Supporting student team project work: the Guardian Agent system

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List of Abbreviations

AI Artificial Intelligence

BCS British Computer Society

CAI Computer Assisted (Aided) Instruction

CAL Computer Assisted (Aided) Learning

CGT Collaborative Group Technology

CMC Computer Mediated Communication

CoP Community of Practice

CSCL Computer Supported Collaborative (Co-operative) Learning

CSCW Computer Supported Collaborative (Co-operative) Working

EMS Electronic Meeting Systems

FE Further Education

GDSS Group Decision Support Systems

GSS Group Support Systems

HCI Human Computer Interaction

HE Higher Education

ICT Information and Communication Technologies

IS Information Systems

ISI Information Systems Institute

IT Information Technology

ITS Intelligent Tutoring Systems

KBS Knowledge Based System

QAA Quality Assurance Agency

PBL Problem based learning

PDP Professional Development Planning

VLE Virtual Learning Environment

Abbreviations used for presenting the findings:

FG Focus group

TL Team leader

T4 Team 4

Q Questionnaire

ABSTRACT

The research presented in this thesis investigates student team working, by designing, implementing and evaluating a prototype software system, as an aid for co-located students carrying out their team project work. In higher education team projects are a good way for students to put theory into practice and gain experience of team working, by working collaboratively. But difficulties often arise during the projects, which prevent students from benefiting fully from the experience. Some difficulties are known to arise in organisational teams, and others are unique to student teams, but the getting started stage is crucial for developing team cohesion.

Technology tools are used to support the task-oriented roles of team working, but there is little support for students to get started on their team projects, and to develop a shared understanding. This prototype system provides a function for allocating tasks of the project to appropriate team members and a function to help the team to agree ground rules for team working.

A case study approach was adopted for this research, and the prototype system was developed over three cycles, amending the system according to student feedback. At the end of the study, data obtained from the students was analysed to find out how useful the online support system was for helping the student teams to get started on their projects.

The students in this case did benefit from the functions this system provided, in particular the team leaders used the output to help plan their projects, and output from the system contributed to team cohesion through developing a shared understanding between the team members. These students recognised the potential of the system for helping students working on team projects online, and gave suggestions for modifications to the system that could be incorporated in further development of the system.

1. INTRODUCTION

The research presented in this thesis investigates student team working, by designing, implementing and evaluating a software system as an aid for co-located students in carrying out their team project work. Undergraduate students in the university at which the author works, have reported that they find it difficult to undertake team projects (Jones and McMaster 2004; Cooper and Heinze 2007). This is a problem that has been reported elsewhere, e.g. (Ruel and Bastiaans 2003; Hansen 2006), and results in dissatisfaction with team working, so students do not reap the full benefit of participating in team projects. However, undergraduate team projects are a good way to learn skills and prepare for team working in the workplace. The literature identifies three main stages of any project: getting started, carrying out the tasks and completing the project. There is also evidence that getting started on a project is a crucial stage in effectively achieving outcomes. The author had been working on software agent technology, so it was proposed that using agent technology might provide some additional support to students for getting started on their team projects, which would alleviate some of the difficulties they typically encounter. In this thesis undergraduate students, working on IT systems development team projects are being investigated, in order to find out whether team communication through a software system, based on agent technology, can enhance the students' experience of team working.

Working in a team can enable people to achieve more than if the individuals were to work alone, because they share knowledge with each other and learn from each other.

> *"The whole is greater than the sum of the individual parts"* (Taylor-Powell 1999).

In organisations, teams of individuals with specialist skills work together to produce outcomes, that would not be possible from individuals working alone, see for example team working in the medical domain (Opie 2000), or in software development (He et al. 2007).

In higher education students learn through a variety of directed learning activities, some of which are collaborative, including team working. Learning may be enhanced by the act of discussion with other learners, and by practicing the theory being taught

in real life situations or simulations of real life situations (Bennett et al. 1996). One of the learning activities often used in higher education is an extended project, carried out by a number of students together, a team project. Team projects are good for teaching the practical skills such as those required in systems development, but at the same time are also good for providing opportunities to learn about team working skills, i.e. process as well as product (Dillenbourg 1999).

Face to face or co-located team working has been the predominant format in the past, but new technology, growing out of telecommunications, is enabling alternative forms of communication as part of working in teams, which may be fully or partly distributed for various reasons (Attaran and Attaran 2002). A mixture of co-located and computer mediated communication is now commonplace both in organisations and in higher education. Traditional team working skills are being extended to include skills of online working, and student team project working is no exception.

