Matching the Affordances of Wikis to Collaborative Learning: A Case Study of IT Project Students

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Abstract
The use of Web 2.0 technologies is increasingly common in many aspects of life: social, work, and study. The study reported here looks into how one type of Web 2.0 tool, the wiki, was being used to support groups of IT students involved in a collaborative authentic-task in their undergraduate studies to develop a software solution required by their “clients”.

The study indicates the existence of a mismatch between what supports are needed by the students, with how they use the wiki tool to support their needs. The mismatch is not the result of a lack of technical skills or aversion to technology, but rather the lack of ability to perceive the affordance of the tool in meaningful ways to facilitate the collaborative activity at hand.

1. Introduction

In recent years, we have seen a growth in the numbers of Web 2.0 applications as well as an increase in the accessibility of those applications and services via mobile devices, together with the proliferation of sophisticated devices such as smart phones, netbooks, iPads and everything in between. We can't avoid using Web 2.0 technologies, regardless of whether we know or agree with what "Web 2.0" means. According to the 2010 Horizon report, people are expected to become even more mobile, technology trends are moving towards cloud-based computing, and people's work and study are increasingly becoming more collaborative. They are all the ingredients which will ensure that Web 2.0 gains a greater foothold in our way of life.

However, despite the prolific use of Web 2.0 tools, our investigations over the past two years show that, as with many other technologies, they are underutilized.

In particular, we have focused on the use of wikis as a tool for collaboration. We have observed that individuals and groups attribute certain affordances to the technology and they use the technology according to those affordances.

The case study reported in this paper concerns the use of wikis for collaboration by Information Technology (IT) students and is part of a larger study which includes two other case studies in the area of education. The aim of the study is to investigate the match between a set of web 2.0 tools and collaborative learning strategies to support meaningful learning within the context of problem solving in higher education from the viewpoint of the teacher and the student. Following this investigation, the aim is to create a framework that could assist individuals and groups to become more aware of the affordances of the tools so that they can use them to their full potential. However for this paper, we will concentrate on presentation of the IT student viewpoint.

This IT case study is particularly interesting because both the teacher and students are not technology adverse and yet real issues arise in how to effectively use the wiki for collaboration.

The Web 2.0 tool used in this case study is the TRAC (http://trac.edgewall.org) wiki and project management system, the collaborative learning process is the use of group work within the software project development life cycle, and the problem to be solved is the problem case given by the lecturer or industry sponsor in the context of the project.

The TRAC wiki offers a range of affordances that may be used to support collaboration. According to Gibson [11], affordances describe the possibilities of action between a person and an aspect of the environment and can be used to describe features of software that may support learning [2]. But we use Engeström’s activity theory framework [8] throughout the study as the unit of analysis to guide our investigation at the level that is meaningful to the unit’s learning outcome. We treat activity theory as the microscope through which we explore the notion of affordances and how affordances impact on technology usage. This is further discussed in the section 2.
methodology is presented in section 3. In Section 4 we present the findings, and conclusions and future work are presented in Section 5.

2. Theoretical background

Whether we take an individual or inter-subjective epistemological view on collaborative learning, one thing that we can draw from both is that learning is a group activity which informs and influences individual learning [21]; this learning is essentially an exercise in meaning-making, done individually to form individual understanding, and collectively within a community to build knowledge. Hence at the community level, the process could be viewed as taking the form of “collaborative knowledge construction” [20].

Any collaboration framework designed to use Web 2.0 tools would then need to place social interactivity at its core. Activity Theory [8, 9] frames the collaborative activity by encompassing the social and cultural contexts of human activity, and allows 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 interacting and working together towards a common motive. Engeström [8] explains that the interaction would involve instruments used for production, sharing of artefacts, rules and customs governing the interaction between members of the community, and the division of labour amongst them. The interactions can then be categorized into four activity subsystems, which are: production, exchange, consumption and distribution.

