Explore, Discover, Share, Discuss: A student centred approach to learning

Dobrila Lopez
Christchurch Polytechnic Institute of Technology
130 Madras Street,
Christchurch
+64 3 940 8000
dobrila.lopez@cpit.ac.nz

Mike Lopez
Christchurch Polytechnic Institute of Technology
130 Madras Street,
Christchurch
+64 3 940-8000
mike.lopez@cpit.ac.nz

Martina Simpson
AUT University
Faculty of Health and Environmental Sciences,
90 Akoranga Drive, Auckland
64 9 921 9999
martina.simpson@aut.ac.nz

ABSTRACT
This paper presents a teaching approach that fosters high engagement, builds student capabilities, and encourages productive use of both contact time and non-contact time. The approach has been used at levels 5, 6 and 7 in a computing degree taught at a large metropolitan polytechnic in New Zealand. The teaching approach was developed as a Design Science Research project. A problem definition sets out the issues motivating the approach and the objectives to be met. The design and development over a two year period is then presented and the approach is evaluated from student, lecturer and theoretical perspectives. The teaching approach brings together a number of ideas from a constructivist agenda: starting from what a learner already knows, creating an active role for the learner, promoting reflection, learning from peers, and the clarity of thought promoted by presentation of findings. It also serves to foster soft skills, such as the ability to communicate clearly and to work effectively with co-workers, both of which are highly valued in an organisational context. Students were initially reluctant to engage with the teaching approach; their expectation was that the lecturer would present them with an organized list of facts. However students quickly adapted to the approach and by the third week were fully engaged in active learning in all sessions. Their feedback suggests they ultimately valued the approach.

Categories and Subject Descriptors
K.3.2 [**Computers and Education**]: Computers and Information Science Education - *Computer Science Education*

General Terms
Design, Experimentation, Human Factors

Keywords
Learning and teaching, Design Science, soft skills, constructivist agenda, lifelong learning, inquiry-based learning, inductive teaching, research-based learning.

1. INTRODUCTION
In recent years there has been a move away from a paradigm in which learning is seen as the transmission of knowledge from expert to novice, towards a student-centred paradigm in which the learner takes an active role (Boud, 2000). In this paradigm the role of the teacher is seen as fostering, facilitating and supporting student learning (Race & Pickford, 2007). At the same time there has been a move towards larger classes, reduced contact time, and increased emphasis on self-directed learning (Ministry of Education, 2012), while reduced government funding has led to a call for educators to "do more with less". Meanwhile, there has been an increasing awareness of the demand from employers for so called "soft" skills (although these may be very hard to develop). There has also been a growing awareness that education requires more than just accumulation of skills and knowledge at the start of a career: that learning is a life-long activity that is not only necessary to accommodate the rapid rate of change in the modern environment, but is also life-enhancing in its own right (UK National Committee of Inquiry into Higher Education [the Dearing Committee], 1997). Many educators agree with these values, but like Black and Wiliam (1998), are left with the question of how this can be achieved. This paper presents an integrated approach to learning and teaching that hopefully addresses part of that question.

The teaching approach was developed as a Design Science Research project (Hevner, March, Park, & Ram, 2004). Design Science Research involves the "production of interesting (to a community) new knowledge" (Vaishnavi & Kuechler, 2008, p. 26). Unlike other research paradigms, this knowledge can be embedded in the instantiation of an artifact (March & Smith, 1995). The key characteristic that distinguishes Design Science Research from routine design is the risk or uncertainty associated with the implementation (Vaishnavi & Kuechler, 2008); once the risk and uncertainty are removed, the design process becomes routine design.

Although, like many Design Science Research projects, the development was iterative, it is generally recommended that findings are presented in a linear manner (Peffers, et al., 2006). Accordingly, the rest of this paper is organised as follows. Section two identifies the problem and motivation for the approach. Section three presents the objectives of a solution that arise from the problem definition. Section four describes the design and development of the approach. Section five demonstrates how the approach meets the objectives. Section six evaluates the success of the approach in meeting the objectives from student, teacher and theoretical perspectives. Finally conclusions are drawn in section seven.

