Research in progress: Assessing individual student learning within team-based engineering curricula

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***Abstract**: The assessment of individual students' learning in team-based courses can be problematic for academic staff and students alike. Qualitative approaches used in this setting may also be seen as lacking validity by those who consider only quantitative assessment approaches to be viable. This five-institution research project is designed to gather data from academic staff and students about their experiences with assessment in team-based settings with the goal of deriving assessment practices that are fair to students and yield data that can guide program development and accreditation processes. This paper reports on the research design, efforts to date, and future directions.*

Introduction

Project teams are ubiquitous in professional engineering and team-based coursework offers a perfect opportunity to prepare engineering students for professional life. The assessment of individual students' learning in team-based courses, however, can be problematic for students, academic staff, and administration alike.

A student's grades must reflect what she or he has learned as an individual within the team context in terms of the specific learning outcomes associated with that course. Within engineering team-based projects, individuals have traditionally been assigned a grade heavily influenced by the team's project deliverables. This use of team-created deliverables as indicators of individual student learning has multiple prospective problems. For example, a less-than-successful project as reflected in a team's project report, presentation, or prototype often results in reduced grades for its individual members. This result can be both unfair to students and professionally unethical for academics as the conditions and actions that constitute project "failure" are often the source of significant learning. When team-created deliverables serve as the basis for assessing individual students' learning, the rich potential for learning among team members is both ignored and stifled.

Engineering educators using team-based approaches need a validated assessment model that includes an individual student's qualitative account of her or his own learning (e.g., portfolios or oral examinations.) These narrative approaches, in combination with more traditional assessment activities, allow for a more nuanced view of an individual student's learning in team-based coursework, particularly in terms of their meeting institutional academic standards. Internationally, portfolio assessment is considered a valid approach in a range of engineering institutions (Cress and McDonald-Cress, 1995; Jorgenson and Howard, 2005; Mourtos, 1997; Payne et al., 1997).

These methods of assessment, however, are currently viewed with scepticism in many engineering programs within Australia and have been characterised as "overly subjective" by critics. While such qualitative assessment models have been the subject of teaching and learning research (Michigan

Engineering, 2010), grading decisions based on these models must be capable of withstanding external scrutiny. They must also be accepted as valid by the Australian accreditation body for engineering programs.

The goal of this five-university research project is to develop a valid model for assessing individual students' learning gained in a team environment. From the outset, it has been important to the research team that this model serves the needs of administration, academic staff, and students. For administrative and academic staff needs, educators must gather data to assure that academic standards have been met and to inform the improvement of program and university outcomes. For both students and academic staff, assessment must also encourage students to learn from mistakes and failures, to be creative and challenge themselves, to develop reflection and self-assessment skills, and to support their development of the full range of desired graduate attributes – all of which help students take responsibility for their own learning and professional capability.

This remainder of this paper describes the background of this ALTC-funded project, including the overall design, progress to date, and future actions.

The Elements of the Project

In this project, researchers from five tertiary institutions are investigating current practices for assessing individual student learning in team-based engineering coursework at their institutions. The questions driving this research are:

1. What methods are currently in place at member institutions for assessing individual students' learning in team-based coursework?
2. What do faculty and students see as the strengths and weaknesses of these methods?
3. What connotes the effective assessment of an individual student's learning in a team-based course?

This research and development project is a synthesis of design research (Brown, 1992; Collins, Joseph, and Bielaczyc, 2004) and Grounded Theory inquiry (Strauss and Corbin, 1998; Charmaz, 2006). The research team is conducting open-ended interviews with academic staff and students about their experiences with assessment in the team-based setting. The interview transcripts are being analysed for recurrent and outlying themes. These findings from this analysis will inform the construction of a broad working model for effective assessment of individual students' learning in team-based courses. This model will then be used to create assessment strategies for specific team-based courses at the member institutions. The evaluation of these pilot assessment strategies will in turn help refine the broad assessment model in order to disseminate this assessment approach beyond the member institutions in this study to other universities and to Engineers Australia.

A foundational practice in any qualitative research project is to delimit the researchers' own beliefs and biases about the topic at hand. By bracketing these biases, the research team can better appreciate the diversity of perspectives that participants can offer, and also question the strengths and weaknesses of the very perspectives that the researchers hold so dear. To this end, the research team recognizes that the following bodies of literature have influenced its understanding of assessment in the team-based setting:

- **Assessment is a significant 'driver' of student learning** in that students may engage course activities in direct relation with the weighting these activities are given in the assessment process (Worman et al., 2009). Biggs (1999) suggests that student learning is maximized by a "constructive alignment" of learning outcomes, course activities, and assessment methods. Experience suggests that the team-based learning context poses a unique challenge in terms of designing assessment for individual students that does not compromise the collaborative spirit of this learning and teaching approach.

- **Assessment must serve both the student and the institution.** Assessment serves the institution when it gathers information about students' engagement with and achievement of academic standards (assessment of learning or summative assessment). The role of assessment in team-based pedagogies such as Project-Based Learning (PBL) often emphasises assessment activities that directly support and promote student learning (assessment for learning or formative assessment), with these activities often designed to help students explicate and reflect upon their own learning. (Weimer, 2002).
- **Technical content is often combined with acculturation into professional engineering practice** in team-based undergraduate engineering courses. Bruffee (1999) suggests that a more holistic view of assessment is required to capture students' learning in this synergistic approach, especially in terms of students' engagement with this acculturation, an element that may not be accessible through traditional quantitative modes of testing.

