Journal of Universal Computer Science, vol. 17, no. 2 (2011), 311-331
submitted: 17/9/09, accepted: 7/12/10, appeared: 28/1/11 © J.UCS

Realising the Potential of Web 2.0 for Collaborative Learning Using Affordances

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Abstract: With the emergence of the Web 2.0 phenomena, technology-assisted social networking has become the norm. The potential of social software for collaborative learning purposes is clear, but as yet there is little evidence of realisation of the benefits. In this paper we consider Information and Communication Technology student attitudes to collaboration and via two case studies the extent to which they exploit the use of wikis for group collaboration. Even when directed to use a particular wiki designed for the type of project they are involved with, we found that groups utilized the wiki in different ways according to the affordances ascribed to the wiki. We propose that the integration of activity theory with an affordances perspective may lead to improved technology, specifically Web 2.0, assisted collaboration.

Keywords: Collaborative Learning, Web 2.0, Affordances, Activity Theory
Categories: H.4.3, J.1

1 Introduction

Complex social networks are not new, however due to recent technological developments social networking has emerged as a dominant form of social organization [Wellman, 02]. Technology has allowed individuals to form communities based on their shared interest rather than kinship or locality. This significant proliferation of the Internet has shifted our paradigm of community and interaction and opened up new possibilities in the workplace and learning environment. Either within the corporate boundaries or in academic settings, in the virtual and networked organizations, people are working with shifting sets of supervisors, peers, and subordinates [Wellman, 02]. Web 2.0 provides the social software to both inspire and support these new ways of interacting. In the educational realm, Web 2.0 is particularly attractive with respect to collaborative learning.

Many claims have been made about Web 2.0 tools, but many were made without strong evidence [Mason, 08]. As we found in the two case studies reported in this paper, making Web 2.0 technologies available to students does not guarantee their utilization or improvement in learning outcomes. There is still a need for deeper conceptualisation of the relationship between Web 2.0 tools and teaching-learning processes [Carsten, 08] to clarify how and through what mechanism Web 2.0 tools support learning. Similarly, in the early days of groupware, studies found that while

groupware held potential for distance education and collaborative learning it was "not completely successful for all learners in all situations" [Schrum, 96]. Failure was attributed to a lack of understanding of factors such as appropriate applications, group processes and problem solving.

Initial attempts to employ Web 2.0 technologies for collaborative learning, such as the work by Mason & Rennie [Mason, 08], tend to be centred on the technology itself and provide informal ways of looking at each individual tool closely as a separate phenomenon. A fully conceptualised framework is needed to refocus the investigation towards components of a learning activity and addresses issues such as choice of modalities, group interaction and social negotiation of meaning. This paper seeks to lay the foundation argument for that framework based on Norman's notion of affordances [Norman, 88]. The framework acknowledges that Web 2.0 tools are embodied within the new social interaction phenomenon and can pervade every aspect of a learning activity.

In this paper we present two cases studies which investigate the usage of a particular wiki to support group projects. Firstly, we briefly introduce Web 2.0, followed by an explanation of Engeström's Activity Theory which we employed to redesign the unit considered in the first case study. The case study revealed haphazard and varying usage of the wiki which had been provided to support collaboration. Again using an evidence-based approach, we conducted a second case study involving groups of second year students conducting their first group-based activity. Employing an affordances perspective we characterise the utilisation patterns in both case studies. We conclude with future work suggesting the incorporation of activity theory with the affordances perspective.

2 Web 2.0

Awkwardly named, the term "Web 2.0" was first coined in a brainstorming session with no clear definition attached to it. The term was given the misleading numerical "2.0" designation, which would normally indicate a new major software release that was replacing a previous version. Summarising O'Reilly's [O'Reilly, 05] observations of the new web-based applications, Table 1 is adapted to show the distinctions between this new breed of system comparing characteristics with their earlier counterparts; further annotation on the outer columns are added to clarify the explanations. The key characteristics of viewing the web as a platform and harnessing collective intelligence have driven the paradigm shift. It is not merely a medium of communication between applications, the web itself has become the application. Participants are no longer just consumers of content; they are producers as well, leading to the trend of user-generated-content. The value of a service can now be measured by the number of people using and contributing to it, rather than the traditional measurement which considered the number of viewers.

The Web 2.0 phenomenon continues to proliferate due to the growing internet-connectedness and improving quality of connection and has redefined the playing field. At its core, it is still just a collection of tools, but these tools have enabled the extension of social interactions and relationships well beyond the physical boundaries (e.g. facebook, friendster), connecting people with the same interests (e.g. linked-in), creating virtual communities (e.g. myspace, ning) that share each other's thoughts,

learn from each other and contribute artefacts such as text (e.g. wikipedia), pictures (e.g. flickr, picasa), audio (e.g. voicethread), video (e.g. youtube, howcast), browsing history (e.g. del.icio.us, stumbleupon), and annotated web pages (e.g. diigo) or even location-specific information that can be pulled out by GPS-enabled handheld devices and presented by augmenting the information layer on top of the "reality" as seen through a camera; all of these are done on a scale and in ways which has not been possible before.

