ASEE International Forum
Omni Hotel at CNN Center
Saturday June 22, 2013

Invited Paper - SPARKPLUS : Enabling collaboration and dialogue for learning and developing standards

Dr. Keith Willey, University of Technology Sydney

KEITH WILLEY (BE 1st Hons and Medal, PhD) is a member of the Faculty of Engineering and Information Technology at the University of Technology, Sydney. He commenced his academic career after 20 years in the Broadcasting and Communications industry. In the area of education, Keith's research interests include the learning and assessment associated with working in groups, the use of self and peer assessment for collaborative peer learning, the nature of informal learning in professional practice, flipped learning, academic standards, and improving peer review. Keith is an Australian Learning and Teaching Council Fellow. He has received several awards including an Engineers Australia Engineering Excellence Award (Education and Training), the UTS Medal for Teaching and Research Integration and both the Australasian Association of Engineering Education (AaeE) Teaching Excellence and Research Design Awards. Keith has been a visiting scholar at universities in Australia, Europe, North America and Asia. His commitment to developing high quality teaching and learning practices is supported by his educational research that has been published in numerous conference papers and journal articles. Keith is the Project Manager and lead developer of the self and peer assessment software tool known as SPARKPLUS. This software is currently being used by faculty at over 20 Australian Universities and several Universities and High Schools in Europe Asia and North and South America.

Mrs. Anne P Gardner, University of Technology, Sydney

ANNE GARDNER is a member of the Faculty of Engineering and Information Technology at the University of Technology, Sydney (UTS). Anne's research is in engineering education where she works with Dr. Willey in improving understanding of the learning associated with and assessment of collaborative learning, workplace learning by professional engineers, and improving the peer review process for engineering education publications. Anne also contributes to the development of the software tool SPARKPLUS. Anne has received recognition for her work in educational research and development including an Engineers Australia Engineering Excellence Award, and Australasian Association of Engineering Education (AaeE) Teaching Excellence Award and Research Design Award. Anne is currently a UTS Learning 2014 Fellow, a role requiring leadership in demonstrating and disseminating innovative teaching and learning practices throughout the university.

SPARK^{PLUS} : enabling collaboration and dialogue for learning and developing standards.

Abstract

Professional learning is often informal, learnt on the job through engaging in practice with peers. Hence, to prepare students for professional practice they require opportunities to develop their ability to work in such collaborative /socially constructed learning environments.

The authors have conducted several studies investigating the impact of collaborative learning activities on the people that participate in them. We found thoughtful design is required, including scaffolding, to motivate desired approaches and attitudes to learning. The results of these studies informed the development of a collaborative learning activity framework and the educational technology tool SPARK^{PLUS}. In this paper we use exemplar activities to describe the findings of these studies and demonstrate both the framework and the support provided by SPARK^{PLUS}.

Introduction

There is an expectation by organisations that the professionals they employ, including engineers, engage in ongoing learning in order to meet the demands of continuing change. Much of this learning is informal, learnt on the job through practice with peers.

Recent writers on workplace learning [1, 2] argue that many traditional assumptions about professional learning are problematic in that learning has often been seen as something that individuals do, for example attending a course. This simplistic view fails to consider how the social dimensions of work provide a rich context for professional learning. More specifically, some of these studies show that the work is not only a context, or backdrop, but is fundamentally implicated in learning [3, 4, 5]. Hence, to prepare students for professional practice they require opportunities to practise, experience, reflect and improve their ability to work in collaborative /socially constructed learning environments.

In an educational context, collaboration is generally described as an approach involving joint intellectual efforts between students, or between students and the instructor [6]. Dana [7] reports that compared to traditional competitive or individualistic learning environments, benefits of collaborative tasks include higher student achievement, greater use of higher level reasoning and critical thinking skills, more positive attitudes toward the subject matter and satisfaction with the class. However the benefits are not automatic. Thoughtful design, assessment scaffolding and the support of educational technology, particularly in large classes, contribute to both their success and sustainability.

In this paper we use exemplar activities to describe the findings of several studies that informed the development of a framework and educational technology to support learning through collaboration and dialogue and the development of professional judgement.

Background

The authors have conducted several studies investigating the impact of technology assisted collaborative learning activities [8-12]. Our findings highlighted the need to develop activities that cultivate students' judgement, facilitate peer feedback, promote learner independence, and reinforce development of their professional engineering identity.