2. PROBLEM IDENTIFICATION
Although the specifics may vary from institution to institution and course to course, nowadays only a minority of a student's learning time is typically spent in scheduled classes, with the majority of the time spent in self-directed learning outside of class time. Combined with larger classes, this means that in-class time is a precious and critical resource, and there is very little time available in classes for an educator to engage in one-to-one tuition with individual students. Consequently, one key goal of a

This quality assured paper appeared at the 3rd annual conference of Computing and Information Technology Research and Education New Zealand (CITRENZ2012) incorporating the *25th Annual Conference of the National Advisory Committee on Computing Qualifications*, Christchurch, New Zealand, October 8-10, 2012. Mike Lopez and Michael Verhaart, (Eds).

successful teaching approach is both to make effective use of the available in-class time and, also, to promote productive use of the out of class learning time. In-class time is ideally suited to learning activities such as discussion, feedback, or presentations. Non-verbal cues make an important contribution to these and it is difficult to achieve the same effectiveness in on-line forums. On the other hand, out of class time is ideal for activities such as reading, exploration and self-paced instruction. Students may need guidance, however, on how to use their time effectively in these activities.

Employers value so-called *soft* skills, such as working effectively in a team, communicating clearly, and trusting and supporting co-workers (Leitch, 2006). There is an affective component to many of these skills. For example, computing professionals often need to present their work to clients, and educators typically use in-class presentations by students to help develop this capability. However, giving a presentation for the first time can be a daunting challenge for many students. Even in a supportive classroom environment, the fear of presenting can be very real, and this fear can lead to impaired performance, setting off a debilitating feedback cycle. It is important that an educator is sensitive to this risk and uses presentations thoughtfully and with regard to the impact on students' self-efficacy.

Bandura (1994) defined self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p. 71). A strong sense of self-efficacy fosters intrinsic interest and deep engrossment in activities. In contrast, people who doubt their capabilities may shy away from difficult tasks which they view as personal threats. They may slacken their efforts and give up quickly in the face of difficulties (Bandura, 1994). Self-efficacy is a major predictor of academic attainment (Pajares, 1996; Vuong, Brown-Welty, & Tracz, 2010), and successful mastery experiences are the strongest source of self-efficacy beliefs (Bandura, 1997). A successful teaching strategy should therefore create opportunities for challenging mastery experiences that are either within a student's capabilities, or just beyond (Vygotsky, 1978) as long as appropriate scaffolding (Wood, Bruner, & Ross, 1976) has been put in place.

In contrast with the historic model of learning as the transmission of skills and knowledge from expert to novice, the constructivist agenda emphasises an active role for the learner (Bean, 2011; Bonwell & Eison, 1991): learners construct knowledge by seeking meaning from their experiences. From this perspective, it is important to start from what the learner already knows and can do, and then to provide experiences that challenge and build on these. Additionally, students can learn a great deal by observing their peers engaged in learning activities (Bandura, 1986). This can be further enhanced by the student acting as a teacher. Often called *learning by teaching* (Ketamo & Suominen, 2010), this promotes deeper learning by involving students in the analysis, synthesis and evaluation of findings. Creating such an active role for the learner fosters high engagement. Moreover, incorporating peer instruction (Simon & Cutts, 2012) can not only directly enhance learning, but also promote a culture in which students build trust in their fellow students as co-workers.

We would like our students to develop professional judgement of the quality of their work and that of others, and to be able to give and receive both positive and negative feedback in a constructive and supportive manner. We would also like our students to become reflective practitioners: to form a habit of reflecting on their work and identifying possible future improvements. Finally, we would like our students to think critically about findings, to be systematic and methodical in their approach to investigation and to embrace the idea of lifelong learning.

3. OBJECTIVES OF A SOLUTION

From the foregoing, we were looking for a teaching approach that would:

- Use both in-class and self-directed time effectively
- Develop students' soft skills
- Foster self-efficacy
- Utilise observational learning
- Utilise peer instruction
- Promote clarity of thought and critical thinking
- Develop professional judgement
- Integrate feedback and reflection
- Embrace lifelong learning values

In particular, our goal was to integrate these objectives into a simple and coherent conceptual framework. Although many of these elements have been studied, and implemented in teaching, in isolation, integrated solutions are rare. In education we are faced with a situation where there are many clients, stake holders and decision makers, each with conflicting values. In the Design field, creating a holistic solution in this environment is what is known as a "wicked" problem (Buchanan, 1992).