Basic service	**Web 1.0**	**Web 2.0**	**New characteristics**
Online advertisement	DoubleClick	Google AdSense	Dynamic advertisement based on the page content
Photo sharing	Ofoto	Flickr & MySpace	Personalized templates, tagging, annotating & comment
Website	personal websites	blogging	
File sharing	Akamai	BitTorrent	Peer to peer source & each downloading machine becomes server
Music sharing	Mp3.com	Napster	
Online encyclopaedia	Britannica Online	Wikipedia	Open content & collaboratively written
Online event organizing	Evite	upcoming.org & EVDB	Event request & comments from collective users
Identity	domain name speculation	search engine optimisation	Marketability
Visitors volume	Page views	cost per click	Navigation behaviour
interfacing 2 programs	screen scraping	web services	Merging into 1 platform: The Web.
Centralized authorship	Publishing	participation	Democratisation of authorship
Centralized managed content	content management systems	wikis	Open content
Pre-defined	directories (taxonomy)	tagging ("folksonomy")	User-defined
Single provider	Stickiness	syndication	Federated provider

Table 1: An Observation-based Comparison of Web 1.0 Vs. Web 2.0 (expanded from [O'Reilly, 05])

2.1 Impact on learning

From an educational viewpoint, the proliferation of computer-supported social networks has promoted the constructivist approach to a greater community than ever before, requiring teachers to start taking the transition seriously. An often made call for educators to change the way they teach has recently become more apparent. Jonassen, Peck & Wilson [Jonassen, 99] explained there are two implications when teachers make the transition from the traditional transmission model to the self-regulated learning model:

- Firstly, teachers have to relinquish some of their *intellectual authority*; as learners need some space to construct their own meaning of the world. Teachers thus can't be too instructive in the learning design. The teacher's role has shifted from knowledge transmitter to facilitator who assists students to both discover the larger community of scholars in a particular topic and evaluate their own beliefs and understanding compared with the generally accepted conceptions. Perkins [Perkins, 92] called this journey a "conflict-faced" path.
- Secondly, teachers must further relinquish the *managerial authority* of the learning process itself; teachers are, *de facto*, no longer in full control of all the learning activities which learners can embark on; there are a significant number of resources available and relatively accessible and this makes it almost impossible to determine what a learner can and cannot know. This also means that learners are required to become gradually more "self-regulated", and be more responsible in managing their own learning tasks [Collins, 89], [Perkins, 92].

We are particularly interested in handling the effects of loss of managerial authority. Activity theory provides a rich understanding of the learning process and thus offers a framework for understanding how learners utilise Web 2.0 tools to inform learning design decisions.

2.2 Activity Theory

Social interactivity is clearly at the core of Web 2.0, therefore any design framework that intends to inform use of Web 2.0 tools needs to place social interactions and relationships at its core. Activity theory [Engeström, 87], [Jonassen, 02] focuses on the broader social and cultural context of human activity, allowing a comprehensive explanation of social interactions and relationships. Central to activity theory is the idea that the appropriate unit for analysis of human activity is an activity system which involves a group of people working towards a common motive [Engeström, 87]. Activity systems explain how people interact, with each person contributing to the fulfilment of a common motive.

Engeström [Engeström, 87] developed a framework to describe activity systems (Figure 1). The framework describes how the efforts of a group or an individual towards an object are mediated by instruments of production, rules and customs, the community and the division of labour. The relationships between these components are represented with four subsystems: production, exchange, consumption and distribution. Activity systems contain a hierarchy of social activity, individual actions and individual operations [Engeström, 00]. These relate to a collective motive,

individual goals and individual conditions, respectively. [Brentsen, 02] describe this hierarchy as explaining why, what and how the activity takes place (Figure 2).

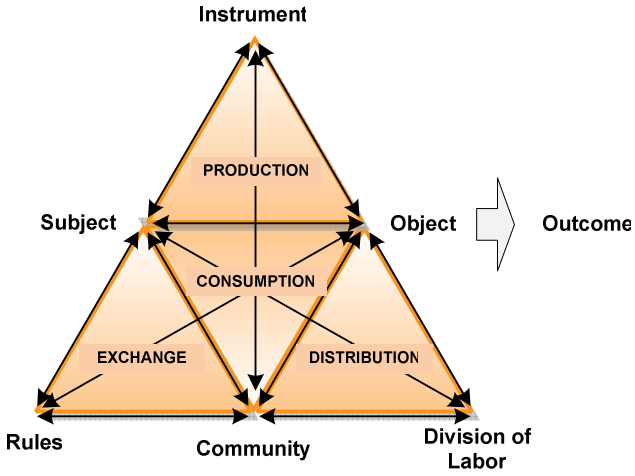

Figure 1: Development of Human Activity Theory [Engeström, 87]

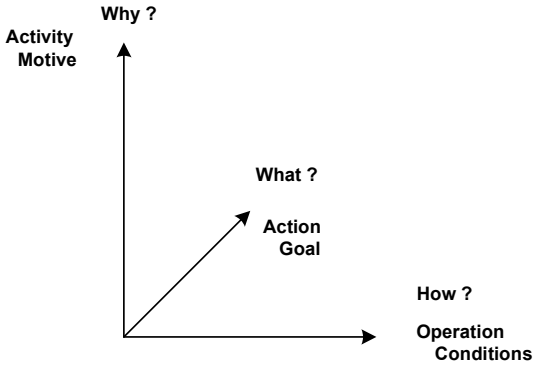

Figure 2: Constituents of activity as analytical dimensions [Brentsen, 02]

In today's complex and highly integrated software systems, design cannot be achieved by an individual and thus "doing" design involves collaboration. From a learning perspective, collaboration involves working with peers and teachers. Working in teams is an essential graduate capability for Information and Communications Technology (ICT) students. We were interested to understand how ICT students collaborated and in particular what role Web 2.0 technologies might play in supporting them to design a software product. Two case studies involving two separate cohorts of ICT students are considered next.