Student team project working has three stages: getting started, carrying out the tasks and completing. Technology for supporting team working is aimed at the second stage, carrying out tasks, rather than the first stage of getting started. Support for team working in organisations is based around groupware, and in higher education around virtual learning environments, and these systems are good for supporting the task aims of team working, by enabling document sharing and discussion. It was proposed that an online software tool might be an appropriate means of providing support, specifically aimed at students, to help them to get started on their team projects.

1.1. Aim of this research

In this research the overall aim is to design, implement and explore the use students make of an online system for supporting getting started on team project work.

A research question was formulated to achieve the aim of this research:

- How useful is online software support in the first stages of co-located student team project working?

In addition, more specific questions will be answered by this research, as follows:

- In what ways does output from the automated system to allocate tasks and agree ground rules help students to get started on their team project work, and impact upon relationships between students?
- How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working, and how suitable is the software perceived to be for online student teams?
- Which other functions could be incorporated into a support system that would help students with their team project work?

1.2. Research objectives

In order to address these comments, the process of this research breaks down into two parts, implementing a prototype system (Objectives 1, 2 and 3) and exploring the use students make of this system (Objectives 4, 5 and 6). These are expressed as the following research objectives:

1. Conduct a literature review to establish team working issues, and more specifically issues of student team working;
2. Identify functions that an agent system could perform to help students to get started on their team projects;
3. Design a software system, based on agent technology, and implement it using a prototyping method, which would:
    a. Identify changes to the current implementation that can be incorporated into the next prototype;
    b. Evaluate the suitability of the pre-programmed content in each version of the system;
4. Use survey tools to find out how the output from the prototype system is used to help students to get started on their team projects;
5. Use survey tools to find out how suitable this sort of system is for supporting student team projects;
6. Gather feedback from students to ascertain what other functions could be incorporated into the system.

The context for this research is undergraduate students, in the UK, working in teams, on projects related to design and development of business information systems. These

students are co-located, on a university campus, and their learning at university is supported by a variety of ICT (Information and Communication Technology) tools.

Although the context for this thesis is higher education, the research is primarily aimed at implementing a software information system, and exploring the use students make of this system, rather than investigating the students' learning. Hence this thesis is information systems research and not education research.

An interpretive approach is to be taken by the author, because the object of the study is not to test a set of pre-determined hypotheses, but to find out more about the effects of the interventions taken upon the students undertaking team working.

The research is based upon a case study method, because it was intended that the research should be undertaken in the field, where there is limited possibility of controlling the environment, and the "how?" and "why?" are being investigated. Even though this research was carried out over several iterative cycles, it may still be regarded as a single case study. The case study is partly evaluative and partly exploratory, as defined by Bassey (1999:63):

> *"...enquiries which set out to explore some educational programme, system, project or event in order to focus on its worthwhileness."*

Data analysis through explanation building was chosen for this study, with the analysis of feedback from each iteration of the prototyping helping to guide the next cycle of testing, and building up to a description of student reaction to the system, as explanation for their actions.

The online system, called the Guardian Agent System, was designed to help with task allocation and agreeing ground rules, as important functions for getting started on their team projects. These functions will be evaluated through feedback from the students to determine the extent to which these functions assisted the student teams in developing group cohesion, and getting started on their projects.

1.3. Rationale for this study

In the workplace teams or groups of employees need to work together to achieve business objectives, particularly in the field of information systems development. In much of the literature student team working is perceived as similar to organisational team working, but there are significant differences concerned with the educational purposes for the team working, which often manifests itself in dissatisfaction of the students involved.

In distinguishing between a "group" and a "team", Belbin gave a useful description of both in an organisational context (Belbin 2000). Groups comprise any number of members, and as their size increases individual contributions tend to be reduced, also there is often a hierarchical structure to a group. On the other hand a team is usually smaller (anything between 2 and 15), has shared objectives, with each team member considering how best to contribute, and often imprinting their personal identity in the social setting of the team. An idealised definition is as follows:

> *"A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves as and are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationship across organisational boundaries"* (Cohen 1997, as cited in Powell et al. (2004)

This definition works well in the organisational context, but the concept of "an intact social identity" and "share responsibility for outcomes" are problematical in the context of student teams. In this research the author will use the term "team" to refer to groups of two or more individuals brought together to carry out a student team project in higher education, although in this context many writers use the terms group and team interchangeably.

The word "team" also seems to have been hijacked as a "buzzword" for modern organisational structuring, e.g. the use of "team building" in whole departments, to motivate employees and encourage conformance to a corporate identity (Ezzamel and Willmott 2001). This has become more widespread, because it appears to give autonomy to the workforce, but at the same time it gives control to management,

particularly through the technology used in the working environment (Sewell 1998). However, this meaning of the word "team" is not the meaning referred to in this research, but instead the team in this research is defined as a vehicle for bringing together a variety of specialist workers to achieve a finite outcome.