The project team has planned an inclusive approach throughout the project, seeking the perspectives of academic staff, students, and the accreditation body. Data collection on current assessment practices and participants' preferences is being conducted in the following areas:

- Interviews with Academic Staff. The research team is conducting interviews with academic staff from a variety of perspectives: Heads of program, lecturers, curriculum designers, those who teach in PBL-based programs, and those who teach stand-alone team-based courses in more traditional engineering programs. Participants are being asked about the purpose and goals of assessment, the strengths and weaknesses of their current methods, and their ideas for improvement at their institutions.
- Consultation with the Accrediting Body. The research team will conduct interviews with the staff at Engineers Australia, exploring the role of assessment in the accreditation process, evidence of rigor in assessment, and the organization's guidelines for assessment.
- Student Focus Groups. The research team is also conducting focus groups with students at the member institutions to gather data on the impact of current assessment methods as well as students' ideas for more effective methods for assessing individual students' learning on teams.
- Assessment Documentation. A third stream of data for this project is the documents used in the assessment process at the various institutions.
- A review of the current literature on assessment in the PBL context.

The transcripts from the interviews and focus groups are being analysed in NVIVO, a qualitative analysis software application. The research team will synthesize the perspectives expressed by various participants, allowing themes and their interrelationships to emerge naturally from the data.

Current Status

This project (ALTC PP-1380) was funded by the ALTC late in 2009 and begun in earnest in February 2010. By mid-year 2010 the research team has:

- formed the research team
- gained ethical clearance
- designed data collection instruments, including interview and focus group protocols
- recruited and interviewed participants at four out of five institutions
- identified 87 PBL publications for review

The research team anticipates completing this first wave of data collection by the end of September 2010.

Results to Date

Research team members are just beginning the data analysis process as this paper is being submitted. This section reports anecdotal observations based on the research team's engagement with academic staff and students here in Australia as well as at an institution in northern Europe. While these findings are certainly preliminary, the research team believes that the issues raised in this section can progress conversation within the engineering education community about effective assessment in the team-based setting.

In terms of assessment, the academic staff participants in this study have expressed a wide variety of perspectives as to their motivations and their engagement with their institution's preferred methods. At one end of the spectrum is the instructor who assigns a final report and a final exam as the sole means of assessing student learning. Here the instructor takes a summative approach, saving all assessment events until the end of term. At the other end of the spectrum is the instructor who takes a more formative approach, creating "mini-activities" throughout the term in order to give her students ongoing feedback and guidance on their learning as well as giving students individual oral exams at the end of term to explore their learning across the scope of the project.

These two examples give rise to a number of questions that are guiding the analysis:

1) To what extent do instructors assess the individual student's learning of the full scope of an engineering project, including areas such as technical expertise, professional communication skills, domain knowledge of the problem context, and innovative thinking?
2) What are the tradeoffs between assessment distributed across the term and assessment only at the end of term – for both academic staff and students? For example, such tradeoffs may include balancing academic workload (Feedback to individual students takes time) vs. student learning (Individual students have varying needs for feedback, so how much is enough?).
3) Assessment can be conducted in written, oral, and skills demonstration formats, or any combination of the three. Do engineering educators have the requisite knowledge or experience to know when these methods can be employed most effectively? Academic staff may also have limited skillsets for effectively engaging assessment in any format.
4) Academic staff and engineering students are both concerned with "passenger" students, those who rely on the other team members to do the lion's share of the project work but then expect a passing grade. How can assessment methods either support passenger behaviour or encourage these students to strengthen their engagement with coursework?

The research team is already finding that academic staff and students are passionate about assessment in team-based courses, even if ideas differ within all parties about goals and methods.

Next Steps: Building Models, Creating Strategies

The research team will meet in October 2010 to synthesize the interview data, the assessment documentation, and the trends derived from the literature review. Using methods based in participatory design (Kensing and Madsen, 1991; Sanders and Williams, 2003), the team will use the data to identify and map out the key considerations involved in the assessment context for team-based courses, investigate the interplay of concerns expressed by a variety of stakeholders, and derive a broad working model for the effective assessment of individual students' learning in team-based pedagogies.

The majority of the efforts in 2011 will involve adapting that model and creating strategies for specific engineering courses at each of the member institutions. The research team will continue employing the Grounded Theory methodology, collecting data on the experience of both academic staff and students as they engage with the goals and activities related to this newly formed assessment strategy, in order to refine the working assessment model. The final stages of this research activity include disseminating the findings through workshops for educators outside the member institutions and outside engineering education.

The research team will also collect ongoing feedback about methods and findings from two sources. First, an external evaluator will monitor progress and provide ongoing support and suggestions to research team and to ALTC's project team. Second, an external reference group is being created to ensure that the findings from this project are practical and relevant for academic staff in a variety of institutions and for Engineers Australia.

Conclusion

This project is revealing a fascinating situation for those involved in team-based coursework: the lack of a universally recognized approach to assessing individual students' learning. While the research team has no intention of developing a monolithic "best practice" model, this research team feels that it is important that both academic staff and students have access to an assessment approach that effectively meets the needs of administrators while also supporting the full scope of an individual student's learning in a team-based course.

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