3 Studies into Collaborative Learning and Web 2.0

As some motivating background to the two studies we conducted and prior to the emergence of Web 2.0, in 2004 we conducted a 30 item online survey with our second and third year ICT undergraduates to better understand their learning experiences and needs. From the 103 responses received, we found that students had various perceptions of the role of collaborative learning. While group work did not feature as a typical response to how lectures, tutorials or practicals (laboratory sessions) could be improved, it was the second most common response to the open-ended question "describe the ideal way for you to learn computing". To determine how much collaborative learning was currently going on we asked what percentage of time was spent learning computing alone. The response was an average of 72.3 % of their time; meaning 28% is spent working with others. However a subsequent question which asked how much time they would like to spend working with others, the response was an average of 44%, with the mode response of 50%. This was a highly significant difference between the observed and desired amount of time spent working with others (paired t-test, $t = 7.78$, $df = 99$, $p < 0.001$). The 16% absolute difference becomes a more substantial figure when it is considered as a proportion; on average students wish to spend an extra 60% more time working with others. Interestingly 37 respondents thought working alone was more effective for them to learn computing. 64 did not agree that working alone was better for learning computing. Students were asked about the benefits and drawbacks of working in isolation and of working in groups. The results are shown in Tables 2 and 3. Furthermore, 72 respondents believed that lecturers should provide more formal opportunities for working with others in the activities they set, but 28 disagreed.

Less distractions	28
Can focus on concept formation/difficult problems	14
Can choose own pace	13
More time efficient	12
Can choose own area to focus upon	9
Not held up by less motivated/lower ability peers	9
Flexibility of time chosen to work	7
Satisfaction of personal achievement	7
Fairer (since credited for work performed)	5
Less conflict	5

Table 2: Responses to "What things do you like about learning computing in isolation? What are the disadvantages of working with others?" (comment/frequency)

Can get help/alleviate frustration of being stuck	27
Can improve techniques/understanding	16
Saves time	13
Seeing things from multiple perspectives	12
Finding solutions/errors they wouldn't have otherwise	12
More fun/less boring	7

Table 3: Responses to "What things don't you like about learning computing in isolation? What are the advantages of working with others?" (comment/frequency)

For tasks that specifically involved collaboration, 39 preferred to meet with their group online from anywhere and 63 preferred to meet with their group face-to-face rather than online. The preference for face-to-face communication by our students was confirmed in a separate virtual laboratory study we conducted [Bower, 05] where only 25% of the online groups chose to participate from home.

Since the advent of Web 2.0 in 2005, characterised by the increasing pervasiveness of social software (e.g blogs, wikis, chat rooms, communities of practice, etc) and other technologies (e.g. MSN, text messaging, etc), we were interested to see if student attitudes to online communication had changed. Specifically we wanted to see if they were ready to embrace the use of technology to collaboratively learn and collaboratively design. This time rather than use a survey instrument as in 2004 which clearly revealed a mismatch between reported desire and action when it came to collaboration, we used a more evidence-based methodology by examining the actual collaboration recorded online and also the methods reported by groups in their project plans, personal blogs and other documentation. We conducted two case studies in 2008 involving two separate cohorts of students. To focus our data collection and analysis we limit our attention to the students' utilisation of wikis for collaboration in group activities.

3.1 Case Study 1 – Introducing affordances

The first case study involved two 3rd-year computing project units at Macquarie University. A total of 54 students in 11 groups, comprised of 4 or 5 members, participated in the study in Semester One 2008. The units are compulsory for students enrolled in the Bachelor of Information Technology or Bachelor of Information Systems at Macquarie University. These are capstone units [Clear, 01] aim to tie together the student's previous learning and prepare them to enter the workforce. Students are observed to have high interest and a level of engagement with the unit.

The units were built around a single project, which the students have to work on as a team for the whole semester. The project was their key activity and it is both the learning vehicle as well as the assessed outcome for the units. The teams were asked to take on the role of a software development team to design and build a computer-based solution for a hypothetical client. The team activity involved gathering user requirements, developing models and designing and implementing a solution from among the range of possible solutions they have identified. At the end of the activity, the group was expected to deliver the final software product and all project

documentation, which were marked. The groups were formed by the lecturer at the beginning of the semester based on the student's grade point average (GPA), gender, time availability, personality type, planned time commitment and their grade expectations.