Activity systems contain a hierarchy of social activity, individual actions and individual operations [9]. These relate to a collective motive, individual goals and individual conditions, respectively. Bærentsen & Trettvik [3] describe this hierarchy as explaining why, what and how the activity takes place.

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.

Figure 1 depicts a Web 2.0 supported collaborative learning activity. The activity is framed at the level that an individual learner works collaboratively in meaningful ways to produce the required deliverable artefacts. Since the influences of web 2.0 tools permeate throughout the whole activity, hence the second triangle is added into the diagram.

The framework may be used to identify affordances and promote them to groups of learners in order to align their collaborative activity with the forms of activity that match the learning outcomes.

Following the ideas of Leont’ev, Kuutti [15] presented the argument that an activity can operate at different levels, called: operation, action, activity (Figure 2), and the levels are recursive, which means for every action, there is an activity which that action is part of, and there are operations which comprise the action. This recursion is then constrained by the corresponding context, which are the goal, motive and condition. At any given time, each level can be a part of a larger integration of activities.

On the other hand, Gaver [10] suggested that technology affordances can both be nested, where they collectively enabled the actor to do new things; as well as sequential, where the perception of one affordance would lead to the next. This same view can be extended into a higher abstraction of affordances, which is at the social level that is relevant to the meaning-making process of collaborative learning.

Therefore, affordances can also be aggregated at different levels within the hierarchy of activity (ie 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 technology affordances that allow distributed, open access. This combination affords groups social affordances [14] of exchanging ideas, coordinating work, etc, or in short “collaboration” in constructing an entry to the wiki. This form of collaboration would not be possible without each affordance which collectively affords a social environment, and allows a very different form of group activity than that allowed by each affordance separately.

Henceforth we can classify the affordances into two levels, the “technology affordance” and “social affordances”, as seen in Figure 3. This framework guides this study by consciously thinking about the affordances which support each part of the activity within the collaborative environment.

However, Laurillard et al. [17] found that there are many times when students focus too much on the operational aspects of the tasks, or the navigational aspects of the interface, which – although necessary, they are considered to be less productive in contributing towards the learning of the content itself. Just understanding how to click a button or scroll down a window does not mean that you grasped the meaning of the contents in the window or even know why the command button gave the answer which appeared next.

Figure 3. Levels of affordances

3. Methodology

The case study reported in this paper employed an action research approach. The unique position as unit convenor held by one of the researchers allows this study to have a deeper knowledge of the cohorts of students participating in the study but also necessitated the need for precautions to be taken to avoid “tinting” the samples [4]. Due to the situatedness of this case study [6], it must be noted that the findings of this case study may have limited generalization to other situations, which is the reason for the existence of other case studies in a different faculty (i.e. Education) as an attempt to later triangulate the findings reported in this paper.

Figure 4 summarizes and visualizes the research process carried out in this case study. All were carried out as planned except the “Nominal Group Technique” due to logistic constraints.

The IT case study involved cohorts of second and third year Computing students. The third year students work in teams on a year-long project, while second years students work in groups to learn the knowledge and skills to produce the artefacts that they will need to produce in their third year project.

The activity in focus in this IT-based study is the collaboration involved in following the industry’s good practice and recognized standards to develop a set of desired deliverables, namely a software product and its supporting documentation. In order to follow the process and produce the product, students adopted several web tools to support their work. This study looked into those tools and how students reflect upon the use of those tools.

Figure 4. Research Methodology

Due to the nature of the tasks there are a range of tools that were in use e.g. TortoiseSVN for document
version control, a system for job ticketing, and other programming and modelling tools to draw diagrams, schematics and writing the programming code itself.

The focus of all analyses performed was on data related to the students’ approaches to collaboration, their actual collaborative activities and, in particular, their use of the Web 2.0 tool known as TRAC.

