Tablet classroom interactions

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Abstract
At the start of this year, a new learning environment enabled the teaching in the first programming unit to change from a traditional model of separate lectures/practicals/tutorials to integrated workshops using wireless enabled tablet PCs. This restructure facilitated a more student centred and active learning approach. Consistent with other units taught using this approach an improvement in student outcomes, satisfaction and retention rates was observed in the programming unit. In this paper we argue that an important factor in this improvement has been the increased level of interaction both between staff and students and also among students themselves. In both constructivist and community of practice theories social interaction is seen as a critical ingredient in effective learning environments. Using the community of practice framework an analysis is made of the dynamics within the programming unit to examine the impact of these interaction factors on the complex nature of learning so as to better understand why the improvements are occurring.

Keywords: mobile learning, novice programming, communities of practice.

1 Introduction
Since 2004, the School of Information Technology has been using a wireless enabled tablet classroom to teach a subset of its units. This approach has been well received by students and staff and has resulted in a general improvement in student outcomes and retention rates and anecdotally in increased class attendance. This year the approach has been used in the first programming unit and the same results observed.

Pinpointing the exact reasons for the success of the approach has been problematic as the changes to the units have been substantial. However, we believe understanding the reasons is critical if the innovation is to be successfully repeated by us or others. Albert Shanker, the former president of the American Federation of Teachers, wrote (as cited in CC2001, p. 28) that

“Educational experiments are doomed to succeed,” in part because the energy their creators bring to the experiment creates an excitement that encourages success. Given enough enthusiasm, almost any pedagogical approach will succeed as long as its proponents remain committed to that vision. The real test is whether the initial success can be sustained when others adopt the approach.

Identifying the important elements in the approach provides some defence against this phenomenon.

A number of influential aspects of the tablet-teaching environment for the first programming unit have been identified. In this paper we will examine one: the increased emphasis on the social aspects of learning and the processes students undertake when meaning making. With reference to both constructivist (Jonassen 1996) and community of practice frameworks (Wenger 1998) we provide our justification for why we believe this aspect has been so influential.

2 Social interaction and learning
In both constructivist and community of practice theories of learning, the importance of social interaction and students’ engagement with their peers and the lecturer is recognised.

2.1 Constructivism
For constructivists, knowledge is constructed through the activity of the learner trying to articulate their own personal understandings of new concepts and ideas. While learners construct their own knowledge representations, “all views, or all constructions, are not equally viable” (Savery and Duffy 1995, p. 33) and learners must be able to justify their position and its viability (Tam 2000). This happens when learners interact with others and so test their understanding and examine the understanding of others. Through this social negotiation of meaning, learners can come to a shared understanding (Savery and Duffy 1995) and test and refine the validity of their understanding in an ongoing process (Jonassen 1996, Laurillard 1993).
2.2 Communities of Practice

Within a community of practice perspective, learning is a holistic activity. Lave and Wenger (1991 p. 53) write, "Learning involves the whole person; it implies not only a relation to specific activities, but a relation to social communities – it implies becoming a full participant, a member, and a kind of person. In this view, learning only partly – and often incidentally – implies becoming able to be involved in new activities, to perform new tasks and functions, to master new understandings. Activities, tasks, functions, and understandings do not exist in isolation; they are part of broader systems of relations in which they have meaning."

Wenger (1998) argues that the negotiation of meaning is the process by which we experience the world and our engagement in it as meaningful. Further, meaning exists only in its negotiation and so the process and product of learning are not distinct. He writes, "By living in the world, we do not make meanings up independently of the world, but neither does the world simply impose meanings on us" (ibid. p. 53). We negotiate because "meaning exists neither in us, nor in the world, but in the dynamic relation of living in the world" (ibid. p. 54). The meaning we make is always in relation to the context it occurs within and is social in nature regardless of whether the activity that gave rise to it was individual or group based.

Wenger (1998) explains that this negotiation of meaning involves the interaction of two constituent processes, participation and reification. Participation is taking part in the meaning making process and also includes the relations with others that reflect this involvement. Reification is "giving form to our experience by producing objects that congeal this experience into 'thingness'" (ibid. p. 58). For example, with programming the reification may be the source code produced, programming standards followed or references used while participation refers to the process of creating the code, learning the syntax, understanding the requirements and discussing the design. The more students actively participate and create reifications, the greater the negotiation of meaning or learning that occurs.

Wenger’s use of the word participation is very broad and is not tantamount to collaboration. It can involve all kinds of social relations and not just those that are constructive. Further, participation is about taking part and includes all activities such as reading text, making decisions or doing work alone.

Reification is a two edged sword. Reifications, such as a textbook explanation or a written law, give form to a certain understanding and serves as a focus around which the negotiation of meaning can occur. The concrete nature of the reification helps with communication but can also cause meaning to be over simplified or confused. For example “knowledge of a formula can lead to the illusion that one fully understands the processes it describes” (ibid. p. 61).

