more engaging picture-in-picture presentations (slides and presenter). The key however is that the recorded lectures are structured and delivered in ~20 minute sections with links to the reading material, and again not as substitutes for the print materials. In PBT the original face-to-face lectures were designed as interactive Q and A with experts, for which the students were expected to come prepared through their prior reading. (In recognition of this structure we labelled these as “expert sessions” rather than “lectures”.) However, for the online version we repurposed the material as more straightforward content delivery, which students watch *prior* to engaging with the suggested reading. The lectures now focus on where we might expect students to need help with or reinforcement of the text book material (or research papers) based partly on previous experience of the Q and A.

2.2 Induction

In semester 1, first year chemists work on a PBL induction activity designed to familiarise them with PBL and to give them the opportunity to form strong social links with other students. The activity was adapted for the 2020-21 academic year to an on-line led approach with a change of timescale (from seven to ten weeks). Students were allocated randomly to teams of four or five and given access to a file sharing tool and a team whiteboard. Teams attended regular online facilitation sessions hosted on Blackboard Collaborate Ultra in a communal PBL room (with breakout rooms used for individual teams). Between these sessions students were given access to their own Collaborate rooms to work on the problems.

The first Chemistry facilitation session included an icebreaker activity and and introduction to the PBL approach. The icrebreaker activity required each team member to introduce themselves to the rest of their group and to tell their favourite chemistry joke. Once all team members had introduced themeselves and told their joke, the team members voted for their favourite joke which they then told the entire cohort to determine the overall favourite joke. This light-hearted introduction provided students with a memorable way of meeting their team mates.

Students in PBT are assigned to diverse groups of four or five. We use *Blackboard Collaborate* software for online group work with a facilitator moving between break-out groups. We used a two week induction period comprising a non-credit bearing problem for which students received feedback from academics and peers, allowing students to thoroughly familiarise themselves with the technology and their group members. This was crucial to the success of the later assessed group activities.

2.3 Group Workshops

The level of engagement in chemistry facilitation sessions was generally good with very vibrant discussions taking place in some teams. It is true to say that some teams were less engaged and perhaps the online format made it more challenging for facilitators to intervene when they noticed a team lacking in focus or engagement.

Chemistry students adopted a different approach to the first problem on the development and evaluation of a learning resource [4] from that of previous cohorts in the classroon enviornment. In 2020/21 many groups created online quizzes and videos. This may reflect the changes to the learning environment.

With one facilitator to five or six groups in PBT we found it to be much more difficult to keep track of the online break out room conversations than in a face-to-face setting, and the online activity can lack any “buzz”. The structure was adapted by requiring each group to record their discussion points in real time in a shared OneNote file that can be viewed continuously by the facilitator and retained as a record of the workshop. The precise psychology eludes us, but this has led to much deeper engagement in the workshops.

2.4 Tutorials

Previously in PBT students completed weekly set exercises individually, which were then peer marked within a group in a class setting. To prevent cheating (groups agreeing to give each member unearned marks) random samples of marked work were checked by academic staff. In the move to online these exercises have been designated as formative and carry no marks, obviating the need for checking. Contrary to the expectations of some academic staff (including one of the authors), this has not led to any diminution in engagement. In fact, on the contrary, the work of preparation for the tutorials has been relieved of the stress of a summative assessment, and the online discussion of group members' solutions has focussed to greater extent on the learning content.

3. Scaffolding online

In the face-to-face version of PBT students have a handbook (provided electronically) to guide them through the material, with the regular expert sessions to provide pacing. Moving to online, the now asynchronous lectures no longer served this role. To guide students through PBT online, materials were placed in weekly folders. On Friday afternoon of the preceeding week a post was released guiding students through the activities for the forthcoming week. This suggested both the order of activities and the recommended time on task for each element.

4. Skills

A key feature of the natural sciences programme is the embedding of skills for employability through the problem-based and group pedagogy and the authentic assessments. Skills sessions were retained as an essential component to support development of broader academic skills (for example literature searches and referencing) and to support specific assessments (for example group presentations). In addition we introduced a new skills session specifically to support students to work effectively outside class in an online setting. The existing skills sessions were adapted from two-hour face to face workshops to one-hour sessions with instructional material moved to online recordings and appropriate activities moved to pre-session preparation.

In chemistry student team work (which took place in facilitation workshops, see section 2.2) was supported by a series of lectures that helped intoduce students to the PBL methodology and assisted their development of key skills (e.g. oral and written presentation skills) that they would need to use in PBL facilitation sessions. These skills sessions were delivered through a combination of pre-recorded material together with live online sessions, which included interactivity activities based on the content of the pre-recorded sessions.

5. Conclusions

PBL becomes more like PBT under online teaching. PBT is largely preadapted to online learning with minor tweaks. Thus, very little (if anything) of the academic content and skills development is lost in moving to PBT on line (although naturally the social interactions are more limited).

6. References

[1] Sarah Gretton, Derek Raine and Craig Bartle, Scaffolding Problem Based Learning with Module Length Problems, Conference: European Science Education Research Association Conference 2013, 2014, DOI:10.13140/2.1.2156.4162

[2] Raine D J., Innovative Practices (York, Higher Education Academy) 2015,

[3] Williams, D. P. "Context- and problem-based learning in chemistry in higher education", in Seery, M. K. and Mc Donnell, C. (Eds.), Teaching Chemistry in Higher Education: A Festschrift in Honour of Professor Tina Overton, Creathach Press, Dublin, (2019), pp. 123-136.

[4] Dylan P. Williams, Learn on the Move: A Problem-Based Induction Activity for New University Chemistry Student" J. Chem. Educ., 2017, 94 (12), pp 1925–1928, doi:10.1021/acs.jchemed.7b00399