TRAC is a software development project support system, which started at the University of Sydney and has been developed as open source software. As stated in the documentation:

TRAC is an enhanced wiki and issue tracking system for software development projects. TRAC uses a minimalistic approach to web-based software project management. ... It provides an interface to Subversion, an integrated Wiki and convenient reporting facilities. TRAC allows wiki mark-up in issue descriptions and commit messages, creating links and seamless references between bugs, tasks, change sets, files and wiki pages. (http://trac.edgewall.org/)

TRAC is designed as a collaborative tool and its usefulness for this purpose has been investigated by others. For example, [13] found that TRAC did support collaboration and that collaboration was “not worse” when TRAC was used. However, they also concluded that further research is needed to show whether the collaboration via TRAC is better than other alternatives. We have, however, not found any studies that evaluate collaboration using TRAC from the perspective of affordances.

We commenced our study in 2008 by collecting computerized activity logs, individual blogs, group discussion boards and written reports; we also observed and characterized usage of the wiki through the artefacts produced by the students. The IT case study involves three cohorts of second and third year Computing students. The third year students work in teams on a year-long project, while second years students work in groups to learn the knowledge and skills to produce the artefacts that they will need to produce in their third year project.

Consistent with action research, the research techniques we have used have been modified as new insights or gaps in the data have emerged. To find out why the IT students from two separate cohorts in 2008 were not using the technology most effectively, we felt the best option was to ask them. To this end, we developed an online survey to determine their reasons.

To gain a deeper understanding and explore the issues more thoroughly we also invited students to participate in face-to-face interviews. The guiding questions used in the interview to gain insights into the students attitudes, experiences and usage of the wiki for collaboration are given in Appendix A. An invitation to participate was given at a compulsory lecture attended by all of the students. A follow-up email was also sent to elicit participants.

4. Findings

The IT case study has been conducted over a two year period. Commencing early in 2008, we observed two separate cohorts of students, the first involved 54 third-year students and allowed us to initially assess the students’ usage of TRAC. The second cohort was 122 second-year students. In 2009, we observed a third cohort of 84 third-year project students. Observation and analysis of their usage of TRAC, has allowed us to identify the emergence of several affordances. We note that while there have been different students involved over that period of time; the findings have been consistent for all 2008 and 2009 cohorts.

The first cohort of 54 students, comprised of 11 groups, was observed over a whole year. During that time they had been members of two different groups. In the second semester new groups with completely new members were formed, that is, no team member was the same as in semester one. This effectively meant that we observed 22 groups from the first cohort over the whole year. The second cohort we observed were 122 second year students in 29 groups for six weeks. We were particularly interested to observe this group as they were in the process of learning the concepts they would need for their final year project and we would observe them again in the following year as they collaborated in the project.

Based on analysis of the collaborative activity in TRAC and related documentation such as reflective reports of both 2008 cohorts, it was clear that the wiki was not being utilized to its full potential and was used in different ways. With the incoming 2009 cohort of 84 third year project students, we conducted a subtle intervention in the form of a short video explaining, in the familiar context of a collaborative activity to plan a group outing, what a wiki is and how to use a wiki in general. Despite this, in the first half of 2009, the 2009 cohort continued to show patterns of behaviour consistent with previous years.

Summarized findings from each of the cohorts are presented next, with a focus on the rich data and insights provided from the in-depth interviews involving cohort 3.

4.1 Cohort one.

A total of 54 undergraduate students in 11 groups of 5 and 4 members, participated in the study in Semester 1 2008. The students were enrolled in a compulsory third year capstone unit [5] that aims to tie
together their previous learning and prepare them to enter the workforce.

The activities in the project focus on: management, software development life-cycle, a set of deliverables and the final product. The case study gathered data from the groups’ reflective journals, which is a written report worth 10% that requires the team to look at the processes they have 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 has used their wiki functionality to support collaborations.