The units were first offered in 2005. In 2008 the units were redesigned due to the observation that an increasing number of groups were experiencing internal conflict with team members. For the redesign, as recommended by Jonassen & Rohrer-Murphy, [JonassenRohrer, 99, pp. 63-66] we applied activity theory by reconsidering the:

- *Tools* – resources used in the transformation process, either physical such as computers, or mental such as heuristics;
- *Subject* – the individual or group of participants engaged in the activity;
- *Object* – the physical or mental product being developed;
- *Community* – the interdependent aggregate who share a set of social meanings ;
- *Rules* – social regulations that inherently guide (to some extent) the actions or activities acceptable by the community, so that the signs, symbols, tools, models and methods that the community use will mediate the process;
- *Division of Labour* – prescription of task specialization for members within the community.

As a result we redesigned the learning outcomes and the aligned assessment tasks. Two of the five intended learning outcomes (ILO) concerned collaborative learning. To encourage successful teamwork a three hour training session on team skills was provided in week 3. A number of assessed discussion boards and a reflective online personal blog were also established on Blackboard to encourage communication, knowledge sharing and participation. To assist students in managing their group's project resources, an open source tool known as Trac (http://www.edgewall.com/Trac/) was introduced. Trac is an "enhanced wiki and issue Tracking system for software development projects" which started at the University of Sydney and has been developed as open source software.

Based on the findings of Kay et al. [Kay, 06], the system was expected to sustain the big five elements of teamwork [Salas, 05]: team leadership; mutual performance monitoring; backup behaviour; adaptability; and team orientation. At the core of these collaborative elements is the Trac wiki's functionality, which binds together the other project management processes support functions in Trac.

Each group was given its own space within Trac and encouraged to utilize the tool as it deemed appropriate, while also being allowed to adopt other tools to support their team's activity. Formal training on the use of Trac was not provided, as the first part of this study did not wish to influence the students' perceived affordances of the tool, but students had access to and were informed about the availability of standard documentation that came with the system. The wiki in Trac was seen by the teacher to provide a communication channel for the internal use of the group. The discussion boards provided a similar function to the wiki but at the class level. The personal blog supported private communication between individual students and the teacher.

3.1.1 Data Collection

The case study gathered data from the groups' reflective journals and via a written report worth 10% which required the team to look at the processes they had gone through for the entire semester, considering issues and challenges they faced, what they had done and learnt, what worked and what didn't. Data was also gathered from the Trac system logs and the groups' wiki pages to describe how each group used their wiki functionality to support collaboration.

3.1.2 Case Study 1 Findings

Five categories of utilisation were observed in the Trac wiki. These are discussed below, ordered by their sophistication in supporting collaboration. Table 4 provides a matrix detailing how each group had used their Trac wiki.

1. The first category is the complete absence of usage (N=1). Group 4 did not utilize the wiki feature at all. This occurred because of a technical mismatch with the system they were building. They were given permission to use their own version control system. It is unclear whether any product in place of the Trac wiki was employed. However, the group reported some difficulties in managing collaboration, such as miscommunication of responsibilities and difficulties in sharing resources.
2. The most basic and the second most popular (N=7) use of the wiki was as a communication medium to facilitate the exchange function of the learning activity system. The dominant pattern of this use was a single group member posting an announcement for the others to view. The exception was group 11, which used the wiki as a medium for bidirectional communication amongst team members.
3. The most popular (N=8) use of the wiki in this case study was as a shared files vault, where each team member or an appointed person uploaded files for later reference, a need that is driven primarily by the nature of the unit which produces numerous deliverables. The feature of uploading, storing and downloading files became the most popular use of the wiki.
4. A more sophisticated use (N=3) of the wiki was as a coordination web space. In this usage, wiki postings were predominantly done by a single group member, with the postings positioning the wiki as a workgroup portal to access other parts of the Trac system and share resources.
5. The most sophisticated use (N=1) of the wiki was to create a collaboration web space, where the wiki has been personalised and multiple members contributed to the wiki.

The reflective journals also revealed that students had been using other external tools to support their collaboration and communication. It interesting that some of the functionality utilized in these other tools was available in Trac. Their decision to utilize a feature in a particular tool rather than in another raised the question of why such a phenomenon may have existed.

Utilization of Trac Wiki	Group no.										
	1	2	3	4	5	6	11	12	13	14	15
Communication (exchange) • Post announcement											
File sharing • File upload and download											
Coordination web space • Coordinate workload (distribution) • Tracking progresses • Share bookmarks (consumption)											
Collaboration web space • Multiple contributors • Personalized sections (collaboration)											

Table 4: Utilization of Trac Wiki in Case Study 1

3.1.3 Case Study 1 Discussion

The results show that although the groups had access to the same software and had the same motive to produce deliverables, each group differed greatly in how they went about the group activity. The most notable result was that only one group used the wiki in a way that can be described as Web 2.0, creating a collaborative web space which supported both personalisation and co-construction of meaning. The other groups that used the wiki utilised the features in a way that supported communication but didn't reach the level of social interaction that characterises Web 2.0. One group didn't use the wiki at all.

Activity theory provided an appropriate framework for the design of collaborative activities; however the collaboration occurred in very different forms. In order to properly use Web 2.0 to support collaborative learning, greater emphasis is needed on understanding how group members relate to each of the available features of the software. The concept of affordances appears to provide the ability to focus on the way specific features of software are perceived.

Affordances describe the possibilities of action between a person and an aspect of the environment [Gibson, 79] and can be used to describe features of software which

may support learning [Bower, 08]. Groups using the Trac wiki had access to a range of affordances that may be used to support collaboration. However, the groups differed in the way they realised these affordances.