Our aim is to promote a learning focus as opposed to a task-focused disposition in students. A student's core identity may be such that they resist this change in focus limiting their engagement with these activities. We found scaffolding to be valuable to motivate desired approaches, behavior and attitudes to learning.For example, we constantly remind students that "mistakes compress learning" and to benefit most from any activity they should be pushing their learning boundaries until they make mistakes and / or discover what they do not know [13]. In addition, we found that in summative activities students, with some justification, tend to strategically focus on how to achieve the best mark. Conversely, formative collaborative activities provide a low-risk environment [14] allowing students to push their learning boundaries, make mistakes, identify gaps in their learning and have these addressed by their peers. However, we acknowledge the need to develop quality scaffolding to motivate the participation of some students in formative activities. Furthermore we suggest that without the assistance of educational technology the administrative burden and cost to provide these type of collaborative activities, especially in large classes, is likely to be unsustainable.

Analysis of the results of these studies informed the collaborative learning activity framework (Figure 1) and the educational technology tool SPARK^{PLUS} [15]that are previewed in the remainder of this paper.

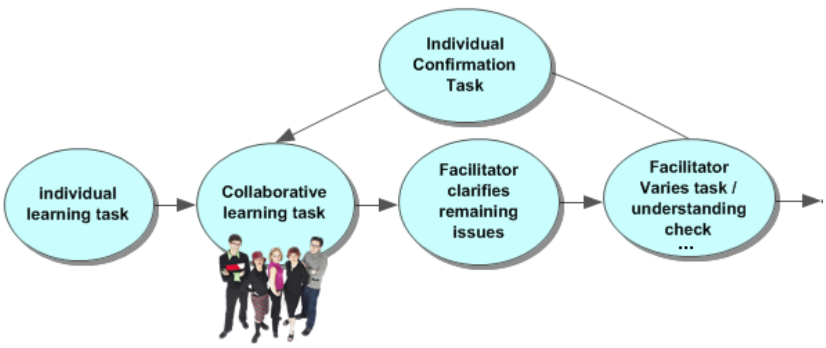

Figure 1 Collaborative Learning Activity Framework

Framework

The first step in any collaborative learning activity should be an individual task, usually undertaken out of class, allowing participants to identify gaps in their own learning / understanding. This is followed by a group task where participants have their learning gaps addressed by their peers while completing the activity collaboratively. The dialogue within this task not only provides the social dimensions important to learning but provides a discourse to challenge participants' understanding and judgement, convert tacit understandings to explicit explanations and socially construct meaning, language and standards. Breakout groups are then brought back together for the facilitator to clarify any outstanding issues. To discern a difference, learn and develop judgement, one must have experienced a variation from previous experience [16]. Hence, we recommend that next instructors vary an aspect of the activity to change the outcome and have participants complete this first individually then collaboratively to verify their understanding. Finally, a confirmation task that applies the learning in a new context and/or a more complex situation should be undertaken individually to confirm understanding and reduce the occurrence of "collective ability" [17 - 20] (where as members of a team participants appear to understand the activity learning outcomes, but are unable to demonstrate this learning individually); then collaboratively as part of the next repeated cycle.

Both students and academics are active participants in the various stages of the framework, albeit with differing roles. The following sections describe how the framework was applied to two different activities: one where the participants were academics, and in the other, students.

Tutor Benchmarking

The motivation for this research is the international trend to focus on learning oriented assessment activities and demonstrated learning outcomes. While a key factor in these activities is the provision of feedback to students, the capacity of academics to provide quality judgements and feedback is often taken for granted. Without appropriate consensus around the meaning and understanding of academic standards there is no assurance that assessment standards and practices are valid and/or reliable. Furthermore, if academics don't understand or can't articulate the standards they are assessing, how can they provide students with quality learning oriented feedback on their work? In several studies [21 – 23] we found significant benefits in implementing the framework (Figure 1) using SPARK^{PLUS} to co-construct understandings of academic standards amongst instructors and tutors as described below.

Application of Framework for Tutor Benchmarking using SPARK^{PLUS}

Prior to Assessment meeting
Individual assessment: assessors/tutors are provided with a copy of two pieces of work to grade against specified criteria, entering their assessment (grades, reasoning and feedback comments) into the multiple assessor tool in SPARK^{PLUS}.