Solving such problems requires what Cross (2001) calls *designerly* ways of knowing: a combination of reflective practice (Schön, 1983), action research (Lewin, 1946), and Design Science Research (Hevner, March, Park, & Ram, 2004).

4. DESIGN AND DEVELOPMENT

The pedagogy underpinning the approach is based on inductive teaching (Prince & Felder, 2006) and inquiry based learning (Brew, 2003; Justice, Rice, Warry, Inglis, Miller, & Sammon, 2007). The key features of the model of learning are summarised in Figure 1.

Figure 1: The pedagogy underlying the approach

The model requires that learners take ownership of their learning (Blau & Caspi, 2009). Self-regulation (Pintrich & DeGroot, 1990) is also required throughout the learning journey.

Our teaching approach was developed over a two year period and has been implemented in degree courses at levels 5, 6 and 7 in the New Zealand Qualification Authority (NZQA) framework. Each of the courses had a similar structure. The first half of each course sought to build students' skills and knowledge in a subject, and the second half comprised a group project that aimed to integrate these in a practical context. In essence, the goal of the first part of the course was to build the skills and knowledge required for successful completion of the project. This, in turn, involved, not only technical skills, but also the "soft" skills needed for effective collaboration.

The focus of this article is on the implementation in the level 5 course. This was the most recent of the development iterations and thus represents a more fully developed instantiation of the approach. This course introduced students to a wide range of digital devices and technologies, connectivity between them, and cloud services. For this course, we believed it was important for students to have hands-on experience with real devices and arranged a substantial pool of devices ranging from computers (PC, Mac, tablets, games consoles), through network devices (e.g. switches, routers, access points etc.), to peripherals (printers, scanners, external hard drives) and stand-alone devices (mobile phones, GPS devices, PDAs, music players, digital cameras, video camcorders etc.) and cloud services. Overall, there were over 30 technology types, and it was not feasible for all students to have hands-on experience with each of them. We used a complex rotational scheme in which each student in a group investigated a device or technology and reported findings to the group, and where each group, over the course, had exposure to each device and technology; thus, each student either explored the device or technology themself, or listened to a presentation of a peer's findings on it.

Each topic was investigated using an Explore, Discover, Share Discuss (EDSD) cycle. Each cycle spanned two class sessions (Figure 1) and there were six cycles in total.

Each investigation started in the second part of a scheduled class with a briefing by the lecturer. This introduced the investigations (explore, discover) that students were expected to carry out before the next scheduled class. In the first part of the subsequent class, students presented their findings to a small group of their peers (share), engaged in a discussion of their findings with the group (discuss), and provided feedback. Self and peer evaluation was carried out at this stage. For these share and discuss sessions, there were multiple concurrent presentations and the lecturer moved from group to group, observing presentations, and participating in the discussion.

