Using team-based learning to enhance student project work and skills for post-graduation success

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Overview

• Introduction to Imperial College and the case study

• What is team-based learning (TBL)?

• You (our audience) get to experience TBL

• Why we used TBL

• Were we successful?

• Impact of TBL across the university
Civil & Environmental Engineering at Imperial College

- Master of Engineering – 4 year course – JBM accredited

- 90+ students per year
  - Approx. split 60:40 males to female
  - Approx. split 25:25:50 Home to EU to International

- Entrance requirements
  - A* - maths & physics + A in chemistry or another

- Guardian & Sunday Times University Guide (UK) 1 no. for Civil Engineering

- National Student Survey(2016) - Overall Satisfaction, 96%

- Graduates – 86% employment (70% in Engineering) & 12% Education

- Research Assessment (REF14) 47% 4*
Course breakdown

• Course can be simplified into;
  • **Main core technical disciplines**
    • Structural mechanics & materials
    • Fluid mechanics
    • Environmental and Water Resources Engineering
    • Geotechnical engineering
  • **Supporting technical skills**
    • Mathematics
    • Computational methods
    • Drawing / CAD
  • **Professional studies**
Professional Studies

Year 1
- Professional Engineering Practice
- Creative Design
- Construction Challenge Week

Year 2
- Business & Project Management
- Creative Design
- Constructionarium

Year 3
- Group Design Project

Year 4
- Electives

Case Study.
Last Week of 1st year
Construction Challenge Week

- Students work in groups to develop a *Response to Tender* to provide contracting service for the transport of disposal of material excavated from a tunnel. (Quality submission)

- Documentation (ITT) and process identical to engineering practice

- Course is full-time for 5 days
  - Days 1, 2 – Learning structured by TBL
  - Days 3, 4, 5 – Independent group work on the project

- Assessment
  - Performance in TBL sessions
  - Interim report
  - Final report *(adjusted by individual contribution)*
  - Personal Reflective statement
enhance student project work and skills for post-graduation success.

- Knowledge
  - Commercial aspects in contracting industry
  - Sustainability
  - Stakeholder analysis
  - Project Management (technical aspects)

- Skills
  - Project management (inter-personal aspects)
  - Critical thinking & Independent research
  - Written communication

- Behaviours
  - Collaborative
  - Inclusive

Content analysis of reflective statements
What is TBL? – the steps

1. Advance assignment
2. iRAT individual readiness assurance test
3. tRAT team readiness assurance test
4. Instructor clarification review
5. tAPP team application

What's next?

Appeal

(Parmelee et al. 2012)
Key educational features

• Clear **learning goals** to guide and monitor learning
• Carefully selected **advance assignment** that scaffolds learning
• Preparatory work that needs to be done
• Opportunity to apply new understanding with **immediate feedback**
• Collaborative, **active learning with peers**
• “Compare their current understandings with those of the group …integrating information obtained by new experiences into existing mental schemes” (Hrynchak & Batty, 2012)
• Self-managing teams
Key educational features

• Every individual accountable to the team
• Feedback on processes - learning and teamworking
• Modelling and learning critical reasoning through real world problem solving (Hrynchak & Batty, 2012)
• Application Exercise –
  • Significant problem
  • Same problem
  • Specific choice
  • Simultaneous report
• Peer evaluation with negotiated weighting
• Reflection in and on action (Hrynchak & Batty, 2012)
Step 2: iRAT

Individually complete the 6 MCQs on paper

Time allocation: 3 mins

When you’ve finished please await instructions
Step 3: tRAT

As a team answer the 6 MCQs using the Immediate Feedback Assessment Technique

Time allocation: 6 mins
Step 5: tAPP

As a team discuss the 2 issues and make a specific choice from the range of options (A,B,C,D). Be prepared to post and defend your choice.

Time allocation: 6 mins
Why use Team Based Learning?

- TBL was used to orient the students before the main technical task
- Ensure pre-reading is completed
  - Sense of subject mastery before they start
- Immediate feedback of iRAT/tRAT
  - Value all opinions - Not ‘he/she who shouts the loudest’
- tAPP questions build on knowledge but required discussion
  - Answers aren’t black & white
  - Apply thinking & get immediate feedback
- Appeals process
  - Encouraged to challenge orthodoxy
- tAPP all shown together & random person give justification
  - Sustained and broad contribution across the group
Practical Lessons Learnt

• More relevant to certain STEM areas / subjects
  • Knowledge based
  • Answer depends on context.

• Team make-up
  • Not self-selected
  • Mixed ability
  • Balance of gender and nationality

• Team size
  • Not too big – somebody knows the answer
  • Too small – frustration when getting iRAT/tRAT wrong
Practical Lessons Learnt

• Prior learning & TBL topic
  • Specific/relevant to the follow-on task
  • Volume achievable (pre-reading timetabled & appropriate cognitive load)

• tAPP Questions
  • Relevant to the follow-on task (although not obviously so)
  • Appeals process improved debating skills
Student outcomes – Personal Reflective Statements

Extract from module overview

‘The personal reflective… should be approximately 200 words in length and cover your thoughts on how your team managed the task.