During Assessor/Tutor Meeting
Collaborative discussion and assessment: tutors logon to SPARK^{PLUS} or are provided with a print out of the SPARK^{PLUS} results (Figure 2) to compare their grading and comments to that of the other tutors (displayed anonymously) and reflect on any differences. Tutors are formed into small groups to discuss their individual grading and subsequently to collaboratively, reaching a consensus, re-grade and provide feedback comments on each report.

Facilitator led discussion: a facilitator, often the course co-ordinator, leads a discussion focusing on exploring any differences in grading and/or reasoning that have emerged in the small group discussions.

Vary activity: To assist participants to clarify and reflect on their judgement we recommend that the facilitator vary an aspect of the activity to change the outcome; for example, by modifying an assessment criterion or task objective.

Let's assume that the original task was to produce a five-minute video to teach a professional audience cardiopulmonary resuscitation (CPR) and an assessment criterion asks tutors to evaluate the video's capacity to engage the target audience. The introduced variation could be to change the target audience to teenagers. The cycle is now repeated to highlight tutors' grading sensitivities and broaden their understanding, with them reassessing the work considering the varied task objective, first individually then collaboratively.

Finally, a confirmation task is undertaken where tutors assess an additional piece of work to confirm their understanding and capacity to articulate the reasons for their assessments. Again this confirmation task is undertaken first individually, then collaboratively, followed by a discussion exploring any outstanding differences in grading and/or reasoning.

Impact/Discussion

Implementing the framework using the software tool proved to be an efficient and effective process to:

- socially construct tutors' understanding of assessment criteria including agreeing on the factors to consider and their relative importance when assessing against the criteria,
- benchmark their judgement and reasoning against other tutors and instructors,
- develop a shared descriptive language to improve feedback comprehension, and
- assist tutors to explicitly articulate their tacit judgements allowing them to improve feedback to students

Tutors were overwhelmingly positive about the impact of this collaborative activity providing comments such as: *"It validated my understanding of the subject and fine-tuned a few concepts"*, and *"It was a fast way to get issues discussed and resolve differences"*.

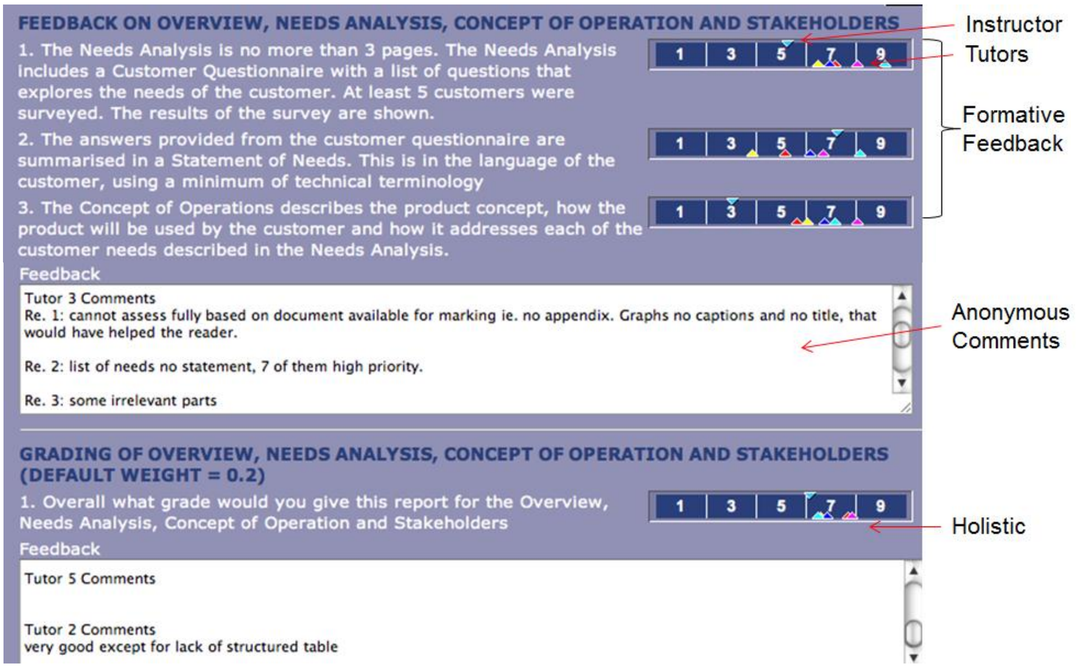

Figure 2: Results screen for tutor benchmarking activity showing how the course co-ordinator (triangle on top side of slider) and the tutors (triangles on bottom side of slider) rated the work including any comments they made (to save space a number of criteria have been removed from this screenshot).