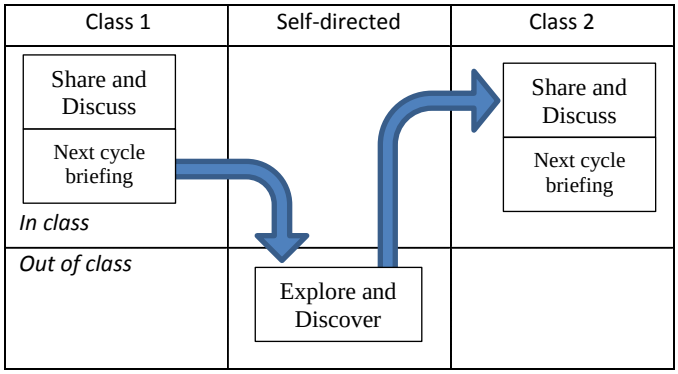

Figure 2: The EDSD cycle

We believed that calling the approach *research* would be intimidating to many of our students so we chose the everyday terms explore, discover, share and discuss to ground the approach in what students already knew. This terminology also enabled the lecturer to focus on different aspects of investigation each week. The term *explore* captured the idea of systematic investigation of potential sources of information; the term *discover* denoted critical thinking about the source of information, its trustworthiness, and its relevance to the topic; the term *share* highlighted the need to abstract and summarise findings and to consider relevance and appropriateness to the target audience; the term *discuss* signalled a focus on the need to engage the audience in the subject, and to give and receive feedback in a professional, sensitive and appropriate manner. However, we noticed that as the weeks progressed, students naturally started to use the term research to describe their investigations. Nevertheless, we believe it was important to avoid the use of the term at the outset.

At the end of each discussion, we asked students to engage in peer and self-assessment. Their peer assessment was submitted to both the presenter and the lecturer; their self-assessment was submitted to the lecturer, and they were also asked to comment on the usefulness of the feedback they received from their peers.

At the end of this stage of the course, students were asked to submit a written summary of the explorations of their group and their reflection on the effectiveness of the learning approach; this reflection was the source of the student evaluation presented in section six of this paper.

5. DEMONSTRATION

This section sets out the mapping of the approach to the objectives that were set out in section three.

In-class time was used mainly for presentations, discussion and feedback. Class time is appropriate for each of these because of the importance of non-verbal cues. Self-directed out of class time was used mainly for the self-paced activities of investigation, analysis, abstraction and synthesis of findings. Guidance was given progressively over the weeks on how to carry out each of these processes effectively.

The context of group work allowed the lecturer to use mini-lectures and discussions to develop students' soft skills, such as working effectively in a team, communicating clearly, and trusting and supporting co-workers. This idea of trusting and supporting co-workers was initially challenging, with a number of students believing that other students would not be able to come up with the "right" answer without being given "the facts" by the lecturer. However, constructivist assessment and evaluation do not look for whether the learner obtained the one and only correct truth, instead its focus is on the ability of the learner to solve problems (Vrasidas, 2000). The approach taken to address this challenge was to task those students with giving appropriate feedback to the other students, so as to build their capability.

The approach aims to foster self-efficacy by engaging the students in challenging tasks which are within their reach. One area which we felt was particularly important in this regard was presentations. To keep the challenge within their reach, we asked students to present to a small group rather than the whole class; later in the course, once their confidence had grown, they presented their group project to the whole class.

The approach also seeks to harness observational learning and peer- instruction. Students learn a great deal from their peers, not just about the subject matter, but also about ways of working, organising, presenting etc. Moreover, by involving students as

teachers of the group we sought to promote clarity of thought and critical thinking in the presenter by engaging them in the abstraction, analysis and synthesis of findings.

Peer and self-assessment is used to build and develop professional judgement. As with the issue of trust mentioned above, this provided only a context and a starting point for the lecturer. Students were initially reluctant to give negative criticism, even when couched in terms of how the work could be improved. The approach taken was to examine the role of a *critical friend* in discussion around feedback; a critical friend, a term usually attributed to Desmond Nuttall in the 1970s, focuses on successful outcomes and gives both unconditional support and unconditional criticism (Costa & Bena, 1993).

Feedback was integrated into all aspects of the approach, both feedback to peers in presentations, and feedback to the teacher (Hattie, 2009). Similarly, reflection was integrated throughout, both informally and formally. An example of informal reflection would be asking a student how they felt their presentation went.

Finally, the approach is designed to promote and embrace lifelong learning values by building a student's confidence and capabilities as an independent learner.

Of course, the approach does not guarantee success in any of these goals, but rather provides a context in which the lecturer can address these goals naturally and systematically.

6. EVALUATION

This section presents an evaluation of the approach from three perspectives: student, lecturer and theoretical. Evaluation from the student perspective is based on a qualitative analysis of the student reflective report mentioned in section four above. In this report, students were asked to reflect on their experiences with devices, group work, their learning in the course, how useful (or not) it was, the EDSD methodology, and on the course in general. Although all students (n=37) submitted these reflective reports, the evaluation is based only on those (n=25) who gave consent for their reflective reports to be analysed for research purposes.