From the literature, organisational team working revolves around the three intertwined areas of team, individual and task, represented as overlapping circles on the conceptual framework (Figure 1.1). Team working comprises task and maintenance roles, which overlap, and the literature suggests that having a common purpose and equitable division of tasks play a part in successfully achieving the task roles of a team project. The maintenance roles are affected by individuals' expectations of behaviour, how members adapt to the social situation of their work, methods of communication and how conflict within the team is managed. Leadership is regarded as key to successful projects, whether formally appointed or informally emerging from within the team.

But in higher education student teams are situated in the context of constructivist or experiential learning, with the aim of achieving learning outcomes, including transferable team working skills. There is technology to support various aspects of student team project working, as in organisational teams. But achieving a common purpose and dividing the work appropriately are hampered by the variable nature of team projects, the diversity of the students involved and a need to also support their learning (Figure 1.1). The effectiveness of a student team project as a learning activity depends upon the background of the students involved and their commitment to the project. The conceptual framework shown in Figure 1.1 summarises the factors that affect organisational and student team project working, many of which can be seen to be similar. The interplay between task, team and individual is crucial for achieving the process and product in organisational teams, whereas the interplay between learning through team projects, the technology to support this learning and the tasks of systems development projects, plays a role in the processes of achieving learning and the products of learning skills that may be transferable to the workplace. The desired outcomes from student team projects are learning about team working processes and skills associated with the products of the tasks; the team project is a vehicle for this learning.