- The group in category 1 did not utilise any affordances.
- Groups in category 2 utilised the communication affordance of the wiki, posting notes for other members.
- Groups in category 3 utilised the file sharing affordance of the wiki (i.e. uploading and downloading files).
- Groups in category 4 combined the affordances displayed by category 2 and 3 and utilised the wiki to provide coordination affordance in dividing the work amongst team members and coordinating tasks.
- A single group (category 5) took it one step further by not only utilising the affordances mentioned above, but also utilising the wiki to aggregate resources and personalize access.

Viewing usage of the wiki as the utilisation of affordances provides a framework for exploring the gap between the potential collaboration afforded by the wiki and the way the wiki was used. In the second case study which follows we have sought to identify what affordances might be attributed to the Trac wiki.

3.2 Case Study 2 – Characterising Affordances

To gather more data and see if we could refine and define the affordances associated with Trac, a second case study was conducted in the second half of 2008 using 144 second year undergraduates enrolled in a unit called "Requirements, Analysis and Systems Design" (RASD). These students needed to collaborate for a group-based assignment involving the review and revision of a requirements document, creation of the analysis models and design models including the system architecture, design of screens, report and complex algorithms. Students were given 8 weeks (including the two-week mid-semester break) to produce the specified designs. Groups of 5 were formed in week 4. This was the first unit these students had experienced involving working with more than one other student on an assessment task. Just over half of the teams chose to self-form (groups 1-18). The lecturer formed the remaining 11 groups.

To ensure all students met the learning goals, students were required to participate in all types of tasks. For example, rather than one individual do all the UML sequence diagrams, each student needed to contribute at least one of the sequence diagrams to the final solution. Class and Use Case diagrams were to be the result of collaborative discussion. The first task (out of 16) in the assignment required a half-page team statement which outlined team members and their roles, planned methods of communication, conflict and change management strategies. The second task required students to use subversion for version and change control and also to use Trac. Failure to use subversion resulted in the loss of marks. Use of Trac attracted bonus marks. Data was collected in the same way as for case study one (see section 3.1.1). The next subsection considers the patterns of usage of Trac by the 29 groups followed by consideration of other collaborative technologies used.

3.2.1 Case Study 2 Findings with Trac

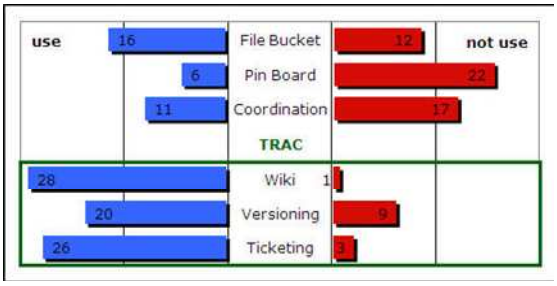

Figure 3: Trac wiki utilization in Case Study 2

There are a few common usage patterns observable for Trac by the RASD cohort. Many of these are similar to those found in the first case study. As shown in Figure 3, 28 of the 29 groups chose to use Trac, 20 used versioning and 26 used ticketing. In contrast, the unit convenor noted that in the previous year's offering of this unit only around half of the groups decided to use Trac, despite usage being worth bonus marks, and those that did use Trac made very little use of the features of Trac beyond uploading files. In 2008, 20 groups out of the 28 (71%) utilized Trac for more than document versioning (which was mandatory in the assignment specification). These groups utilized the wiki components as well as the ticketing system as communication tools. However, most of the usage was one-way communication (involving posting announcements, minutes of meetings, news and other resources) that most commonly was done by one and the same group member (90%). Only two groups out of 20 used the system as a multi-way communication tool by giving comments to other posts and using the wiki as a discussion board (e.g. see Figure 4).

Despite being given the same instruction and opportunity, it appears that teams perceived the Trac system to have different affordances and utilized those affordances according to their needs. We then tried to characterize a number of specific affordances in relation to the activity students are engaged in. There were three dominant groups: Subject-Rules-Community (Exchange); Subject-Tools-Community (Production-Consumption); Subject-Division of Labor-Community (Consumption-Distribution). Note that a group may exhibit behaviour, which indicates more than one affordance for Trac.