Following Cross (2001), evaluation from a lecturer perspective is based on reflection of the lecturers involved. Evaluation from a theoretical perspective is based on an analysis of the classroom environment, the role of assessment in a constructivist learning environment and the involvement of students, not just in peer and self-assessment, but in discussion of the rubrics and criteria used. This is also based on reflection of the lecturers involved.

6.1 STUDENT PERSPECTIVE

The students were mainly school leavers with the balance upgrading qualifications as part of continuing professional development. The gender mix was approximately 1/3 females. It is worth noting that although many of the school leavers had substantial previous experience with computing technologies they were lacking in research skills and balanced judgement.

We start with one student's observation about the approach:

> In my life time I have reviewed and performed internet research on hundreds of modern technology, but I have only reviewed ten pieces of technology using the EDSD (Explore, Discover, Share and Discuss) Cycle technique, I am very interested in this method of research because it can span out to not only technology but to other tasks as well, the EDSD Cycle makes reviewing products quite organized and structured.

It is clear that this student not only understands the methodology, but sees benefits beyond the immediate goal of passing the course. In a broad sense, this student has learned how to learn (Entwistle, 1998). This is an ultimate goal of any educational process and all educators. Another student expressed the same idea differently:

> I learnt that if I structure the way I research not only technology but theoretically anything, I will have a rich and professional opinion, I think that throughout my years I have been using this process but haven't realized that it's called "Systematic Investigation".

As the course unfolded, students were developing both new skills and confidence in their skills:

> As I was using the EDSD Cycle I was developing more skills along the way, not only technical skills but also presentation skills, I am a shy person and during this class I have become a little bit more confident in my work and my presentation.

Although, many of the students were uncomfortable with presenting to the whole class, our approach gives them the security and safety of presenting to a small group of their peers with whom they feel comfortable:

> I can safely say that I have gained enough confidence to explore, discover and discuss new technology but I feel that I haven't gained enough confidence to share this information with a large crowd, I think the system of placing us in groups was a wise thing to do because a lot of people who enter in the field of computers are shy and want to be behind the scenes. Due to what I see in my group I feel that they have gained confidence as well, they have been engaging in conversations and interjecting one another in a positive manor about new technologies.

Many students were aware of the need for communication skills in their future careers in computing and saw this approach as starting on a journey to build these skills. As one student put it:

> Being in a group has really opened my mind to understand that I have to have the skill of "communication in groups", If in the future I lack this attribute, I will be shy and not people orientated which is not a good trait in the computing field.

The method progressively develops their presentation and communication skills within the group as the course and presentations proceed. It also gives them time to gain confidence in their own work, and in their ability to manage the process of investigation. They also built confidence in the work of their peers, helping them learn to trust their co-workers:

> As I have learnt more and have expanded my knowledge and the way I obtain knowledge, I have become more confident in accepting a task in developing a professional opinion about new technology. I think my group has built at least a little bit of confidence because every week their presentations increase in performance which is a plus in my books.

The students were also developing their peer assessment skills by giving feedback each week on their peers' presentations. Students were initially reluctant to give much feedback, but with enough time, encouragement, and guidance from the lecturer, the feedback started to become informative and useful to the students. As one student put it:

> My group's feedback to me was very informative, for example one of my group members suggested that I look into the audiences eyes instead of reading off my presentation, now I understand that my audience wants me to talk to them and make them understand what I'm presenting. When I give

> feedback I tend to stay on the positive side because I am not comfortable mentioning the negative things, but now I know that it is important to know your faults so you can work on them.

As the above comment suggests, it is probably not realistic to expect students to give complete, fair and realistic peer feedback in the initial stages. A more realistic expectation is to get students to understand the benefit they get out of it and to start them on a journey in which they progressively build these skills.

Regarding the overall goal of lifelong learning, we leave the final words in this section to one of our students:

> The last six weeks of this course have been quite enjoyable; it has helped me gain courage to speak within groups and helped me to recognize the EDSD Cycle. All the devices I have reviewed have been very good practice in research and developing presentations. My opinion on the last six weeks of this course is that it can help me throughout my life pertaining to getting information on new technology, so this prepares me for the real world in recommending the best products for the target audience's predicament.