Through an iterative process involving text analysis we systematically analysed the artefacts produced by individual groups and examined the system logs to see how each member contributed in producing that artefact. The 11 groups demonstrated five patterns of TRAC usage, that formed the perceived affordances of the students:

1. The first category is the complete absence of usage (N=1) and realization of affordances. This occurred because of a technical incompatibility with the system they were building and they were given permission to use their own version-control system. It was unclear whether the product they were using was comparable with the TRAC Wiki. 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. This utilization of the wiki supports the exchange activities (Subject-Rule-Community) of the group. Groups showing this pattern utilized the communication affordance (Kuutti, 1995) of the wiki. The dominant pattern-of-use is where a single member posts announcements for others. 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 for cohort one 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 task which produces numerous deliverables that need to be shared and ‘consumed’ by others. The feature of uploading, storing and downloading files became the most popular use of the wiki to support the consumption activities. We refer to this usage as a realization of the file sharing affordance 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, and positioned the wiki as a workgroup portal to access other parts of the TRAC system and shared resources. This usage pattern combined the affordances displayed by category 2 and 3 and utilized the wiki to provide a coordination affordance in facilitating the distribution activity of dividing (coordinating) task load amongst team members to produce the required deliverables (artefact-Community-Division of Labor).

Kuutti [15] describes the 3rd and 4th usage as “automating”, which the wiki affords to distribute documents and support the coordinator’s role in the team.

5. The most sophisticated use (N=1) of the wiki was to create a collaboration web space, where the wiki has been personalized and multiple members contributed to the wiki. In addition to realizing all of the above affordances, they utilized the wiki to aggregate resources and personalize access. This use is much closer to the “sense making” function (Kuutti, 1995) which encompasses multiple sub-systems within the group’s learning activity. Thus, we call this a sense-making affordance which may allow the group to gain a shared understanding of the problem; consider the merits of a range of possible solutions or to resolve issues, conflicts or misunderstandings which may arise.

4.2 Cohort two.

A total of 122 2nd-year undergraduates enrolled in a “Requirements, Analysis and Systems Design” (RASD) unit in semester 2 2008 were formed into 29 groups to work for 6 weeks on an assignment that involved the review and revision of a requirements document, creation of the analysis models and design models including the design of the system architecture, screens, reports and complex algorithms.

TRAC was deployed as a compulsory tool for the students to control versions of documents, but the use of the wiki or project management functions were optional, although they could earn bonus points. All but one group chose to use the TRAC wiki. As an aside, in the previous offering of this unit a year earlier, almost no groups had chosen to make use of the wiki so we could see a notable willingness of cohort two to use the wiki.

From analysis of the usage patterns of the 28 groups utilizing the wiki, most of the usage was one-way communication (communication affordance to support exchange activities). This involved posting announcements, minutes of meetings, news and other resources, which was most commonly performed by one group member, usually the appointed leader or the person who had chosen to take on the leadership role (89%, N=25). Only two groups used the system as a multi-way communication tool by giving comments to
Each group was given the same guidance and access to the wiki, but we observed different usage behaviours that indicated each team perceived different affordances of the TRAC wiki and utilized those affordances according to their needs.

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.

A characteristic of affordances is their subjectivity because different interests or needs drive the discovery of different affordances. As we found in our groups, it is possible for an object of attention to have more than one affordance. We have characterized a number of specific affordances under three main types:

Subject-Rules-Community (Exchange): This communication affordance enables the members of a group to exchange comments (e.g. time availability) that do not necessarily contribute directly to the production of a shared object (i.e. the design documents), but are more to support the community itself.

Subject-Tools-Community (Production-Consumption): This affordance allows individuals to publish (produce) their work online and also access (consume) the work of others. We define two types:

1) File bucket – where files are uploaded, stored and downloaded. This was the most common affordance used by 57% of groups (N=16). Some groups categorized and structured the files and resources; others put everything on a single page, but they are mainly supporting the consumption activity of the group.