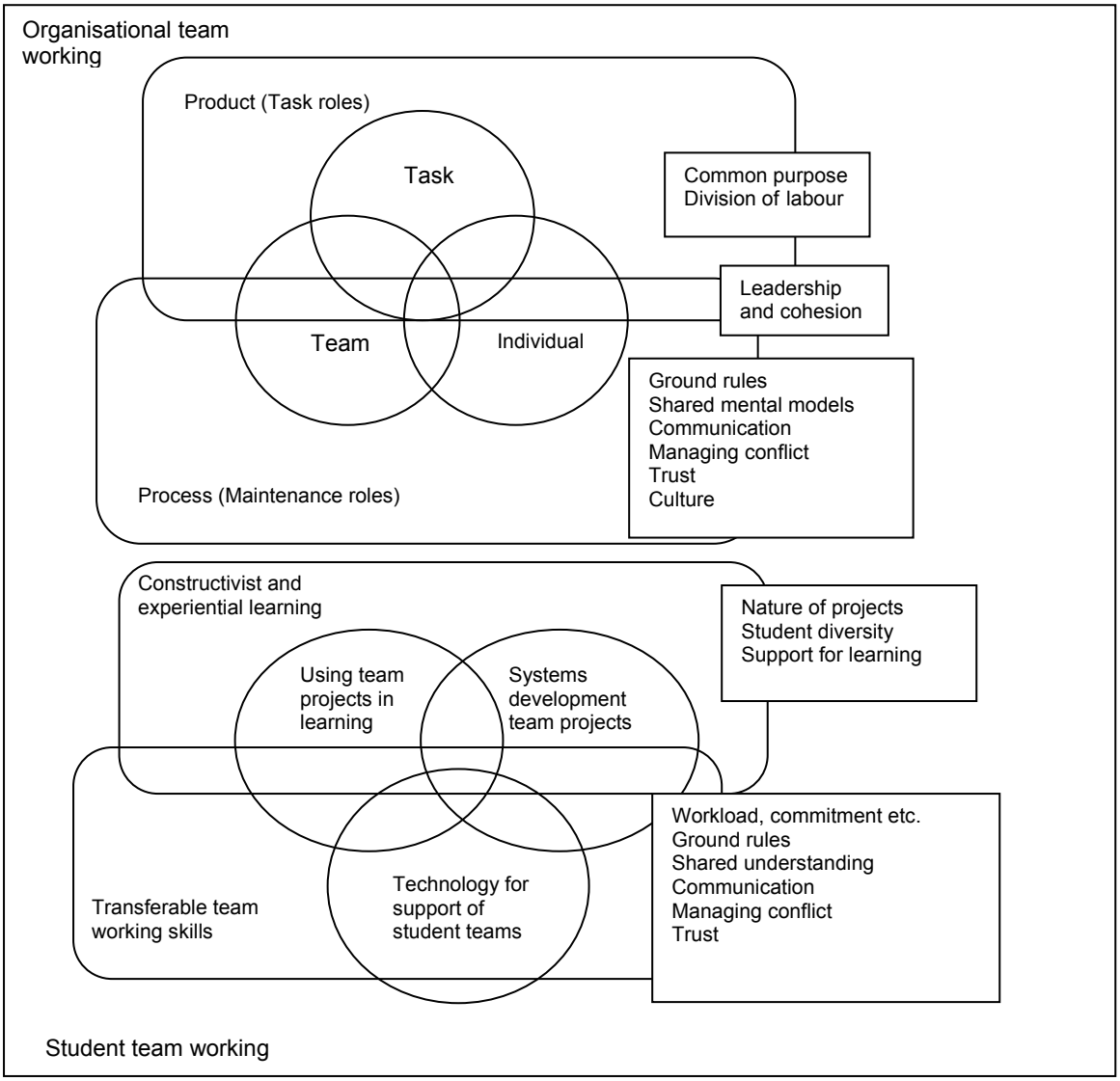


Figure 1.1 Conceptual Framework for this study

There has been considerable research into team working in organisations, based on a co-located environment, which suggest issues of team working which might impact on the success of the outcomes. Most of this research agrees on a division of team processes into task and maintenance roles (Beranek et al. 2005), and the interdependence of these roles (Belbin 2000). When individuals develop as a team, they are said to pass through the stages of forming, storming, norming and performing (adjourning added later) (Tuckman 1965). It is the ways in which team members pass through these stages that determines the degree of success for a team project. At the forming stage of a project, there is emphasis on developing positive group dynamics, through trust building and developing team cohesion, to help the team through the storming stage, and to norming and performing, where the tasks of the project are

carried out (Golembiewski and McConkie 1975), the need for good communication, to deal with norms and expectations (Hartley 1997), effective team leadership (Zaccaro et al. 2002), and dealing with conflict (Brown 2000).

In order to share knowledge in teams, organisations must nurture ways to create, capture and share knowledge and expertise; team working also requires this sharing, so knowledge management, often through a leadership role, is an important part of team working. Some software tools help knowledge management in organisations, as part of the support mechanisms for teams (Zack 1999). Other software tools enable communications, essential for trust and team cohesion (Bos et al. 2002).

The growing use of team working in organisations requires that universities produce graduates with knowledge and experience of team working and who have developed some team skills. Team project work is also a good learning activity for many learners, because students can perform well in the collaborative situation (Chapman et al. 2005); but equally some students do not perform well, and gain little from the experience of team working, especially if the experience has been negative.

Research results indicate that using team projects as learning activities in higher education is desirable for a number of reasons:

- The resulting learning uses cognitive, constructivist or experiential types rather than behavioural, which is more aligned to adult learners (Dyke et al. 2007);
- Using real world problems can be motivating for students, and gives opportunities for students to apply their previous experience, and become more self-directed in their learning (Atherton 2005);
- The range of activities involved allows students to engage with learning in ways different to their preferred approaches, further developing their studying skills (Entwistle 1977);
- The range of activities, linking them together and synthesising the problems, provides opportunities for developing cognitive, affective and psycho-motor skills (Atherton 2005);

- Team projects incorporate elements of collaborative and co-operative working, promoting team working skills acquisition (Prichard et al. 2006);
- Team projects are also increasingly used for assessment because in a class of over 100 students there will be far fewer pieces of work to mark (Fellers 1996).

Technology advances have given students a greater degree of freedom to manage their learning processes, by enabling students to study from any location and at their own pace, also choosing what tools and activities to learn through (Conole and Dyke 2004). Team working in higher education is typically co-located, i.e. all students are available to meet regularly face to face. But there is a tendency now for students to work from home, supported by tools on the Internet. In the same way, as organisations work more in global teams today, the skills that students should acquire are changing. Students need to be able to cope with the difficulties that may arise when working globally as well as face to face in teams, and appreciate the benefits to personal development and to the organisation. Software known as Groupware is used in organisations, and to a certain extent in higher education, but may not be adequate for providing students with some of the team working skills they need. The affordance provided by tools may not be the same as those intended by the system's designers; technical affordance, educational affordance and social affordance are all desirable properties of an educational information system designed to support team working (Conole and Dyke 2004).