In regard to the software's facilitation tutors reported that the screens (e.g. results screen in Figure 2) made it easy for them to observe where their opinions and reasoning differed from the other tutors and where as a group there was the most agreement and disagreement.

Tutors also found that the comment summary screen (Figure 3) helped them to understand the reasons for grading differences and highlighted issues to discuss in the collaborative dialogue: *"I was able to see what they were thinking and learn and improve my own* [feedback]*...".* While the differences in tutor perspectives were initially exposed by comparing their individual ratings in SPARK^PLUS^, it was in the subsequent collaborative dialogue where these differences were explored and discussed that the standards to be used in grading were co-constructed. Because comments are anonymised, each comment is discussed on its merits free from the bias that may result from dominant personalities or perceived differences in expertise. Interestingly it was sometimes the tutor whose rating differed the most from their peers who raised an issue others had not previously considered, but after discussion all tutors agreed was important.

In addition, tutors reported that observing the differences and ambiguity in the language each used (to explain their reasoning on the same report), helped them appreciate our previous findings that discrepancies and ambiguities in feedback language significantly contribute to students' perception that grading is unfair, commenting that: *"I can see consistency across the tutors is important", and "I can see the potential for frustration by the students".*

Exploring these differences through discussion not only required tutors to explicitly articulate what were often previously tacit judgements but also to co-construct a language to describe reports of different standard allowing them to provide more specific feedback to students.

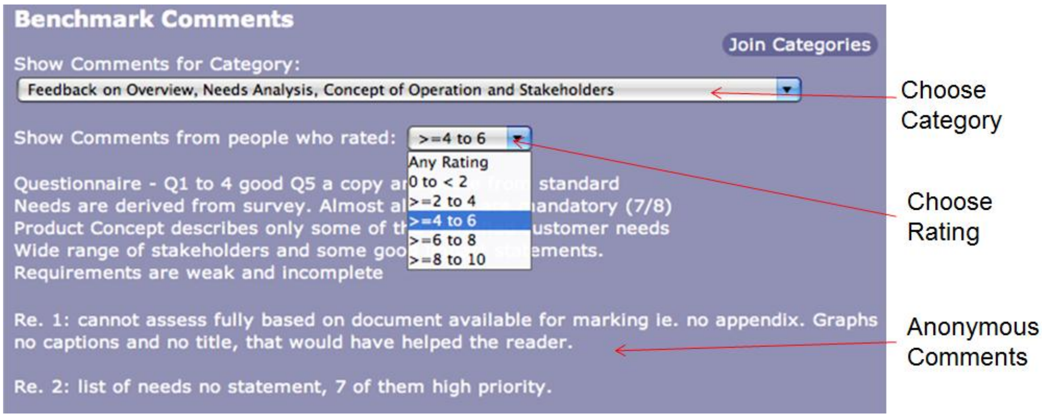

Figure 3: The comment summary screen allows all comments to be displayed at once or only for a preselected rating.

Student Collaborative Learning

The learning benefits of combining the framework and SPARK^PLUS^ have also been applied to students in a range of activities including the *'flipped'* activity described below.

Pre-class, self and peer assessment formative learning activities are designed to be undertaken at the start of each subject topic, enabling students to assess their level of understanding before in-class lectures. The intention is that class time is spent on higher cognitive interactive activities, focusing on material that most students 'don't get', rather than on material that students can understand by themselves.

Prior to class:

1. Students undertake readings, research and/or development activity.

2. Students answer and provide their reasoning for a series of online multiple-choice questions facilitated via SPARK^{PLUS} (Figure 4).
3. a) students can log on and use the SPARK^{PLUS} summary screens showing histograms and confidential comments submitted for each answer choice (A, B C etc) to compare their answers (Figure 5) and reasoning to their peers (similar to Figure 3). Note: Having observed that many students see the instructor's answers and explanations as providing closure, being all they need to know, answers are not published until after class to encourage students to make comparisons with their peers and think for themselves.
   b) academics also use these screens to identify topics that are troubling students and/or any regular misconceptions.

