

Examining the affordance of a software tool to support students in team project work

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Abstract

This paper presents the findings from a case study to investigate how undergraduate students used the output from a teamwork support tool. In designing this sort of software tool usability is considered, but analysis of the findings from this research suggests that the affordance of any support tools should also be considered, because without adequate signposting, the perceived affordance may not be the same as the intended affordance, as anticipated by the designer. This leaves the students unclear what the action possibilities of the software are, and how best to use the functions provided.

Case study was chosen as an interpretive research method, because it would provide rich data to demonstrate the variety of possible uses for the support tool. The tool under consideration in this study was designed to help the student team to allocate tasks to team members, according to ability and preference. The research was carried out with undergraduate students undertaking team projects in the information systems discipline. A grid based on the work of Sadler and Given (2007) was used to analyse the students' feedback on the system, according to whether the action possibilities intended by the designer were perceived or not.

This research showed that the students used the output from the tool in a variety of different ways, depending upon their perceptions of the affordance of the system. The perceived affordance of the system depended upon the efficacy of the signposting of the affordance, and the individual students' previous experience of team working. In this case the sharing of knowledge was hampered by a lack of signposts to the action possibilities of the tool. Student team project working is an unstructured network of individual learners, so each student may exercise their discretion in using support tools, sometimes even disregarding a tool. Although the findings from this case study are from co-located students, these students use online tools to maintain communication with each other when not on campus in the same way that online student teams do. So the results suggest that this tool, and others similar to it, may be equally suitable for supporting online student team working, provided the affordance of the tool is signposted with suggestions for action possibilities.

Keywords

Affordance, Usability, Student team projects, Teamwork, Task allocation.

Introduction

When designing and implementing information systems, consideration is given to the usability of the system from a human computer interaction (HCI) perspective. The usability is important for determining whether the users can successfully perform the actions intended by the system to achieve their objectives. The term "affordance" goes beyond usability, by considering what possible actions can be achieved by the system, and what actions users choose to take as a result of using the system to perform their objectives. The actual affordance provided by software tools may not be the same as that intended by the system's designers.

In this paper an exploratory case study (Yin 1994) is used to investigate the ways in which students in higher education chose to use the output from a new software system to support their team project work, by providing a means of connecting the individual team members into a network of learners. The notion of affordance is introduced; starting from a theoretical perspective, the context for the case is described and an evaluation of the

outcomes from using this software system are discussed to demonstrate the ways in which the affordance of this system affected the actions of these students.

Theory of affordance

It is apparent that why and how users adopt a technology to help them is a very complex matter. McGrenere and Ho (2000) defined the “usefulness” of a system to be its planned action possibilities, and a system “usability” to be its perceived possibilities. They further recognised the need to not only design possibilities of affordance into a system, but also signpost these affordances to the user, to make the system usable. In this way the “perceived affordance” will be dependent upon the users’ experience and knowledge. Designers incorporate their perspective on usability into tools, but users may not have the same perceptions, so may either disregard the tool, or use it in a different manner to that which was intended. McGrenere and Ho (2000) argue that clearly signposting affordance is important in designing software systems from a HCI perspective, because poor design leads to confusion for users, either over whether an action is possible with a system or how easy it is to perform. Gibson first used the term “affordance” to refer to the properties offered by something to an individual, i.e. real affordance as planned by the designer within a specific context. For example a flat surface affords support to a dice, but not a ball, so affordance is specific either to the action capabilities of an object or the object’s properties (McGrenere and Ho 2000). Norman suggested an enhanced definition of affordance, in relation to human computer interaction, including the notion of degrees of affordance and a dependence on past experience, knowledge or culture of the user to determine what affordance the item provides for an individual (McGrenere and Ho 2000). Gibson’s interpretation is that affordance can be fixed at the design stage, whereas Norman suggests that affordance depends on the user’s experience and knowledge, and that there may be degrees of affordance. Table 1 gives a comparison of Gibson’s and Norman’s definitions of affordance.

Table 1. Comparison of Gibson’s and Norman’s interpretations of affordance (McGrenere and Ho 2000)

<p>Gibson’s interpretation of affordance:</p> <ul style="list-style-type: none"> • Action possibilities in the environment are related to the action capabilities of the actor; • Independent of the actor’s experience, knowledge or capabilities; • Affordance exists or does not exist.
<p>Norman’s interpretation of affordance:</p> <ul style="list-style-type: none"> • Perceived properties may or may not actually exist; • Actors require clues as to how to use the property; • Dependent on the experience, knowledge or culture of the actor; • Degree of affordance shown by how easy or difficult the action is.