Higher education is aimed at students as adult learners, who may have different motivations to learn from those of children (Knowles 1990). Learning results in changed behaviour in individuals, resulting in an ability to adapt to changes in the environment, it is an individual activity, but promoted by collaboration with others in a social situation (Bennett et al. 1996). Adult learning relies on using existing experiences upon which to hook new knowledge, a form of constructivist learning (Vygotsky 1978). Kolb (1984), suggested that learning is a cyclical process, relying on doing, reflecting, conceptualising and trying, implying that practicing what has been taught in theory is important, based in turn on the work of Dewey, who said that learning in a social context was best for developing individuals (Dewey 1944).

Collaborating with peers is an important form of learning, ranging from discussion of a topic to problem-based learning. The team project is an opportunity to learn from mistakes, and develop collective and individual skills, but it is very difficult to assess the degree of developing these skills, unless students are given an opportunity to reflect on their performance in team working. Personal development planning (PDP) literature talks about team working skills, but does not specify what sorts of skills, or how they can be acquired (Edwards 2005). Undergraduate team projects are very complex, and students elsewhere have also reported difficulties in team working, resulting in negative experiences of the learning activity, e.g. (Chiasson and Dexter 2001).

Various tools using technology are available to help with aspects of team working, such as project management, file sharing and communication and groupware (Attaran and Attaran 2002). Co-located students are being encouraged to use these tools for their projects, in preparation for using the technology at work. However, the literature suggests that they are more useful for supporting the task roles of a project than helping students come to a shared understanding of each other, known as the maintenance roles (Olson et al. 1993). Thus they do not necessarily help with many of the team working difficulties, and may even exacerbate them (Ford and Morice 2003). Experience of using online team working support tools may benefit co-located students as well as online students, as preparation for the global workplace (Hurst and Thomas 2004).

Intelligent tutoring systems were developed to enable online individuals to engage in flexible learning (Farr and Psotka 1992; Hwang 2003), and suggest the possibility of a software system to help students to acquire transferable skills. Software agent systems are a form of intelligent system that can be customised to the individual student, and provide specific help, training or guidance as required by the situation (Thaiupathump et al. 1999). Multi-agent systems are groups of software agents working together to achieve the same goals, by passing information between each other and tapping the specific resources of individual agents (Wooldridge and Jennings 1995). Multiple intelligent agents working together mirror the arrangement of teams of students working together to achieve the same goals, and this gave rise to the suggestion that multiple agent technology might be harnessed for designing a support system for

students engaged in team projects. Providing an online system to store, analyse and disseminate information to each team member may provide helpful support to the team working together on a project.
This thesis is concerned with investigating whether online support, specific for student project teams, may alleviate some of the difficulties student experience when carrying out team projects, and thus enable them to benefit from the advantages that team project working can bestow upon learners.

1.4. Outline of the thesis

Having identified the purpose of this research, a rigorous approach will be undertaken to achieve the stated aim, within the context chosen. This section provides an outline of the contents of the chapters that form this thesis.

Chapter 2 outlines the range of research methods that can be adopted for an information systems research investigation. The chapter presents a review of accepted paradigms, and provides a justification for the chosen methodology of interpretive case study. The range of possible research instruments are reviewed and the chosen methods to be used are then described and justified.

Chapter 3 forms the literature review of this thesis, aiming to examine and critically evaluate previously published work on team working and the place of team projects in higher education. Issues related to organisational team working in the co-located context will be examined, followed by a consideration of student team project working as a learning activity.

Chapter 4 starts with an examination of the issues of student team working that have been reported previously, and will form the basis for identifying possible solutions to the issues raised by the literature. The literature review continues with a critical evaluation of the current technology support used in higher education, including intelligent tutoring and software agent technology, as the chosen means of developing a prototype system. At the end of this chapter there is a description of the proposed prototype system to support the students in getting started on their team projects.

Chapter 5 describes the cycles of prototype development, implementation and evaluation of outcomes that forms the evaluation part of the case study, describing modifications to each prototype according to feedback received from student users and tutors.

Chapter 6 provides a discussion of the findings to answer the first research question:

- In what ways does output from the automated system to allocate tasks and agree ground rules helps students to get started on their team project work, and impact upon relationships between students?

Chapter 7 provides a discussion of the findings to answer the other research questions:

- How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working, and how suitable is the software perceived to be for online student teams?
- Which other functions could be incorporated into this agent system that would help students with their team project work?

Chapter 8 concludes the thesis, by bringing all of the findings together to answer the overall research question:

- How useful is online software support in the first stages of co-located student team project working?

This chapter also provides the author's reflection on the manner in which the study was carried out, methods used, findings from the research, and the chapter points to future research directions.

1.5. Summary

This chapter has discussed the rationale for this piece of research, by introducing the difficulties that arise when students participate in team projects in the information systems discipline. The research aims and objectives are given to link in with a conceptual framework for the study. This was followed by an outline of the chapters to be included in this report. The next chapter gives a survey of research methods and provides justification for the methods chosen for this research.