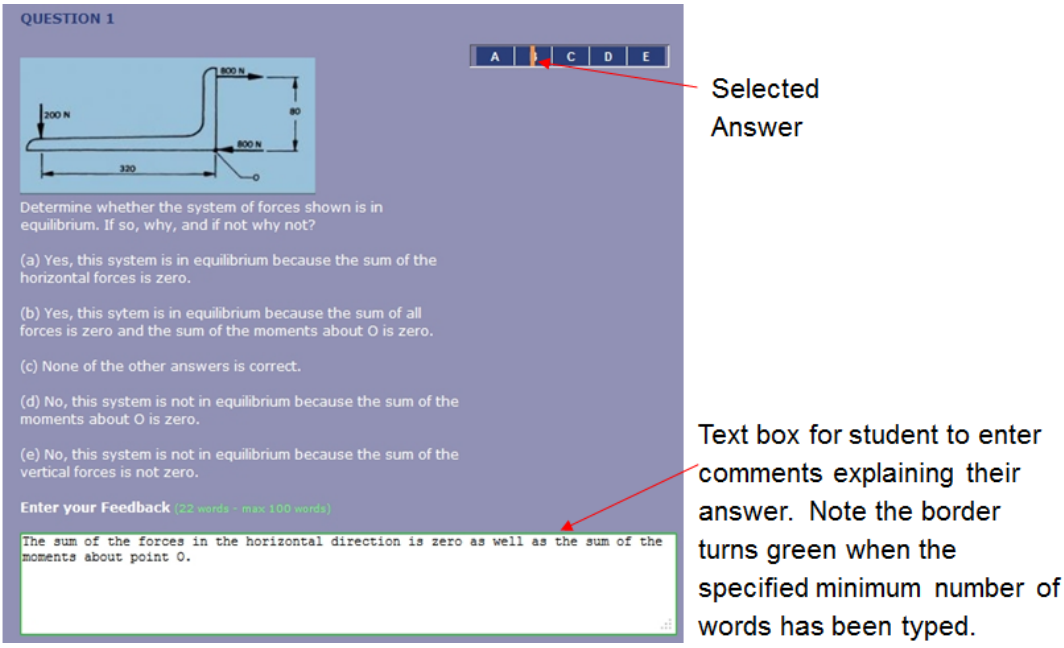

Figure 4: Example question screen in SPARK^{PLUS}.

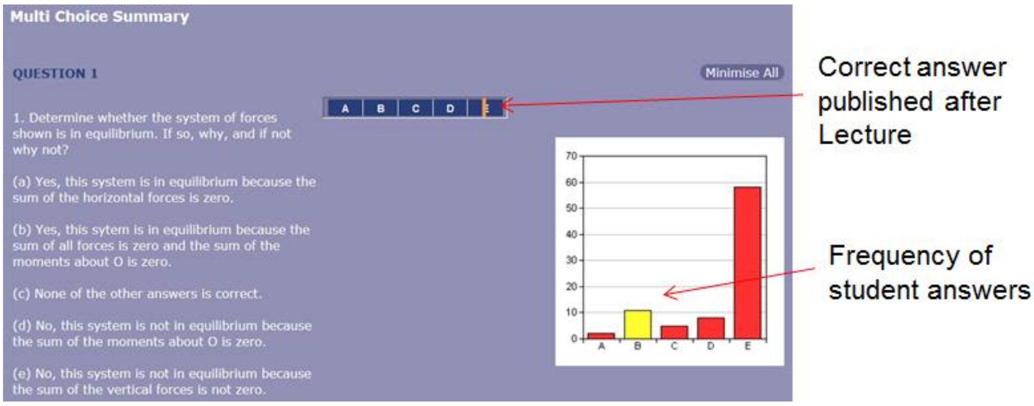

Figure 5: Individual student's result screen.
Note the yellow histogram indicates this student's answer.

During Class

Classes begin with a general discussion of the pre-work activity exploring the associated material in more detail. During this time the instructor, guided by the results (typically displayed in class as shown in Figures 5 and 3) and in collaboration with the students, addresses any common misconceptions or misunderstandings after which more complex material is explored. This activity is often repeated in class for the more complex material, again first individually then collaboratively using either SPARK^{PLUS} or IFAT cards [24].