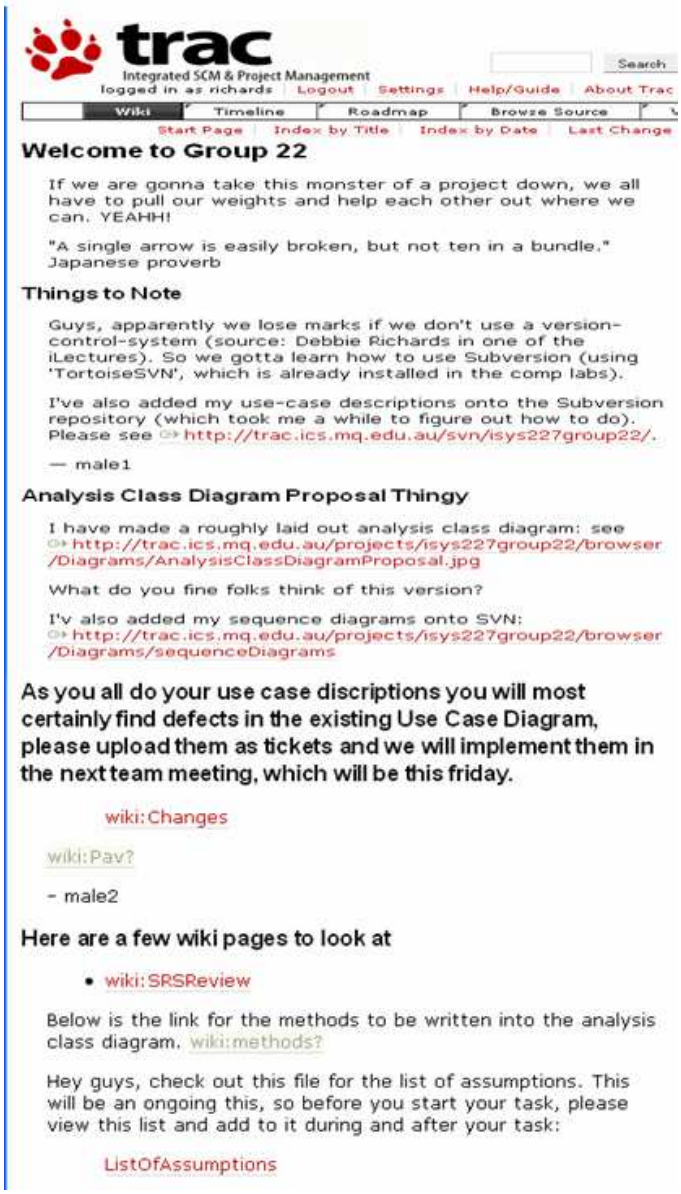

Figure 4: Sample Wiki from Group 22 showing a multi-way communication tool.

3.2.1.1 Subject- Rules-Community (Exchange) affordances

The exchange affordance enables the members of a group to pass comments to one another that do not necessarily contribute directly to the production of a shared object

(i.e. the design documents), but contribute to support of the community itself. For example, comments may be added which inform other members what they are doing socially to indicate their (un)availability or even just to share some of their lives with the others beyond the contact needed to achieve the project tasks.

3.2.1.2 Subject-Tools-Community (Production-Consumption) affordances

The combined production-consumption affordance enables each individual to produce a publishable work online and share it with other members of the community (e.g. through online publication or attachment of files), who in turn would then individually consume that object and produce another (e.g. their own part of the work). There are basically two types of such affordances, which we call File Bucket and Pin board.

File bucket. As shown in Figure 3, the file bucket use was the most commonly used (16/28 - 57%) of the production-consumption affordances, where the community utilized the tools as a place to upload and store files then share them amongst the members of the community. Some groups structured and customized the wiki pages in the system to allow the files and resources to be categorized and structured; while others placed all files on a single page containing a list of the shared resources whiteboard.

The Pin board. There was a 21% adoption of the pin board affordance, which was mainly used to publish drafts or previews of the assessment deliverables and share those publications with other members of the group, such as shown in Figure 4. Each group then built their own discussions or other form of information exchange around this published document. It is observed that, groups who adopted this affordance became more active in the adoption of the exchange affordances.

3.2.1.3 Subject-Division of Labor-Community (Consumption-Distribution) affordances

The combined consumption-distribution affordance enables the group to break down the workload into smaller (i.e. individualized) and more manageable workload chunks for which each group member would then be responsible. The process of breaking down the workload was tied closely to the way each part of the work is consumed within the group. Surprisingly only 39% of the groups utilized this affordance, ranging from a simple list of tasks that were managed manually, to adoption of the built-in task ticketing system to dispatch and track work assignments. Although many tickets may have been raised, it appears that students still heavily relied on other collaboration strategies (e.g. face to face and email) to perform coordination functions.

3.2.2 Case Study 2 Findings with Other Systems

The study also revealed that students tended to use a set of tools rather than just one tool to support their collaboration. There is a particular affordance that students look for in each tool and they seem to prefer using a mix of tools rather than just one. Figure 5 shows that while the traditional email system still prevails as the preferred primary collaboration tool (82%), other systems such as mobile (cell) phones, web

based wiki and online chats have become more widely used with 58%, 53% and 41% usage, respectively. Only two groups (12%) utilized other discussion forums.

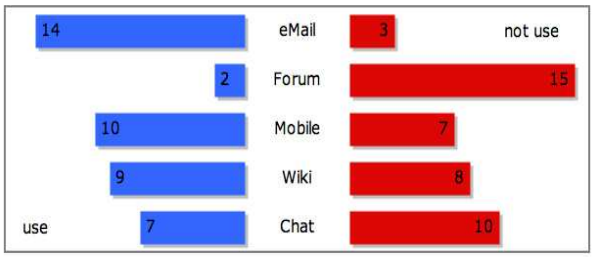

Figure 5: Preference of use for a range of communication tools

3.2.3 Web 2.0 Tools as a Distraction or a Collaborative Aid

In the 2004 survey introduced at the start of this section, distraction was given as the most frequent response by a factor of at least 2 to the question asking "why is working in isolation better?" Wikipedia defines distraction as "diversion of attention of an individual or group from the chosen object of attention onto the source of distraction". We interpret distraction in the context of group work to encompass increased interruptions, communication overheads involving more travel time, more time-constrained and effort-intensive decision making due to conflict resolution, and increased number of unproductive activities not directly related to the task.