2. RESEARCH METHODS

In the previous introductory chapter, the overall area of this research was outlined, and research questions identified. The aim of this chapter is to relate philosophical principles to the act of conducting research, then to consider how the various research methods have been used for information systems and educational research. Justification for the choices of methods for this investigation will then be described, and the process of the research is outlined.

2.1. Introduction

Beginning with the question: "What is philosophy?" Roger Trigg said

> *"philosophy is crucial in questioning our presuppositions, and for helping us to establish our own beliefs about the nature of the world." (Trigg 2001)*

The Greek origin of the word, philosophy, means a love of wisdom. As we strive to find out more about the world we live in, philosophy describes the act of finding out about and describing the things around us. Philosophy may be said to serve as a framework for understanding our world at different levels, considering different aspects as viewed by the different disciplines, and encourage critical thinking of ours' and others' assumptions.

A researcher's philosophical stance influences the choice of design and methods of the research; ideally, the methods for data analysis and the modes of analysis follow defined stages (Miles and Huberman 1994):

- Identify philosophical stance
- Design the research instrument
- Define methods of data collection
- Choose appropriate modes of analysis

However, the chosen methods of data collection should be appropriate for the context of the research.

An alternative view of research suggests that there are two mains types:

- *"**'pure research'**. This approach is undertaken in order to contribute to abstract, theoretical understanding;*
- ***'instrumentalist research'**. An alternative motivation is to contribute to understanding in order to be able to more effectively act or to 'design interventions' into the environment. Two sub-categories of instrumentalist research need to be distinguished:*
    - ***'applied research'**. This commences with a technology (an artefact, a technique, or both) and uses it in an experimental fashion to intervene into personal, organisational or social processes; and*
    - ***'problem-oriented research'**. This begins with a problem. It experiments with existing technologies and/or prototypes new ones, in an effort to devise a solution (e.g. Zmud 1998)." (Clarke 2000).*

This chapter is divided into sections examining the paradigms of research, the alternative methods of research, data collection approaches and some of the range of research instruments. Within each section an attempt will be made to contrast their application to research into information systems and into education, in order to justify the choices made by the author in this research.

The different philosophical stances researchers may take, follow the paradigms of research, which are discussed in the next section. This is followed by sections on the different methods of research that may be adopted, the tools used for these methods and a section outlining the choices made for this research.

2.2. Paradigms of research methods

Research is to find out about something, so that our knowledge about our world is increased (Crossan 2003). A paradigm is a set of concepts, assumptions, values, and actions that form a way of viewing reality for the discipline that shares them. One outline of the paradigms, from information systems research, is the breakdown into positivist or interpretive research, as shown in Table 2.1. This breakdown makes distinctions between the two poles of research approaches. The ontology is descriptive of the structure and properties of the existing field, as viewed by proponents of the approaches; the realism approach representing the positivist approach, and nominalism (or idealism) representing an interpretive approach. The epistemology

describes assumptions about how knowledge can be derived; a method of enquiry whereby regularity of approach, generalisable methods and following rules is associated with positivism, but methods where researchers seek to find insights into the field of study, which may be applicable to other situations is associated with interpretivism. In Table 2.1, the possible methods reflects the extremes of the approach taken, i.e. whether facts are taken at their face value or the style and general feeling for the domain under investigation is taken to further understanding of the domain. Vidgen's uses the term "human nature" to refer to the ways in which we see aspects of our life, and believe we have control or not over the future.

Approach	**Positivist**	**Interpretivist**
Ontology	Realism	Nominalism
Epistomoligy	Positivism	Anti-positivism
Human nature	Determinism	Voluntarism
Methodology	Nomothetic	Idiographic

Table 2.1 Vidgen's classification of research methods (Galliers, 1992)

In addition to the two poles suggested by Vidgen, above, Guba and Lincoln add critical theory to the accepted positivist and interpretivist approaches, and many information systems researchers advocate these three approaches (positivist, interpretive and critical), but the boundaries may be indistinct in many areas of research (Myers 1997).

Positivist studies aim to generalise to a wider population from the specific; interpretive studies aim to interpret a specific context, whilst critical studies aim to critique the specific. In particular:

> Positivist studies are based on there being relationships between phenomena that can be investigated with structured instruments, and so test theory to gain a deeper understanding of the phenomena.
>
> Interpretive studies rely on the fact that people create subjective meanings themselves as they interact within the world, so researchers are trying to understand the phenomena by the meanings individuals assign to them.