Impact/Discussion

These pre-lecture activities have been used as the initial step in the collaborative learning framework (Figure 1) in a range of classes both locally and in our offshore teaching program in Hong Kong. Students reported that it gave them an opportunity to check their understanding and learn from comparing their answers and reasoning to other students in the safety provided by the anonymised reporting in the software. Other students reported using the activities before class as a guide to what they were expected to learn and after class to evaluate their understanding. In attempting questions students regularly described a tendency to answer a question without fully and/or carefully reading it, usually leading to the choice of an incorrect answer. This proved to have a positive outcome with students commenting they became more careful in reading questions particularly in summative activities.

Instructors reported that the summary screens (Figure 5) made it easier for them to identify areas of the subject that students were having trouble understanding. In addition, being able to click on the slider and view the students' comments explaining their reasoning for the different answer choices gave them insights into common misconceptions, especially in cases when students were getting the right answer for the wrong reason. Academics also found this feature useful to display the range of answers and explanations in class and hence facilitate learning oriented discussion. The formative nature of these activities allows instructors to provide innovative variations and students the freedom to focus on learning rather than maximising marks. For example we found vigorous debate and enhance discussions often resulted from providing questions with two correct answer choices expressed in different ways or with no correct answer choices provided where students were expecting a single correct answer.

A number of students reported that they found "*…it too difficult to answer the questions before the content was taught in lectures*...". This response was most common amongst students undertaking their first year of study, and is not surprising given that there may have been few opportunities during their school years to practice self-directed learning. However, with a generally agreed aim in higher education to develop independent learners we argue that the best time to start developing these skills is first year. We do however recognise the difficulties that such 'flipped' classroom activities can provide students and in future semesters we intend to support these activities with short introductory videos on each topic.

Somewhat surprisingly given the high use of technology by most students a small minority reported a dislike for online learning activities: "*I like to work from books and past tests or exams...I don't really like using computers*", and "*...I prefer more traditional methods*", reminding us of the need to provide inclusive alternatives.

Future Directions

We are currently undertaking a trial using the student activity described above to provide learning opportunities within a MOOC. Additional measures have been undertaken to improve the implementation of this activity in a MOOC environment including enabling real-time online collaboration. We also intend to pay more attention to the analytics collected by the software to see if they suggest any issues to be investigated related to student learning; for example, exploring any relationship between learning and how often students logon and/or the amount of interaction when comparing their answers.

More recently the authors are investigating how activity scaffolding can be augmented by identity theory. A relatively under-researched area of engineering education is the impact of university-based learning experiences on the development of the personal and professional identities of our students. Some research, such as that by Tonso[25], McNair et al[26] , Eliot and Turns[27] and Bennet[28], suggests that student's personal identity impacts the way they engage with learning opportunities and that their identity as an emerging engineer can be reinforced by designing activities that encourage students to practice the thinking and language of the discipline.

Conclusions

Activities designed using the collaborative learning framework assisted instructors to co-construct standards improving their judgement, grading, articulation and quality of feedback. Learning benefits were also apparent in using the framework to design activities for students with iterations of individual and collaborative work. The educational tool SPARK^{PLUS} proved to be an efficient and effective tool to facilitate these activities particularly in large classes.