We were interested to see if our Web 2.0 enabled students (who are increasingly choosing to distract themselves by being constantly connected socially via technologies such as text messaging and who are spending many hours online) still consider group work to be too distracting. By observing their usage patterns in Trac and their approach to handling group communication (described in their team statements) we found students in 2008 were more inclined and enabled to collaborate than the students in 2004. To determine whether the high level of collaboration we observed in the second half of 2008 reflected that groupwork was no longer seen as a distraction we conducted a lightweight email-based and optional survey asking the three questions shown in Figure 6. Nineteen responses were received and recorded in brackets after each option in Figure 6. Selected comments to each question are shown in Figure 7.

```
Pick the option that matches your view:
1.Working in groups is a distraction from getting the work done.
    Strongly agree (4)
    Agree (1)
    neither agree nor disagree (3)
    disagree (7)
    strongly disagree (4)
2. "Using technology like MSN, Trac, email, etc, helps to mini-
mise the distractions involved in group work"
    Strongly agree (8)
    Agree (8)
    neither agree nor disagree (2)
    disagree (1)
    strongly disagree (0)
3. What technology did you use that assisted you to learn col-
laboratively?
```

Figure 6: Lightweight survey with RASD students

Q1 Maybe for a 100 level subject, but as far as with the 200 level group work, i think everybody that is still enrolled in the course is there to do well or at least pass, so group work is not a 'social' occasion as it once was. (male)
I don't think it has very much impact because groups can work just as efficiently with it, if not sometimes better? In cases where they live far apart and travelling is an issue. (male)
Q2 The use of Trac and email did in fact keep me from being lazy and leaving my work till the last minute.. i can put that down to the use of a bonus mark for the use of Trac. (male)
Q3 Trac was helpful in keeping Trac of everything :) and email was a big help. MSN would have been good if the other members were actually on when needed to be. (female)
The technology of Trac which enabled us to work in more professional manner. We divided our task and updated it on Track which helped us to finish the work on time and also the work could also be timed. (male)
Text messages helped with organisation, Trac helped us complete the actual project (male)
Trac and the svn repository, but none of them work out without organisation/planning (female)
Not really MSN between all member, too hard to organise, but for like 2-4 teammates, it's good. (male)
Other unsolicited comments received include:
Its good having group projects, it is harder to organise but it promotes communication (male)
All in all, a pretty rewarding assignment, I think the group work was needed, not so much as to cover the content, but to allow an insight into what it would be like actually designing or collaborating ideas for a real life system. that is dealing with other ideas and working as a team and learning to be very diplomatic very quickly...(male)

Figure 7: Comments from RASD students

In answer to question 3, email was the most common and most used form of communication, then Trac, then SMS, then phone, then MSN. The learning management system discussion board was also mentioned by one student. The one person (male) who responded differently to the others had these comments:

- *Q1 - Strongly agree - Motivating other group members should not be another students concern or responsibility.*

- *Q2 - Strongly disagree - If the whole group utilised the tool it would have been invaluable but in my experience (assignment 2), it was ignored by most group members.*
- *Q3 - E-mail was the most useful tool, my group responded to e-mail (most of the time) but never responded to or acknowledged information placed on Trac. (male)*

While the number of responses is small, the message is clear. Groupwork was not found to be distracting and technology could minimize distraction. The 2008 students demonstrated that the use of technology had afforded them to be more collaborative than their predecessors with less social overhead than would usually be associated with physically-based group work. However, at the same time the introduction of a tool that is not immediately recognized or familiar to them added an extra learning curve. Educators need to take this into consideration by providing the opportunity to become familiar with the tool or try to adopt the same tools that students have used socially.

Web 2.0 technologies are often called social software. As such, they are expected to allow individuals to create and share meaningful content and collectively make sense of the world. Creating a shared understanding of the problem domain and a model of the solution were key activities to be performed by the teams in our case studies. While 21% demonstrated the pin-board affordances, the majority of groups did not use Trac for these sense-making purposes. Similarly Collazos et al. [Collazos, 07], found that the use of educational games, even one which involved collaboratively solving a puzzle and combining knowledge, did not result in students engaging in the "social process of meaning appropriation" which requires the design of "key elements such as curriculum, teacher's behaviour, mode of collaboration and interaction, tasks and learning goals" (p. 1030).

4 Conclusions and Next Steps

In 2004 we conducted a online survey study about student's learning behaviour and needs. From the 103 respondents we discovered that 28% of the individual student's time was spent working in collaboration with other students; while the same group of students expressed their desire to spent at least 60% more time in this collaborative working mode. However, the preferred form of collaboration was predominately face to face and within a formally allocated "class time".

Then, after the advent of Web 2.0 and proliferation of mobile devices; we looked in 2008 at how the students used a Web 2.0 tool in their interactions. This time, we imposed a requirement to use Trac, which is a web based tool that can provide the same functionality as a wiki, although it operates within a more confined social space, namely a single group and within the context of a project. There were 54 students in 11 groups in the Semester One 2008 study and observations were made through their online artefacts and reflective journals. The study observed that, students do utilize the technology to interact with each other; however each group did not use the technology in the same way as other groups. It was observed that there were four different types of technology used for group interaction. The most dominant type of

usage was as a platform to facilitate exchange of messages and files. A minority used the technology to coordinate their activities. Only one group used the tool to deeply engage in collaboration involving every member taking an active part in contributing to the wiki.