2) Pin board. There was a 21% adoption of the pin board affordance (N=6), which was mainly used to publish drafts or previews of the assessment deliverables and share those publications with other members of the group (consumption activity). Discussions and other information exchange can then occur around published documents. It is observed that, groups who adopted this affordance became more active in the adoption of the exchange affordances and have more communication going on in the team.

Subject-Division of Labor-Community (Consumption-Distribution): This affordance allows the group to decompose the workload into smaller (i.e. individualized) and more manageable workload chunks for which each group member would then be responsible. This was utilized by 39% of the groups (N=11).

4.3. Cohort three

Cohort 3 consisted of 84 undergraduate students enrolled in their final year project. The students were engaged in pre-determined roles [16] for the authentic task of developing a software application for a client. The application consists of several components and databases, which complicates the tasks and requires several students working together with different roles and responsibilities. The objective of the project was given, as specified by their client’s Requirements Document; and the project management process that they needed to follow was specified in the theories that they had learnt in the previous units of study.

Most of the students in cohort 3 were part of cohort 2 in the previous year. Thus they had previous experience with TRAC as a tool to potentially assist with collaboration.

However, as mentioned earlier, despite being exposed to a subtle intervention involving a short movie clip demonstrating the use of wikis to perform a collaborative task, cohort 3 demonstrated similar underutilisation of the TRAC wiki for collaboration to the cohorts in 2008.

To drill down to the root cause we decided to conduct a voluntary survey and set of interviews. While we had 9 respondents to the survey, in the end, due to high workload of the project unit, only 2 students, representing two different groups could find the time to meet with us to participate in a series of two half hour interviews over the second semester.

4.3.1 Attitude towards the wiki. The survey questions shown in Figure 5 were deployed in all three case studies but have been adapted to fit the IT case study and the focus on the usage of the TRAC wiki. The survey seeks to gain the students’ attitude to and perception of the TRAC tool and working in their group in general.

Students considered the wiki as a relatively easy tool to use, as they became quickly accustomed to the technical features. This is consistent with the fact that they are computing students, thus relatively more familiar with and more comfortable with using internet tools.

They also displayed a more positive attitude and a stronger preference towards using the wiki rather than doing things manually, but interestingly they liked to consider themselves to be less reliant on the tools (65%). Students believed that their usage of the tool did not influence their style in communicating with each other, but rather they were the ones who adjust and select the tool to match their own existing communication styles and needs.
4.3.2 Mismatch of affordances. The data collected from the indepth interviews reveals that "automating" and "communicating" [9] were found to be the easiest perceived affordances, and students were expecting that the wiki would provide those types of support. They also expected and found ways to use the wiki to support the process of exchanging documents, sharing files, or placing announcements and notices about schedules for their teammates. This is also consistent with the earlier studies. However, they lacked the expectation that the tools would support them in "sense-making".

This lack of expectation was not only in the use of the wiki, but extended to any other web tools which they were using. In contrast, when students were having automating and communicating breakdowns, they exhibited great concern and sought to find other tools which would give them those affordances in line with their perceptions and expectations.

"(TRAC) was down over a weekend or something and you’re like okay, it’s probably not going to be fixed until Monday so we’ll have to go on MSN and try and figure something out to get this done."

In cases where they were faced with challenges which need to be resolved immediately, students quickly resorted to a manual process of meeting in person and having a discussion, rather than perceiving any other affordances of the tools. However, due to the high workload they have to cope with in the project, and the limited available time, physical face-to-face meetings were not always an effective use of time and resources. But by choosing to revert to manual processes, the group actually experienced more breakdowns along the way and some groups resorted to going back almost completely to the manual process of meeting face to face, while using the email system only to send documents and as a reminder.

"No, it evolved into email basically especially towards the end it was just all email."

"We did use [the wiki] a bit more to collaborate in a sense of just saying this is always the latest version of - when is the team meeting for example, when is the next sponsor meeting coming up, when is the next teleconference coming up and that kind of thing. So we also found it really useful for that kind of thing."