Bibliograhpy

1. Hager, P. & Hodkinson, P. (2009) Moving beyond the metaphor of transfer of learning. *British Educational Research Journal, 35* (4), 619–638.
2. Fenwick T.(2009) Making to measure? Reconsidering assessment in professional continuing education, *Studies in Continuing Education*, vol. 31, pp. 229-244.
3. Billett, S. (2001) Learning through work: Workplace affordances and individual engagement. *Journal of Workplace Learning, 13* (5), 209–214.
4. Billett, S. (2004) Workplace participatory practices: Conceptualising workplaces as learning environments. *The Journal of Workplace Learning, 16* (6), 312–324.
5. Skule, S. & Reichborn, A. (2002) *Learning-conducive work: A survey of learning conditions in Norwegian workplaces*. Luxembourg: CEDEFOP.
6. Smith B. L., & MacGregor, J. T.,(1992) What is collaborative learning?, in *Collaborative learning: A sourcebook for higher education.*, M. R. M. A. S. Goodsell, V. Tinto Ed.: University Park, PA: National Center on Postsecondary Teaching, Learning, & Assessment.
7. Dana S. (2007), Implementing Team-Based Learning in an Introduction to Law Course., *Journal of Legal Studies Education*, vol. 24, pp. 59-108.
8. Willey, K and Gardner, A. (2008) Using Self Assessment to Integrate Graduate Attribute Development with Discipline Content Delivery. *Proceedings of the 36th Annual Conference of the European Association of Engineering Education (SEFI)* Quality Assessment, Employability and Innovation 2-5 July, Aalborg, Denmark.
9. Willey K. & Gardner A., (2009) Investigating the capacity of Self and Peer Assessment to Engage Students and Increase their Desire to Learn. *Proceedings of the 37th Annual conference of the European Association of Engineering Education (SEFI) Attracting Student in Engineering - Engineering is Fun* 1-4 July. Rotterdam, the Netherlands.
10. Gardner A. & Willey K.,(2010) Critical conversations: how collaborative learning activities can prepare students for Structural Engineering practice. *Proceedings of the 21st Annual Conference of the Australasian Assoc. For Engineering Education*, 5-8 December. Sydney, Australia.
11. Willey & Gardner, (2010) Investigating the potential of self and peer assessment in developing learning oriented assessment tasks. *Proceedings of the 20th Annual Conference of the Australasian Assoc. For Engineering Education*. Adelaide, Australia.
12. Willey K. & Gardner A. (2010), Collaborative Peer Learning to Change Learning Culture and Develop the Skills for Lifelong Professional Practice, in *Proceedings of the 21st Annual Conference for the Australasian Association for Engineering Education*, Sydney, Australia, pp. 222 - 229.
13. Svinicki M. (2004), *Learning and Motivation in the Postsecondary Classroom*: Anker Publishing.

14. Irons A. (2008) , *Enhancing Learning through Formative Assessment andFeedback*: Routledge, 2008.
15. Willey K., "SPARK[PLUS]," http://spark.uts.edu.au/, 2008.
16. Runesson, U. (1999), Teaching as constituting a space of variation, in *8th European Association for Research on Learning and Instruction (EARLI) Conference*, N. Mercer, Ed. Goteborg, Sweden.
17. Willey K. & Gardner A.,(2011) Change Learning Culture with Collaboration, in *Proceedings of the 2011 SEFI Annual Conference:Global Engineering Recognition, Sustainability, Mobility*, Lisbon, Portugal., pp. 93 - 98.
18. Willey K & Gardner, A., (2011) Want to change learning culture: provide the opportunity, in *Proceedings of Research in Engineering Education Symposium* Madrid, Spain, 2011, pp. 259 - 267.
19. Gardner A. & Willey, K., (2011) Investigating the characteristics of successful collaborative learning activities in *Proceedings of Research in Engineering Education Symposium*, Madrid, Spain, 2011, pp. 332 - 339.
20. Willey K. & Gardner, A., (2012) Collaborative Learning Frameworks to Promote a Positive Learning Culture in *Proceedings of the 42nd ASEE/IEEE Frontiers in Education Conference* Seattle, Washington, pp. 638 – 643.
21. Willey, K. & Gardner, A.. (2010a) Perceived Differences in Tutor Grading in Large Classes: Fact or Fiction? *Proceedings of the 40th ASEE/IEEE Frontiers in Education Conference.* Virginia, USA, 27 – 30 October.
22. Willey, K & Gardner A. (2010b) Improving the standard and consistency of multi-tutor grading in large classes, *Assessment: Sustainability, Diversity and Innovation, Proceedings of the ATN Assessment Conference*, The University of Technology, Sydney, 18 & 19 November.
23. Willey K. & Gardner A (2011), Getting tutors on the same page, in *Proceedings of the 2011 Australasian Association of Engineering Education (AAEE) Conference* Fremantle, Western Australia.
24. Epstein Educational Enterprises http://www.epsteineducation.com/home last viewed 26th May 2012
25. Tonso, K. (2006), Student engineers and engineer identity: campus engineer identities as figured world. *Cultural Studies of Science Education* vol. 1, 273 – 307.
26. McNair, L., Newswander C., Boden, D. & Borrego M. (2011) Student and faculty interdisciplinary identities in self-managed teams. *Journal of Engineering Education*, 100 (2), 374 – 396.
27. Eliot, M. & Turns, J. (2011) Constructing professional portfolios: Sense-making and professionalidentity development for engineering undergraduates. *Journal of Engineering Education*,100(4), 630-654.
28. Freer P. & Bennet D. (2012) Developing musical and educational identities in university music students. *Music Education Research*. 14(3). 265 – 284.