Critical studies try to expose contradictions in social systems, which may be deep seated, and use these to criticise the accepted state.

The positivist approach is given first in the next section, and then other approaches, collectively known as post-positivist are outlined. How these are applied to research in information systems and education is then discussed, and finally the choices made for this research are given.

2.2.1. The Positivist Approach

The traditional positivist research approach is based on a philosophy that assumes things can be studied as hard facts, and any relationships between these facts are based on scientific laws. Determinism implies that all things, including human behaviour, are governed by laws, which dictate the outcome from a given set of circumstances. However, it may not be possible to generalise laws about human behaviour (Ayers 2004). It may only be possible to provide a limited superficial view of the topic.

When applied to social situations, positivism says that humans react to their environment, much like molecules, so by changing the environment we can observe how humans react. Researchers must remain detached from the subject of the investigation, and laws derived may be said to explain human behaviour as cause and effect in particular events (Sanghera 2003). Knowledge enrichment can only be a result of a trial, or experience, known as empiricism. This limits furthering our knowledge to definitive experiments, which may be difficult to perform.

2.2.2. Alternatives to the positivist approach

Critics of the positivist approach argue that human interaction in the real world can not be explained through laws as laid down in the physical sciences, so post-positivist alternatives were proposed (Shaw 1999). This movement was demonstrated by Bronowski and Popper (Crossan 2003), who did not agree with the elementary justifications of positivism. This means that reality is not set in stone, but is a creation of the researcher, depending on the context. So there can be many versions of reality, influenced by culture, gender and beliefs, and their intricate relationships, rather than determinism of outcomes.

Post positivists are looking for evidence that is a sound and valid proof of a phenomenon. From Popper's point of view it is more useful to be able to disprove theories than to verify them. He suggested four stages to research:

1. Formal stage - checking the theory for internal consistency, i.e. there are no logical contradictions;
2. Semi-formal stage - separation of propositions with empirical consequences from those that do not have consequences;
3. Comparison stage - comparing new theories with existing theories, making sure the new theory covers more known facts;
4. Empirical testing stage - testing the hypothesis which is least likely to be true, so if it does turn out to be supported by the evidence, then we have gained something interesting (Crossan 2003).

These stages move closer to proof of a theory, by continually looking for ways the theory might be disproved. If predictions are supported, the theory is corroborated, rather than proved. This theory will hold until it is disproved by facts, or a better theory comes along. But it can be held onto as a best guess, until more knowledge arises (Baskerville 1999). The researcher should test the evidence to the limit, knowing that unobservable data does exist, and may be influencing the behaviour of what we observe. We are unlikely to be able to prove theories based solely on our individual experiences.

Interpretive and critical approaches are based on the premise that human behaviour is not determined by general universal laws with underlying regularities, but people are autonomous and understanding of the social world should be from the viewpoint of the individuals that make up the part of the world under investigation. Individuals and events that happen to them are unique to the situation, so the event is non reducible and not easily generalisable to the wider environment. A reductionist analysis will not be appropriate, but results will be reported as "thick descriptions", i.e. qualitative data rather than quantitative statistical findings (Cohen, Manion et al. 2000).

The interpretive paradigm maintains a concern for the individual, understanding the experience of humans subjectively. A positivist approach would assume that actions are a result of some stimulus, reacting to events in the past, whereas interpretive

approaches concentrate on actions, which are intended to affect the future and shape experiences. Positivist researchers use complex methodologies to validate theories, and try to generalise them, but interpretive researchers start by an understanding of the individual and theory emerges from interpretations of the world around, which may be grounded in any data generated from the research. Interpretivism is a contrast to the positivist approach of checking if something is being "done right", by asking whether we are doing the "right thing" (Mingers 1997). The emphasis is on discovery rather than checking, so meanings, perspectives and understanding within a natural setting are paramount, leading to examination of processes, in order to interpret situations (Woods et al. 1998).

Critical research adds to the interpretive paradigm the aim of social critique, identifying restricting or alienating conditions, which may prevent people from changing their circumstances. The ideas of Habermas influenced some of the early critical researchers, at a time when logical positivism was being proposed (Nissen, Klein et al. 1991). However, it can be argued that all research should aim to improve the subjects' conditions, so critical research is no more than should be sought for interpretive research (Doolin and Lowe 2001).

Positivist research continued to dominate during the last century, particularly in the technical and medical fields. However, the dichotomy between positivist and alternative research approaches has meant that information systems researchers who subscribe to each pole have rarely acknowledged each other. In the education research field, previous studies have concentrated on proving that an intervention is effective in teaching, but more recently there has been acknowledgement that learners as individuals bring various background experiences to their learning, which cannot be easily accounted for in positivist research (Eisenhart and Towne 2003).