In an educational context, previous experience of learners can not be assumed, but is constructed based upon other similar experiences. Knowledge of the domain is the desired outcome of the learning experience, and this may depend upon the tasks being undertaken and previous learning. When learning takes place in a team context the cultural background of each member of the team is reflected in the interactions between team members. Individual perceptions differ, but successful team working requires that the loose network of individuals be combined into a cohesive team.

Technology affordance, educational affordance and social affordance are all desirable properties of an educational information system designed to support team working (Conole and Dyke 2004). Knowledge of and knowing how to do something are not necessarily the same thing; just because an action possibility is included, it does not mean that users will choose to perform that action (Dohn 2006). For example Billett (2001) found that workplace training opportunities were not always taken up by individuals if the motivation was not present. Lakkala (2005) found that learners’ use of a collaborative learning environment varied considerably, according to individual perceptions of its usefulness, and John and Sutherland (2005) found that perception of an object’s usefulness to learning influenced the take up of a learning tool. Ryder (1996) similarly found a reluctance to use some technology tools.

The literature suggests that the technology affordance of a software tool is the principal one that affects its usability, but the educational affordance influences students’ perception of the usefulness of the tool in relation to their learning objectives, and the social affordance results from the context of the network of learners within the learning environment.

Student team projects

In Higher Education a team project is one of the best learning activities for developing a number of skills, including team working, and use of CMC (Computer mediated communication) tools. Further, students are learning about team working at the same time as consolidating their learning about the subject matter by applying the theories they have learned. For students team working can be problematical and give rise to difficulties as the students learn to work together, such as maintaining effective communication and dealing with conflict (Lehtinen et al. 2002; Ruel and Bastiaans 2003). With limited experience of team working, students cannot always overcome these difficulties, and as a result many student team projects fail to deliver the expected outcomes. The literature has highlighted some of the difficulties students experience in their team working as organising meetings (Burdett 2003), team members not contributing and free-riding (Ruel and Bastiaans 2003), and coming to trust each other (Whatley et al. 1999). Developing trust can be more difficult as students tend to prefer to work from home rather than on campus, relying on the online tools for communication and to co-ordinate their teamwork. The tutor can play a part in helping teams to overcome problems (Ruel and Bastiaans 2003), but as class sizes increase, tutors are becoming hard pressed to offer timely support (Cooper and Heinze 2003).

In their study, Dunne and Rawlins (2000) recognised that in higher education a safe environment for learning about team working can be provided, although students do need to be provided with some guidance as they embark on their team projects (Hansen 2006; Prichard et al. 2006). The form that this guidance should take is an issue to be overcome; it could be in the form of lecture presentations, written or online notes as guidance, or some form of automated tool, as in this case study. This paper describes the outcomes from a trial of a software agent tool, designed to help students in a project team to get started on their project. The functions of this tool were aimed at helping the students to get to know the capabilities and preferences of other team members, and hence come to trust each other through a shared understanding. Thus the tool would support the learning process and help the students to learn about team working at the same time as carrying out the tasks of the project. Online support for students is becoming an essential part of the university provision, because due to other commitments students often limit their attendance on campus as much as possible, using email, mobile phone and virtual learning environments to make contact with each other.

Research Method

This research was aimed at examining the ways in which students in a team used a new software support tool, and the impact it had upon the process of their team projects, by strengthening the network between the individuals. The research takes the form of an exploratory case study, and because the impact upon their learning and the affordance of the tool was the most important outcome from the research, an interpretive research approach was taken. However, the results were supported by some quantitative findings, which gave an indication of the extent of the effect of the software tool on their team working activities.

A prototype of a software tool to support student team project working was developed and tried with students undertaking team projects as part of their studies. This tool included a function to help students to allocate tasks to individual team members, by asking each student in a team what their preferences and ability levels are for the required tasks of the project. The tool applies a set of rules to the data gathered and produces as an output a set of suggestions for which students should be allocated to which of the tasks of the project, and suggestions for training needs of individuals. The tool took on three different appearances over a four-year cycle of the prototyping, each successive version being amended according to feedback from the previous test with students, and incremental addition of functions. It was installed at first on individual computers in the computer suite, and in subsequent years made available online, to fit in with the demand for working from home.