Originally we thought that students can’t perceive the affordances of the wiki, at a more meaningful level for their collaboration work; but the interview reveals that at the end of the unit, when they were asked if they could have done more with the wiki, they were able to...
reflect on the possibility to use the wiki to do more to assist them to collaborate and in particular to assist them with the sense-making processes and activities.

"Some of them [collaboration tools] would have been really useful. We went through probably easily a dozen versions. For example, the business requirement specification, measurement plan and some of the other documents and GUI design [is] another one. I’m not sure about the GUI design but certainly business requirement specification, probably the high level process ... a few of these other sorts of things; they really could have been done collaboratively on the wiki."

This mismatch seems to be something that the students themselves did not realize. They did not necessarily think critically on the positioning of the tools to explicitly support such processes. In other words, the students were not considering what affordances they needed, and what affordances the tools could offer before they chose the tools. Once they chose the tool, they didn’t seem to show any evidence of sufficient planning on how to make usage of the tools meaningful for their group.

It is all the more remarkable that such a mismatch still occurs even though the students have sufficient IT literacy and are familiar with the use of the tools.

"All these collaborative tools are great but there’s a point at which you need to spend enough time, I suppose, to be familiar with what you’re actually doing, what you’re collaborating on and why you’re collaborating on it as opposed to just doing it yourself."

Some students seem to lack sufficient motivation to put effort into the task itself, and hence they reduce their efforts to explore the affordances of the tools to maximize their collaboration. This contributed to the mismatch of affordances.

Another potential cause is the lack of experience in collaborating using technology, which is collaboration beyond just coordinating tasks and distributing workload. As suggested by one anonymous reviewer, there are further alternate explanations that can be offered for the lack of seeing wikis for sense-making. It is very common (even among educators, researchers and designers) to view collaboration technology primarily as a substitute for face-to-face interaction.

This is reflected in the dominant theoretical paradigm of collaboration as being essentially information sharing, rather than a process that creates new information or knowledge in the interaction [7, 20]. The reviewer further notes that this view is also reflected in the common view of schooling as being about information transfer (from teachers to students, and hence, when students help each other, between students) and learning assessed individually, rather than about developing skills of collectively making sense of the world and building new cultural capital [1, 5]. So it is not surprising that, without specific guidance to counter traditional schooling and conceptions of collaboration, students don't see these potentials. We must also consider any cultural practices as practices of a community [22] and the learning process of one of enculturation, including learning how to use the tools that support the practices of that community.

5. Conclusion

We draw the following conclusions on the basis of the three studies we have conducted over 2008-2009 with IT students who were working in groups on a shared goal with shared outcomes including a common end product. Our conclusions in this paper are thus restricted to this special user group.

The decision for a group to use a tool is mostly on an ad-hoc basis. Other than the tools specified in the unit guideline, students start by using any tools which they have experienced before, and use it according to what they consider to be the best-fit possible. There was no indication of any in-depth planning process in their approach to collaboration. Frequently they do not make use of the full potential of the tool even when they know it has particular features that they are in need of. Such a situation leads to some mismatch of affordances, between the affordances that the tools offer, those they need and the actual affordances used.

They easily perceived the affordances which relate to the role of the tools to support automating and communicating processes, but not in sense-making. We argue that sense-making is the core and main reason for collaboration. Otherwise, they could work independently on their own part in isolation.

Hence there are some underutilized affordances, which the students may or may not have realized before. Just because the student knows how to turn a door knob, doesn’t mean they know how to open the door. It is a matter of realizing the affordance at a meaningful level which is important for the successful use of technology to support collaboration. Following Kuutti’s [15] argument that an activity can operate at different levels, we see a tendency to work at the
operational level rather than at the level of the activity where the learning is intended to occur. This phenomena can also be explained with Resnick’s work on socio-technical capital [18] which teases out the opportunities that technology in general, and the Internet specifically, affords to build what is called "social capital". Interestingly, social-capital is the "fuel" which stimulates collaborative activity, and social capital is also the by-product of a collaborative activity, if that activity is successful. Hence it is a renewable capital. Resnick [18] explains the need for social-capital to be consciously grown through collaborative interaction to fuel further collaboration. When a group has lower social-capital, they would have less trust amongst the members, and less eagerness to collaborate; hence the motivation for each member to perceive and exploit the available tools is reduced. Therefore, lower level technology affordances can be perceived, but not a higher level of social affordances.