Compared to the earlier findings revealing students' preference for face-to-face communication over an online mode of collaboration (38% in 2004 and 25% in 2005 [Bower, 05]), the cohort of students in 2008 were not inhibited to use the technology to interact with others; however, they did not optimize their use of the technology and failed to collaborate with high levels of social interaction. Much of their attention was directed to distribution of messages and artefacts.

The subsequent study in Semester Two 2008 involving a second year cohort of RASD student who participated as members of 28 groups, again through observation of student artefacts, revealed that 71% of the groups utilized more than one feature of the tool. However, the observations also revealed that 90% of those groups used the tool as a means of exchanging resources only. Only two groups utilized the tool for multi-way communication and exhibited high member participation. This overall underutilization of Trac was consistent with the earlier study in Semester One 2008.

What does this mean? Driven by various factors, students are increasingly receptive to collaboration in-the-cloud. This can also be observed in the professional world, where wikis have become key tools within organisations for knowledge capture and sharing. Tomek [Tomek, 01] even believes that knowledge management systems (KMS) should include a collaborative virtual environment (CVE) which emulates a physical reality by providing a space and objects inhabiting that space. Avatars would be used within the CVE to collaborate to achieve certain goals. The systems presented by Tomek demonstrated successful collaboration between students (incidentally involved in software development). Success was largely attributed to the sense of immersiveness experienced by the users. The work predates Web 2.0 and wikis and it would be interesting to see whether a wiki within a CVE or visa versa would lead to increased collaborative sense-making perhaps as a result of a feeling of being there together as is experienced in face-to-face meetings.

Lukosch [Lukosch, 08] notes that web-based collaborative systems currently fall short of the vision of "anywhere and anytime". Lukosch [Lukosch, 08] introduced the notion of a seamless transition between connected and disconnected collaborative interaction for nomad users, who can be workers and/or students who may move between workspaces and places. Incorporation of the requirements identified by Lukosch for nomadic use of collaborative systems into systems such as Trac may result in new affordances.

The closest work we have found to our work is the specification of a number of collaboration patterns by Schmeil and Eppler [Schmeil, 09] as a result of examining knowledge sharing and knowledge integration by groups using the CVE Second Life. Schmeil and Eppler have identified two usage patterns: the collaboration pattern and the learning pattern. They plotted each usage pattern across two axes which they call 3D added-value and design effort. Within those axes one can see how the pattern of uses are mapped out. Design effort is basically time and manpower utilized in the development. The 3D added-value dimension is more difficult to measure and the perceived value may relate to the uniqueness of the affordances specific to Second Life or 3D worlds more generally, but this notion is not considered in the paper. We

conjecture that the extent of added value these affordances provided, depends on how much they matched with the needs of the learning process which the creator had in mind (intended). When the affordance provides what is needed, and the users are able to perceive and use that affordance, then the value-addedness would be manifested, and the intended benefits reaped.

Both activity theory and the concept of affordances are concerned with the way people interact with the world. However, while activity theory emphasizes the socially mediated aspect of group work, affordances emphasize how each individual within a group utilizes the environment to perform their contribution. A change in the form of activity is reflected by a change in which affordances are utilized. Thus, the form of group collaboration may be influenced if certain affordances of Web 2.0 tools are promoted. Furthermore, affordances can be aggregated at different levels to provide a fit with different levels within the hierarchy of activity (that is, common motives, individual actions and individual operations). Separate affordances which allow individuals to perform actions and operations may be combined to consider the way a group acts together. This is critical when considering Web 2.0 tools, allowing them to be discussed in terms of both individual action and group activity. For example, a wiki combines writing and editing affordances with affordances that allow distributed, open access. This combination affords groups collaboration in constructing an entry to the wiki. This form of collaboration would not be possible without each affordance, and allows a very different form of group activity than that allowed by each affordance separately.

Web 2.0 supported collaborative learning activities can be described from an affordances perspective. The activity is framed at the level at which an individual learner works within a collaborative group to produce a deliverable. The framework may be used to identify affordances to promote to groups of learners in order to align their collaborative activity with the forms of activity that match the learning outcomes. While activity theory allows us to describe the functions happening within collaborative learning activities, an affordances perspective allows a deeper understanding of how those activities may be supported by a set of Web 2.0 tools. Combining the theories supports analysis of group collaboration that details how student perceptions of the available affordances contributed to the form of that collaboration.

To explore the hypothesis that providing training in the Web 2.0 tool using an authentic task will allow its affordances to be realised is being explored in a series of other case studies across a range of study disciplines (Computing, Education and Creative Arts), covering undergraduate and postgraduate levels of study. These studies will try to discover the utilised and intended affordances as they are perceived from both the students' and teachers' perspectives during the learning design, in-learning and post-learning phases within each of the selected units. The outcome of the case studies is expected to provide a practical framework that will assist learning designers to match affordances of Web 2.0 tools with collaborative learning processes.

Acknowledgements

Our thanks to the students who participated in these studies.

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