6.2 LECTURER PERSPECTIVE

The evaluation in this section is based on personal reflection of the lecturers who taught using the approach. It includes observations and judgment of the class dynamics, class environment, and the students' success in the course.

Implementation of the EDSD approach had two distinct phases: introduction and maintenance. The introductory phase involved organising the students into groups, explaining the EDSD process, and getting them comfortable with a way of learning that was new to them. The maintenance stage involved a focus on developing capabilities, feedback skills, and investigative competence.

Of these phases, the introductory phase was the more difficult. The difficulties arose because it took time for the students to understand this way of learning, and build confidence in it. We believed it was important to take sufficient time to explain the rationale to the students: *to sell, not tell*. To do this, we drew on many ideas including the need to develop capabilities and skills that were valued by employers and the skills and values needed by all professionals such as judging the quality of their own work and giving appropriate feedback to their colleagues.

It was also important to reinforce the idea that learning happens best when students are active participants and take ownership of their learning. We also sought to emphasise that the process of investigation was at least as important as the products, technologies and the services they were investigating; by the time they graduated, many of these would have been replaced by later versions and technologies, but the ability to investigate systematically would enable them to adapt to such changes. In this introductory phase, students required substantial assistance and guidance from the lecturer. A great deal of lecturer effort was needed to sustain commitment to the process and it was quite hectic much of the time!

In contrast, after about three weeks, students were in the habit of following the structure of the process and naturally maintained it. At this stage the pressure on the lecturer reduced dramatically and it was possible to focus more on capability development. After each of the presentations in their groups, the listening group members would give feedback to the presenter. Feedback was structured around identifying the things that were done well and the elements that needed improvement. Students were encouraged to give specific actionable guidance in their feedback on how improvements could be made. During the presentation time, the lecturer would go around the class attending to one presentation of each group and giving feedback to the presenter after the group members' feedback. In this way every group would get feedback from the lecturer each week. A rotation scheme was used to ensure that the lecturer also gave feedback to at least one presentation by each student over the course. In addition to this one to one feedback to the student, the lecturer gave feedback to each group, and summary feedback to the entire class after reviewing all the submitted presentations; this was typically given in the week after the presentation.

We observed that during the presentations the class were completely involved in their presentations, learning from each other's presentations and comments. It is challenging to make this work in the early stages, but after about three weeks everyone knew what to do and how, and learning just happened. There was deep satisfaction for the lecturer at this stage. Watching students in the class actively engaged, learning, and developing their skills on the way, with little lecturer intervention is encouraging, but we must confess from time to time having thoughts like: "No one needs me here, I feel rejected. Shall I go home?" Ultimately, though, our mission as lecturers is to make ourselves redundant by helping our students become independent learners who no longer need us.

6.3 THEORETICAL PERSPECTIVE

The WIHIC (What Is Happening In your Class) instrument (Fraser, Fisher, & McRobbie, 1996) provides a conceptual framework for evaluation of the classroom environment and thus provides a useful starting point for the evaluation of the teaching approach. The WIHIC framework identifies the following constructs: task orientation, teacher support, investigation, involvement, equity, cooperation, and student cohesiveness.

The approach naturally fosters *task orientation* with clearly delineated tasks for both in-class and out of class time. Similarly, the approach is a good fit with the idea of an active learner and the *teacher supporting* learning through participation in discussion, giving feedback on their work in progress and presentations, individually, to the group, and to the class. *Investigation* is at the heart of the method with students asked to investigate technologies and report their findings to their peers. Moreover, students are actively *involved* in all aspects of the investigation from their individual research, to the presentation of their findings, participation in discussion, reflection and giving feedback. *Equity* is promoted throughout the method: each student investigates and presents a topic each week; the topics are rotated to give each student a fair mix of technologies; all students were asked to peer-evaluate each week; finally, although the lecturer would normally hear only one student from the group per week, each week it would be a different student. The use of stable groups, the emphasis in the approach on building trust in co-workers, and the encouragement of sensitive and constructive feedback create a climate of *cooperation* and build strong *cohesiveness* between the students in their groups. From the above mapping, we conclude that all of the WIHIC elements are represented in the EDSD methodology.