The team support tool was tried on undergraduate students, working on multi-year team projects. The students were taking one of several business information systems programmes of study, and teams were allocated to include students from first, second and final years of study, totalling between 10 and 15 students in each team. The projects undertaken were provided by outside organisations, which could include web design, database development or feasibility studies. Because of the variety of these projects the teams had a good deal of autonomy to organise the work as they felt was appropriate. Teams were asked, through their team leaders, to

participate in the trials, by using the system at the beginning of their projects to allocate tasks to individual members of their team, a process that took about four weeks. After each trial of the prototype, students were asked for feedback on the system through answers to a questionnaire, an interview the researcher conducted with team leaders, and two focus groups to which on each occasion about 8 students contributed. Analysis of the data was through sorting the comments according to themes identified from the literature on student team working. These themes were based around how the output from the system was used to help the teams to get started on their projects, and the impact this output had on establishing team-working processes. The resulting comments ranged from those on the interface and additional functions, to comments on trust, shared understanding and culture. Over the four-year period of the trials about 30 teams used the prototype system, representing about a quarter of all of the teams. The response rate for the questionnaires was about 35%, but interviews were conducted with team leaders from all of the teams that had used the system

The next section of this paper discusses the findings from the analysis and shows how the affordance of the software tool influenced the ways in which the students used the output from the system. This paper concentrates on the function included in the system for allocating tasks to team members.

Evaluating the affordance of the software tool

Sadler and Given (2007), in their work on students' experiences with a digital library search tool, refer to "real (planned) affordance", which the designer intends, and "perceived affordance", which is what the users make of the tool. In order to gain a more holistic picture of the responses of students, the feedback from the students for all four of the prototype trials was sorted into themes, which were then presented on a grid, based on Sadler and Given's work, showing the differences between "intended" and "perceived" affordance of the software tool. The resulting grid comprises categories of intended and perceived, perceived but not intended, intended but not perceived affordance and those effects neither intended by the designer nor perceived by the users as being possible (Table 2). In this case the perceived affordance of the system was found to be at variance with the intended affordance, as students chose whether or not to look at or use the outputs in the ways intended by the designer. These differences will now be explored further in this section of the paper.

Table 2. Grid analysing affordance interpretations of Task allocation function

Intended and perceived <ul style="list-style-type: none"> • Information on members' skill levels • Automated allocation of tasks to individuals • Shared understanding • Think about skill levels • Training needs • Awareness of need to develop new skills • Takes conflict out of decision making 	Perceived but not intended <ul style="list-style-type: none"> • Used to allocate members to sub-teams • Used as a prompt for discussion, sometimes with alongside a paper audit • Pair off less competent individuals with more expert ones • Choosing soft options • Risk analysis for completing tasks
Intended but not perceived <ul style="list-style-type: none"> • Structure the team according to task areas • Not regarded as applicable to certain types of projects • Shared knowledge of abilities • Positive effect on team functioning leading to trust • Some just ticked boxes, so may not be able to trust output • Awareness of team working processes 	Wanted but not provided <ul style="list-style-type: none"> • More information on task durations • Resolving conflict in allocations • Pick out personalities

The usability of the first prototype did lead to difficulties for some team leaders and members, who subsequently decided not to continue with its use. They resorted to alternative means of allocating tasks to their members, in order to get started on their project quickly. Reasons given for not using the system included time constraints, often cited as a reason for not doing something, and a feeling that their particular project did not lend itself to this sort of automated allocation of tasks, as shown by the comment:

"In my project it was cut and dried what needed to be done, useful if programming software, but as a research project, there is really no need for automation." (Team Leader, Team 7, 2004)

Students will not spend time on something if the tool is not immediately accessible to them or has a time overhead to learn it. Some students did not perceive its affordance, i.e. what it could do for them, so did not spend time learning the system.

When considering the responses from students whose team did use the system, there was considerable variation in ways students used the outputs, and the impact the system had on their actions within the team. Table 2 summarises the comments from students according to the intended or perceived affordance.

The system was designed with the intended affordance of providing information aimed at all team members, even though it was the team leader who were required to set up the system for the team members to use. However, it was found that most team members relied on their team leader to provide information to them on summaries of individuals' preferences and the output of tasks allocated to each member, by printing out the suggested allocations of tasks for team members to see. As a result few team members accessed the output allocations or preferences through the online system. Individual perceptions of the potential for the system were different for team members from that of the team leaders. The following comments were from team leaders who clearly appreciated the possibilities of such a system in providing information on team members' skill levels:

- "Yes, showed clearly the technical and other types of people." (Team Leader, Team 10, 2003);
- "Yes a good idea with people you have not seen before." (TL, T13, 2005);
- "...build a knowledge base of the skills existing and required and matched to the specification of the project" (TL, T8, 2004);
- "Affects the way I manage the team and plan work. Assumption that 3rd years are more able, but this is not necessarily so according to the output from the system" (TL, T3, 2008);
- "Another source to look at. Socialising is important. Something else to think about and help making decisions" (TL, T1, 2003).