Participation and reification are complementary and cover the respective limitations in each. Participation is essential in repairing the potential misalignments inherent in reification. For example, we have judges to provide interpretations of written laws. Similarly reification helps repair the misalignments in participation. Our judges needed the written laws and judgements to coordinate their actions and courts.

For successful learning both reification and participation must be in such proportion as to compensate for their respective limitations. Reification without significant participation, for example reading the law without examining cases, leads to a knowledge transmission model of learning where the fullness of meaning may well be lost. Similarly participation without significant reification may well result in learners’ differences, assumptions and knowledge not being clearly articulated and anchored.

In traditional lecture/practical/tutorial formats ensuring this correct balance between participation and reification can be difficult. Laurillard (1993) notes, lectures, while possibly inspirational for some students, may also provide many opportunities for student errors in getting information and making sense of it. Similarly Ramsden (1992) observes that while lectures enable the teacher to ‘cover the ground’, they are not effective for deep learning outcomes needing activity, responsibility, or interaction as students are often passive and dependent. In subjects that require students to understand and apply concepts and principles of coding, the separation of the formal delivery of the information (lecture) with opportunities to explore, apply and practice these concepts and principles (tutorials and practicals) can result in the reification and participation processes occurring in a more disjointed manner. In this case limited negotiation of meaning may occur in the lecture and so significant re-teaching may have to be undertaken as many students are simply not be able to understand and complete the tutorial or practical tasks. In the latter instance, a more appropriate balance between participation and reification is apparent.

Finally it is important to recognise that participation and reification do not define a dichotomy. More participation does not imply less reification or vice versa. On the contrary, increasing one is likely to increase the requirement for the other and lead to more intense learning.

2.3 Implications for teaching and learning

Viewing learning from a community of practice perspective requires a different dynamic in the teacher and student relationship. Burge (1989) describes the teacher’s role as:

- providing resources; helping clarify the boundaries of course content; ensuring that academic rigor is maintained; and helping the
learner exercise real freedoms in how learning is carried out and assessed.

For the student, the change is equally challenging. It gives greater freedom, choice and power but at the cost of accepting a greater level of self-responsibility for learning compared to a more hierarchical transmission model. The prize involved in this effort is that students can take greater ownership of their own learning and experience greater commitment and satisfaction.

3. The tablet classroom

A mobile classroom consisting of wireless enabled tablet PCs was used to teach the programming unit. With mobile technology as the enabler, the aim was to: create a learning environment that recognised the importance of learning in and through social contexts; emphasise the active engagement of the learner; and promote the exchange of ideas between participants. To work towards this goal, the teaching structure was reorganised and separate lectures, tutorials and practicals were replaced with an integrated 3 hour workshop where the time was used flexibly to include some direct teaching (lecture style), hands on practice, and problem solving discussions. This integrated approach facilitated:

- increasing emphasis on social aspects of classroom learning where ideas and concepts are actively explored, constructed, applied and critiqued.
- students actively engaging with learning materials, problem solving individually or collaboratively.
- the teacher’s role shifting to mentor/facilitator: someone to model processes, challenge students to think more broadly and support students in this new environment.

In some weeks these workshops were supplemented by a one hour lecture that was used for organisational purposes. This approach has similarities to the studio teaching classroom (Wilson 1994)

To support the change in focus from predominantly lecturer-centred to a more inclusive learning environment the layout of the learning space was also changed from rows of desks all facing the front of the room to grouped tables. These grouped tables and the affordances offered by the tablet pcs enable and enhance greater student conversations (with both lecturer and students). No large desktop pc monitors block interactions, or provide barriers for student to hide behind.

Within the programming workshops a blended learning approach relying heavily on a content focused website was used. The site contained conceptual material, detailed activities and worked examples. A detailed five step process (see Figure 1) for developing programs was used to scaffold student learning initially. As students’ programming skills improved the structure became less rigid and less detail was provided. Having the five step process explicitly stated allowed students to work at their own pace through examples. Rather than relying on the lecturer to solve syntax problems, by working through the materials many students solved a range of issues for themselves. In an introductory course with a range of student skills and backgrounds this was a clear advantage. The lecturer was free to value-add, discussing the finer points of code, suggesting improvements to students’ code and spending time with those students who were struggling.

![Figure 1: 5 step process](image)

The unit had no assessable group work. While within the workshops, students were encouraged to work collaboratively it was not a requirement of the unit.

While the tablet classroom has only been used in the first programming unit this year, results so far are promising and consistent with other units using the tablet classroom. From 2004 to 2005, the discontinued and fail absent rate dropped 19% and the overall pass rate increased by 12%.

Students' reported levels of satisfaction with the tablet classroom are also high with nearly 70% actively preferring it to a traditional delivery format and 10% neutral on the delivery. These results are consistent with those reported in similar studio teaching classrooms (Carbone, Lynch, Barnden, and Gonsalvez 2002; Wilson and Pipes 1996).