As a potential means to remedy this situation we recommend that students need a trial run on the use of collaboration tools such as a wiki, with an authentic task to collaborate on, before they can perceive enough affordance to make their own use effective. Such trial runs can be built into the design of the assignment instructions, or problem statement in the case of these IT projects, ensuring also that enough time is given to gain an understanding of the problem and the way the tool can be used to assist the problem solving process.

The inability of the individual or group to perceive the affordances of a collaborative tool is a great challenge for those in charge of designing and utilizing cloud-based collaboration tools, and for teachers, students and others who could benefit from the collaborative assistance the tools can provide but who are currently unable to realize their full potential. The mismatch also poses interesting issues for researchers in a number of different disciplines looking at technology, affordances and (under) utilization.

Resnick [18] suggests that we can consciously design collaborative activity to grow social-capital, and argues that doing so by means of technology, hence socio-technical capital, would be more widely acceptable with the current internet-generation. Technology is seen to offer the following affordances: removing barriers to interaction, expanding interaction networks, restricting information flows, managing dependencies, maintaining history, and direction of naming. Resnick’s work emphasizes the fact that there is a strong reason to study the activity of collaboration to make conscious investment in building the social-capital. It would be interesting to examine his subsequent work in measuring social-capital to see how those measurements can be integrated with Activity Theory, which can quite possibly, in the future, be used to create an in-built measurement for any Web 2.0 tool.

A key goal of the case studies we have been conducting is to gain a greater understanding of how to match the perceived affordance of the collaborating team members, and to influence this perception to allow effective and meaningful use of the tool to solve a problem. In the longer term we hope to develop a framework to allow people to identify the affordances they need to perform a certain activity and how to find and utilize the affordances in a supporting technological tool. This will allow teachers to better plan learning activities using supporting technology and students to realize the affordances.

Acknowledgements

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6. References

Appendix A: Semi-structured interview questions

<table>
<thead>
<tr>
<th>IS#</th>
<th>Guiding questions</th>
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<tbody>
<tr>
<td>01</td>
<td>What aspect of the TRAC wiki did you find easy to use? And what difficult?</td>
</tr>
<tr>
<td>02</td>
<td>What additional tools did you use to support your effort to produce the project documents? And why do you choose to use those tools in addition to / to replace the tools provided?</td>
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<tr>
<td>03</td>
<td>How did your group go about working together on a single task?</td>
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<td>04</td>
<td>How did your group go about dividing and assigning the responsibility?</td>
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<td>05</td>
<td>How would you describe your team's collaboration?</td>
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<tr>
<td>06</td>
<td>How would you see the value of the tool in general? And the TRAC wiki in particular? What would you define as effective?</td>
</tr>
<tr>
<td>07</td>
<td>What kind of sharing is sought after and valued in your perspective? How did the wiki and other tools support that needs?</td>
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<tr>
<td>08</td>
<td>How much do you value the tools? What was your perception of the role of the tools in supporting the team's collaboration?</td>
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<tr>
<td>09</td>
<td>Did the sub-group formed out of communication preferences? What tools causing this division?</td>
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<tr>
<td>10</td>
<td>Did you make any adjustment in your communication style and your attitude towards group work after using the tools? What adjustment was made? And why do you feel you need to make such adjustment?</td>
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<tr>
<td>11</td>
<td>How familiar are you with the tools within social and formal learning context?</td>
</tr>
</tbody>
</table>