Through the focus groups team members did identify some benefits of using the system that had been envisaged by the designer, including encouraging individuals to think about their skill levels and a need to develop new skills, suggesting training needs and providing a shared understanding, for example these comments:

- "Team project work is an opportunity to learn re new things, not just about what you can do and what you think you can do." (Focus Group, 2002);
- "Team work can drag you down or push you up, so need to measure individuals' skills" (FG, 2002);
- "It made them think about the skills, choosing them" (FG, 2002).

Some of the ways in which the teams used the output, had not been anticipated by the designer, i.e. "perceived but not intended", such as its use as a prompt for discussion, and for pairing off more able students with those that are less able as a means of training, showing a degree of self-sufficiency in their learning:

- "See all gradings for everyone. So if low mark can put with more confident person" (TL, T10, 2005);
- "Areas spot on. To form the sub teams, so layer of authority and give out orders, better idea of what's going on" (TL, T5, 2005);
- "Task allocation affected by motivation, allocate tasks using a risk analysis approach – don't allocate key tasks to high risk people" (FG, 2002);
- "Agent results used to justify the choices" (TL, T5, 2003).

But actual uses of the output could be less beneficial as well, such as the continued practice of allocating team members to sub-teams within the project team; a practice that the tutor hoped would be discouraged through using this tool. There was also recognition that students could "see through" the tool and continue to select preferences that would cause the tool to suggest one of the "soft options" for them. Students made the following observations:

- "...helped me to know who to put into which part of the team ..." (TL, T8, 2004);
- "use it to divide the team into technical admin and research sections" (TL, T15, 2004);
- "Cynical approach – 2nd years know where the 'soft' options are, if they are asked questions that they realise will allocate them to a certain team they will identify those questions" (FG, 2002).

These were in contrast to the "Intended but not perceived" quadrant, where the intentions of the designer were not fully realised in practice by the students, as recognised by these comments from students:

“Rating/grading but may be subjective – all say they are good at word processing but what is ‘good’” (FG, 2002);
“...but people agree, but don’t act on it. Always honest, make perfect answer” (FG, 2004);
“Project specific skills were used to plan the project, work out what and when things needed delivering” (TL, T17, 2004).

The tool fell short of being perceived as useful by some team leaders:

“Put all details in, but I did it the way I did last year, more accuracy” (FG, 2004);
“...but people get on with their own work rather than look at project as a whole.” (FG, 2004).

Finally the student feedback identified features that were not intended and that could not be carried out directly using outputs from the system:

“Can’t pick out personalities, may not work together in practice. We need to put first years with second and final years” (TL, T5, 2005);
“It did not really assess what people think about, not clever enough. People can make things up” (TL, T9, 2004);
“Down to purpose, and explaining the purpose – if people understand that it is there to help them” (FG, 2002).

The reactions of team members to the system varied considerably, depending upon the use made of the output by their team leaders. Some team leaders were more inventive, or adapted the output to alternative chosen methods, so the system did encourage some autonomy in organising the team. Analysing the findings from the research in this manner highlighted a number of issues that will be discussed in the next section.

Discussion of the findings

The intended affordance of software is often not the same as the affordance perceived by the users, a range of tools may be provided for students to use, but time constraints, and lack of perception may limit their adoption of tools for short duration team projects. It is important to provide students with a variety of tools to help their learning, but they may not always use software tools as we would anticipate.

Although the system did work technically, limitations of the interface did restrict the level of success of the prototype system. Throughout the cycles of prototyping there were frequent references to the inadequate interface, which sometimes prevented the students from making full use of the system, and so preventing the affordance of the system from being recognised. Quantitative results for user acceptance of the support tool were disappointing, with only 50% of the students who answered the questionnaire saying that they thought the task allocation tool was useful to them in their project. Although these students were campus based, they did recognise that the tool could be useful for student teams working online, with 71% of the respondents saying they thought the tool could be useful for online teams. Team leaders did point out that training and information at the beginning of the project would have helped its acceptance, so one or more sessions at the introduction of the project, explaining its functions and how to use the output, were suggested:

“More awareness, needed guidance and a lecture to introduce it” (TL, T10, 2004);
“Explanation on how to make use of the tool, user guidance” (TL, T3, 2008).