4. Participation in the tablet classroom

Pinpointing exactly why the tablet classroom is effective is complicated by the number of changes that have occurred in the teaching of the unit. These include:

- changing the teaching and learning approach from a traditional approach of lecturers/tutorials/practicals to integrated workshops using tablet PCs.
- adopting a blended learning approach
- smaller class sizes due to the recent fall in student numbers

We believe that a major factor has been the increased social interaction observed. Even though the unit contained no planned group work, the level of interaction between students and between the lecturer and students was higher than we had observed in a traditional lecture/computer laboratory structure. Observations made to support this include:

- students sat in groups and regularly discussed problems among themselves
- students moved around the room and at times swapped tablets to compare solutions
students sitting alone were often asked by other students to join their group
• the consistent high level of chatter in the workshop sessions. Contrary to our previous experiences in practical classes where the challenge was trying to get students to talk and collaborate, at times in the tablet classroom, trying to stop student learning conversations long enough for the lecturer to have a say was a challenge.

Students also supported this perception of increased interaction levels. 74% of students believed that the level of interaction was greater than in a traditional classroom with only 10% believing there was less. Factors contributing to this increased interaction include the informality of the workshops, the emphasis on the student as an active participant in the learning process and the constant rotation of the lecturer around the student groups.

Participation is the “recognition of ourselves in others” (Wenger 1998, p. 56) and is characterised by the possibility of this mutual recognition. “[W]hen we engage in a conversation, we somehow recognise in each other something of ourselves, which we address” (ibid. p. 56). In the workshop as students struggle they see others struggle. Students’ problems and solutions are often similar and so they participate by recognising this in others. They compare their solutions to others; they compare themselves to other students: “no one is getting it” or “everyone else is getting it”. As a lecturer we affirm/identify with their struggle and so encourage participation: “yes this can be confusing at the beginning”. This mutual recognition is important as it adds to a student’s comfort level and as one study found comfort level was the best indicator of success in an introductory computer science course (Wilson and Shrock 2001).

In this programming unit, students were constantly involved in reification in the form of producing computer programs. Reification gives form to their understanding and becomes a focus for their negotiation of meaning. The 5 step process helps students get started with programming but by providing such a structured process is it really a negotiation of meaning by students or simply reproduction without any real understanding? No reification is perfect in capturing practices and understanding but the more restrictive the less chance for students to participate (i.e. express themselves). Conversely limited structure (reification) can limit constructive participation and thus the basis for the negotiation of meaning. This structure or labelling helps communication but also can blur real meaning.

An indication of the appropriate balance may be if “participation and reification transform their relation ... to create new meaning” (Wenger 1998, p. 68). So when students program are they simply reproducing the example or are variations, questions, comments being raised? For example are there different algorithms used to work out problems, variations in the interface design, alternate use of events, questions asked to extend the ideas further and interest in other solutions? Encouraging these, discussing what constitutes “good programming” or providing a rationale for one approach being better than another are important to ensure negotiation of meaning is occurring.

This negotiation of meaning is more likely to occur when the level of social interaction within the group is high. Within the workshop not all interaction is on task. However, much is and students do discuss and compare each other’s work, question their own approach to a particular problem or explain issues to other students. All these activities we believe are highly effective learning approaches.

The level or quality of meaning negotiation is a partial reflection of an individual student's ability. Struggling students rely more heavily on the reification (5-step process) and direct their efforts towards understanding it rather than questioning it. More successful students will question the reification and the principles behind it. This struggle is negotiation of meaning and is happening at different levels. It is important to ensure that the reification is never so complete that students do not have to think, engage, and struggle with the problems to solve them. Conversely the reification needs to provide enough structure so that the students’ participation is directed and their knowledge and assumptions tested.

5 Conclusions

To maximise the advantage of any teaching and learning innovation it is important not only to measure if it is successful or not but also to try and understand why. Understanding the why is always likely to a challenge given the dynamic and complex nature of learning. The tablet classroom with its numerous changes was no exception.

In this paper, we argue that the tablet classroom environment used to teach introductory programming was more effective than the traditional format of lectures/tutorials/practicals in part due to the increased emphasis on the social aspects of learning and the processes students undertake when meaning making. Using a community of practice framework we justify this belief by arguing that tablet classrooms enable a more appropriate balance between the duality of participation and reification. With this better balance the level of reification and participation was more intense and so the negotiation of meaning and learning was also correspondingly greater.

With such a complex process as learning, participation and reification can only hope to partially explain any differences. However even a better understanding of one factor effecting learning places us in a stronger position to positively influence the learning environment in the tablet classroom.

Without some understanding of the mechanisms at work in an innovation it will be difficult to consistently repeat or for others to implement. Any improvement will also be “hit and miss” and for this reason we would argue that much effort needs to be put into understanding the whys as well as the outcomes of an innovation.
6 References