Specifically the personal reflective statement should include;

1. What worked well in terms of organisation, communication and project management?

2. How you might organise and manage the task differently if you were asked to repeat it.’

**Question: Did the TBL process help in developing appropriate behaviours?**
Student Outcomes

- Content analysis: Reflective statements post-coded using sentence as unit of analysis.
- Unit coded to each relevant category
- Further categorised as

Ave ≈ 8.7 units/student
Ave ≈ 2.8 codes / unit

...recognising concerns regarding reliability

Cluster: Working together
- Collaboration
- Leadership
- Face-to-Face meetings
- Individual behaviours
- Individual development & learning
- Understanding the role of others
- Individual contribution
- Individual capability & interest
- Stress & anxiety

Cluster: Working processes
- Initial brainstorming
- Work breakdown structures
- Tasking – roles & responsibility
- Delivering a quality report
- Team productivity
- Deliverables & deadlines
- Communication
- Collaboration tools
- Baselines & plan revisions
- Documentation & specification

Cluster: Module design & organisation
- Link to practice
- Course organisation

...recognising concerns regarding reliability
Code Frequency Analysis

- Students had more positive than negative comments

Variation in the proportion of positive & negative statements

[Bar chart showing the distribution of positive and negative comments across different groups]

Group 3 was less positive due to perceptions of differing contribution.
19% of the positive statements were also coded for collaboration.
Majority of statements coded as $\mathbb{R}$ & for collaboration were related to how they split up the tasks between themselves.
Summary of student outcomes

• Overall students were positive regarding the course
• Collaboration was strongly associated with positive statements
• Positive about personal behaviours of team, with minor exceptions
• No statement about the uncertainty of finding the ‘correct’ answer

• The students and I share a common experience of a project that we can explore in later teaching. Clear topics for further development:
  • Critical path analysis
  • Work-breakdown structures & resource levelling
  • Leader v Manager, etc.

Quote from a reflective statement,

“...The ability to work in a group is essential in the professional world and especially in projects with an important stake. I believe that the key for a good group project is speaking. All the teammates have to give their opinion for a decision to move forward. It will also avoid any conflicts. This is what I realized during the TBL sessions...”
Impact of TBL at Imperial

TBL used to teach:
• over 2000 learners at Imperial in 2015-16
• at least 1500 learners in 2016-17

Staff perspectives:
“I attended the Team-based Learning session and it made me completely re-evaluate my strategies for teaching…” (Imperial lecturer and participant at TBL workshop)

“a very efficient way to ensure that the learning outcomes are met, not by some students, but by all students.’ (Imperial lecturer and participant at TBL workshop)

https://www.imperial.ac.uk/staff/educational-development/workshops/introduction-to/team-based-learning/
“People found it great to work with students they never worked with before. The possibility to take some responsibility was greatly appreciated too.”

“Gives us space to think critically and discuss our ideas.”

“TBL encouraged communication…it introduced me to new interpretations and ways of thinking that I didn't think of before.”

“The skills I practised really helped me with the later bioinformatics coursework too as I was then more relaxed about discussing my ideas.”

“it pushed people to make an effort to give their views, and to debate with the other members of the team.”
Imperial College London

Pietro Spanu is a keen and innovative teacher and Professor of Molecular Plant Pathology at Imperial, Moira Sarsfield is Senior Faculty Learning Technologist and Kate Ippolito is Senior Teaching Fellow in Educational Development. Together they work to translate educational strategy and theory into practical applications.

Each team member brings passion for their own specialism and they use their complementary skills to analyse issues from different perspectives, including extensive student input. They believe in creating learning experiences that support the active participation of all students, even in large group settings, and team-based learning (TBL) is an example of this.

Impact of work

Pietro thinks that collaborative, peer-supported learning is particularly helpful for acquiring difficult skills. After attending Kate’s experiential Introduction
Impact of TBL – What’s the evidence?

- TBL is currently used in over 60 healthcare professional training institutions internationally – UG, PG, CPD (Parmelee et al. 2012)
- TBL has been shown to improve medical student exam scores, as compared to small group lectures (Thomas and Bowen, 2011)
- TBL courses produce statistically significant higher than average scores in end of term or national exams (Vasan et al., 2011)
- Educational impact is greatest for students in the lowest quartile – mean of 5.9% increase (Koles et al. 2010)
- In a sample of 1000s, collected over decades, only one example of an individual getting a higher individual score (iRAT) than their team score (tRAT) (Michaelsen, 2012)
- Evidence of increased engagement and lower numbers leaving an over-running class (Haidet et al. 2002)
- Evidence of improved satisfaction amongst learners (Zgheib et al. 2010 and faculty (Conway et al. 2010)
Conclusions

TBL can usefully be incorporated into STEM curricula, where appropriate, to:

• Encourage preparatory work and contribution of all students

• Mitigate against unproductive team working dynamics

• Foster and provide feedback on positive team working approaches that can be fed forward to future practice

• Support reflection on development of appropriate professional behaviours


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