The students in this case also tended to prefer to work in line with their previous experience, which has tended to perpetuate the use of a rigid team structure. As McGrenere and Ho (2000) suggested it is important to not only design affordance into a system, but also to signpost the action possibilities, as perceived affordance is often linked to users’ prior experience. The system was designed to provide information on team members for all team members to access, but it was found that in this case study team members relied upon their team leader to provide this information, so this intended affordance was not perceived by all of the students in this research, because it was not signposted to them. Members of a team who undertake different team roles will perceive different affordance from a software system.

By looking at this aspect of human computer interaction, known as affordance, it is apparent that why and how users adopt a technology to help them is a very complex matter. Designers incorporate their perspective on usability into tools, but users may not have the same perceptions, so may either disregard the tool, or use it in a different manner to that intended.

Conclusions and future work

Team project work is a complex activity for enabling learning in students, as its unstructured nature together with possibilities for a variety of difficulties to arise, can result in frustration for students and consequent poor performance. Developing tools to help students to connect with each other in a team is one approach to solving this problem.

The software system development and trial reported in this paper represents a single function envisaged to contribute to helping students achieve successful teamwork. Feedback from the students suggests that they found the function of task allocation to be useful to them, but often in ways different to those envisaged by the designer. When designing software user requirements need to be established, but users may not be able at the design stage to envisage how a system might help them when completed, so these uses emerge as a system is tested. Although this system worked as technically expected, the interface played a large part in the acceptance levels from the students' point of view; it was found that limitations of the interface, in terms of the lack of instructions to clearly signpost the action possibilities, prevented some students from perceiving some of the intended affordance.

In designing this type of support system, the intended affordance of the system should be signposted, and even then, the affordance perceived could still be at variance to that which was intended. As suggested by the literature, affordance is an added dimension to usability that should be considered. A certain degree of usefulness of the system was shown by the student feedback in this case, but instruction in using the system and suggested ways to use the output would be an essential enhancement for its implementation. From an educational perspective, students may need additional guidance if knowledge sharing in a network of learners is to be achieved, because students need to be aware of the possible affordance choices the system provides.

It was noted in this research that the affordance perceived by online students could be different to that perceived by co-located students, as they have different needs for supporting their communication. Although this research is concerned with co-located students, they are students who use computers and the Internet for communication on a regular basis, and so are also networked learners. Nevertheless it would be useful to investigate the impact of this support tool on students working entirely online. Other future work could consider whether teams with no designated leader use the output from the tool in similar ways.

In using the grid based on the work of Sadler and Given (2007), to analyse the findings from this research, it was possible to identify the ways in which the intended affordance matched the perceived affordance of the system. The grid indicated ways in which the students perceived the use of the system, which were not intended, and uses that although intended, were not perceived by these students, as well as uses of the system that the students would have liked, but were not provided. As suggested in the literature, some users may either disregard the tool, or use it in a different manner, which happened in this case. The grid could be used as an aid to design, by allowing designers to identify barriers to perceiving the intended affordance of systems through testing, and to identify additional features that designers did not intend.

Envisaging how students will use online resources and tools for their learning activities has been problematical. Providing tools for students to use in their learning is as important as providing learning activities. The difference is that students may use their individual discretion whether to, or how to use the tools provided. This agency makes it difficult to predict the methods students will use for their learning, and difficult to predict their actions in respect to their network of co-learners. Hence a need to build into a software support system a number of features which some individuals will use, but others will not. This affordance maintains the student's independence and free will in learning. The intended and perceived affordance of any software tools provided contributes to the degree of acceptance of the technology support for students. Future work could also be directed at determining the relationship between affordance and acceptance in the context of support for a network of learners in the form of a team.

This paper provides an evaluation of a software tool developed to help students to allocate tasks to individual team members, as an aid in their team project work. The evaluation used the notion of affordance, and a grid with four quadrants to analyse the feedback from students. The case study used in this research showed that the students used the output from the tool in a variety of different ways, depending upon their perceptions of the

affordance of the system. The perceived affordance of the system depended upon the efficacy of the signposting of the affordance, and the individual students' previous experience of team working. It is important to provide choices for students, so that autonomy of learning is maintained, and this might mean providing several tools for students to choose from, whilst ensuring that they know what help each tool is capable of providing for them.

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