In constructivist learning environments, assessment and evaluation is constant and part of the learning experience and is used to provide feedback to both the instructors and learners. It should reflect both process and product (Strijbos, Ochoa, Sluijsmans, Mien, & Tillema, 2009). Assessment is central to learning and we wanted to involve our students in the assessment

process itself. We believe that this can promote deeper learning, As Harris and Bell note,

> It is not the actual methods or tools of assessing which we believe should be changed in many cases, rather the underlying philosophy and the aims of their use and application. (1990, p. 97)

From this perspective we wanted to involve students, not just in peer and self-assessment, but in discussion of the rubrics and criteria used. We found the SOLO taxonomy (Biggs & Collis, 1982) invaluable as a starting point for this purpose. With student input, we mapped the unistructural level to considering only one perspective or source in an investigation, the multi-structural level to considering two or more, relational to compare and contrast or considering trade-offs, and abstract/extended to fitness for purpose. Students found this mapping easy to understand and it provided a clear framework, not only for the assessment in the course, but also for the peer feedback generated by students.

7. CONCLUSION

None of the elements in the teaching approach is unique and each has been validated in many contexts. However, we believe that organising these elements into a simple coherent framework is a useful contribution of the approach.

Changing teaching practice is always potentially problematic. Students may be uncomfortable with practice that is not aligned with their expectations and may worry that they will not achieve their learning objectives adequately. A supportive environment is critical to sustain such a change of teaching practice through the early stages in which student acceptance may be ambivalent.

Development of any approach to learning and teaching is an on-going and never-ending process of continuous improvement. The method is therefore unfinished, but we believe it has been developed and evaluated sufficiently to merit sharing with a wider community via this paper.

We will continue to use and refine the approach. The main problem we still face with student acceptance of the approach is in the first few weeks. The initial expectation of students is largely that they will be presented with a set of organised facts which they then have to memorise and be able to repeat in a test. The challenge for us is to change this expectation to one where the student takes ownership of their learning and self-regulates their learning activities.

A programme-wide approach to setting student expectations around self-regulation would make implementation in the early part of the course much easier.

8. ACKNOWLEDGEMENTS

The authors would like to thank Taija Puolitaival of the Centre for Excellence in Learning and Teaching (CELT) at Manukau Institute of Technology for her support and encouragement as the approach was being developed, and for carrying out small group instructional diagnostic (SGID) sessions to elicit student perceptions of the approach during the development.

9. REFERENCES

Bandura, A. (1986). *Social foundations of thought and action.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1994). Self-efficacy. In V. Ramachaudrin, & V. Ramachaudrin (Ed.), *Encyclopaedia of human behaviour* (Vol. 4, pp. 71-81). New York: Academic Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: W.H. Freeman.

Bean, J. (2011). *Engaging ideas: The professor's guide to integrating writing, critical thinking and active learning in the classroom* (2nd ed.). San Francisco, CA: Jossey-Bass.

Biggs, J., & Collis, K. (1982). *Evaluating the Quality of Learning: the SOLO taxonomy.* New York: Academic Press.

Black, P., & Wiliam, D. (1998). *Inside the black box: raising standards through classroom assessment.* London: King's College London School of Education.

Blau, I., & Caspi, A. (2009). What type of collaboration helps? Psychological ownership, perceived learning and outcome quality of collaboration using Google Docs. In Y. Eshet-Alkalai, A. Caspi, S. Eden, N. Geri, & Y. Yair (Ed.), *Proceedings of the Chais conference on instructional technologies research 2009: Learning in the technological era* (pp. 48-54). Raanana: The Open University of Israel.

Bonwell, C., & Eison, J. (1991). *Active Learning: Creating excitement in the classroom [AEHE-ERIC Higher Education report No. 1]*. Washington, DC: Jossey-Bass.

Boud, D. (2000). Sustainable assessment: rethinking for the learning society. *Studies in Continuing Education, 22*(2), 151-167.

Brew, A. (2003). Teaching and research: New relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research and Development, 22*, 3-18.

Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues, 8*(2), 5-21.

Costa, A., & Bena, K. (1993). Through the lens of a critical friend. *Educational Leadership, 51*(2), 49-51.

Cross. (2001). Designerly ways of knowing: Design discipline versus Design Science. *Design Issues, 17*(3), 49-55.

Entwistle, N. (1998). Approaches to learning and forms of understanding. In B. Dart, & G. Boulton-lewis, *Teaching and learning in higher education.* Melbourne: Australian Council for Australian Research.

Fraser, B., Fisher, D., & McRobbie, C. (1996). Development, validation, and use of personal and class forms of a new classroom enviornment instrument. *Annual Meeting of the American Educational Research Association.* New York.

Harris, D., & Bell, C. (1990). *Evaluationg and assessing for learning.* London: Kogan Page.

Hattie, J. (2009). *Visible Learning; a synthesis of over 800 meta-analyses relating to achievement.* London: Routledge.

Hevner, A., March, S., Park, J., & Ram, S. (2004). Design science in information system research. *MIS Quarterly, 28*(1), 75-105.

Justice, C., Rice, J., Warry, W., Inglis, S., Miller, S., & Sammon, S. (2007). Inquiry in higher education: Reflections and directions on course design and teaching methods. *Innovative Higher Education, 31*, 201-214.

Kember, D., Ha, T., Lam, B., Lee, A., Ng, S., Yan, L., et al. (1997). The diverse role of the critical friend in

supporting educational action research projects. *Educational Action Research, 5*(3), 463-481.

Ketamo, H., & Suominen, M. (2010). Learning-by-Teaching in educational game: Educational outcome, user experience and social networks. *Journal of Interactive Learning Research, 21*(2), 237-255.

Leitch, S. (2006). *Prosperity for all in the global economy - world class skills [Final report]*. London: HMSO.

Lewin, K. (1946). Action Research and Minority Problems. *Journal of Social Issues, 2*, 34-46.

March, S., & Smith, G. (1995). Design and natural science research on information technology. *Decision Support Systems, 15*(4), 251-266.

Ministry of Education. (2012). *Briefing to incoming Ministers.* Retrieved August 11, 2012, from http://www.minedu.govt.nz/theMinistry/PolicyAndStrategy/BriefingToIncomingMinister.aspx#TertiaryMinister

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. *Contemporary Educational Psychology, 21*, 325-344.

Peffers, K., Tuuanen, T., Genger, C., Rossi, M., Hui, W., Virtanen, V., et al. (2006). The Design Science research process: A model for producing and presenting information systems research. *In Proceedings of the First International Conference on Design Science Research in Information Systems and Technology (DESRIST 2006) (S. Chatterjee and A. Hevner, Eds)*, (pp. 83-106). Claremont.

Prince, M., & Felder, R. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education, 95*, 123-138.

Race, P., & Pickford, R. (2007). *Making teaching work.* London: Sage Publications Ltd.

Schön, D. (1983). *The reflective practitioner.* London: Temple-Smith.

Simon, B., & Cutts, Q. (2012). Peer instruction: a teaching method to foster deep understanding. *Communications of the ACM, 55*(2), 27-29.

Strijbos, J., Ochoa, T., Sluijsmans, D., Mien, S., & Tillema, H. (2009). Fostering interactivity through formative peer assessment in (Web-based) collaborative learning environments. In C. Mourla, N. Tsianos, & P. Germanakos, *Cognitive and emotional processes in web-based education: Integrating human factors and personalization* (pp. 396-418). New York: Information Science Reference.

UK National Committee of Inquiry into Higher Education [the Dearing Committee]. (1997). *Higher education in the learning society: Report of the national committee.* London: HMSO.

Vaishnavi, V., & Kuechler, W. (2008). *Design science research methods and patterns innovating information and communication technology* . Boca Raton: Auerbach Publications .

Vuong, M., Brown-Welty, S., & Tracz, S. (2010). The effects of self-efficacy on academic success of first-generation college sophomore students. *Journal of College Student Development, 51*(1), 50-64.

Vygotsky, L. S. (1978). *Mind in society.* Cambridge, USA: Harvard University Press.

Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*, 89-100.