2.2.3. Paradigms applied to information systems research

The movement away from positivist research is beginning to shape research within social fields particularly. When conducting research, which has a technical component as well as a social dimension, there is a debate as to whether a positivist approach is appropriate, or whether an interpretive approach could be used to better effect.

Computer science and technology research has followed research into the natural sciences by favouring positivist methods. This process involves applying a sequence of "Observe, Research, Hypothesise, Test and Conclude" over a period of time (Landsberger 2004). After identifying a problem area to research, an observation is objectively noted, along with factors or conditions within the situation. A hypothesis or cause and effect relationship is identified and an experiment devised to test the hypothesis, ideally including a test group and a control group.

In the technology field, where human interaction with computer systems are involved, there is a growing trend against positivist research, because relationships between theory and observation are beginning to be recognised as more complex social systems, with some mechanisms regarded as unobservable (Schrire 2006). The field of information systems research has developed from research concerning technological artefacts, to research concerning human interactions with the technology, and is recognised as separate from computer science research (Checkland and Holwell 1998). As the human interaction necessarily involved becomes the area of interest in research into information systems, both of the philosophical perspectives of positivist and interpretive, have been considered for information systems research (Lee and Baskerville 2003; Palvia and Pinjani 2007). The underlying assumptions of what constitutes "valid" research shaped the choices of research methods and the means of data collection and subsequent analysis. Information systems research is concerned with people and information technology, so whereas the technology may be investigated in a positivist manner, users' interactions are essentially social, and these may not be suitable for investigating in a positivist manner. Research in the field of information systems has to deal with the various users of technical artefacts, within the social context of work, so interpretive approaches are more appropriate, as they lead to a deeper understanding of the interaction of people with technology, rather than proof of hypotheses (Winograd and Flores 1993).

2.2.4. Paradigms applied to educational research

Within the field of education, there was a reaction against the positivist approach to research on the grounds of validity and ethical and political issues, notably Piaget's cognitive theory in children was criticised for its lack of rigour and assumptions he made about children (Montangero and Maurice-Naville 1997). This highlighted the

fact that children may be unable to cooperate fully in a study because of their immature cognitive ability, so calling into doubt the application of positivist methods to educational situations.

An analysis by Eisenhart and Towne (2003), provides an evolution of definitions for "scientifically based " education research, which gives a final set of standards for scientifically based research in the Education Sciences Reform Act of 2002, given in Figure 2.1.

> Applying rigorous, systematic and objective methodology to obtain reliable and valid knowledge relevant to education activities and programs, and presenting findings and making claims that are appropriate and supported by the methods employed;
> Employing systematic, empirical methods that draw on observation or experiment, involving data analysis adequate to support the general findings, using measurements to provide reliable data, claims of causal relationships should be based on random experimentation to eliminate other variable interference, studies presented in sufficient detail to allow for replication, or further investigation, acceptance by a peer reviewed journal or equivalent and using appropriate research designs and methods for the questions posed.

Figure 2.1 Standards laid down by the Education Sciences Reform Act of 2002 (Eisenhart and Towne 2003)

Although rigour and reliability is paramount in the standard, there is, according to their research, much room for qualitative investigations, which consider aspects of the field, which by their nature cannot be scientifically studied, but may lead to further understanding of the variables implicit in the area of investigation (Eisenhart and Towne 2003).

Publication of research into pedagogy within higher education is a comparatively recent development (Barnett 1992), and reflective practice is being encouraged for practitioners in higher education (Brockbank and McGill 1998). This has led to the need to consider which research paradigms are appropriate for research in the higher education field, particularly where new technology is being adopted as an application of information systems in course delivery (Nightingale and O'Neil 1997; Neave 2002).

In the past much research has been concerned with the social implications of education, empowering individuals through learning, rather than investigating the pedagogical approaches to teaching and learning. Educational research broadly falls into four categories: research into learning, such as learning preferences, e.g. (Dixon and Woolhouse 1996), constructivist learning, e.g. (Lester et al. 1998), research into designing programmes of study, e.g. (Toohey 1999) and organisational research, such as teaching partnerships, e.g. (Heffernan and Poole 2005). Alavi and Leidner further suggest that:

> *"There is a paucity of theoretically grounded and rigorous research to guide the development of.. (learning) environments" (Alavi and Leidner 2001).*

Table 2.2, taken from Cohen, Manion et al. (2000), provides a comparison between normative (positivist), interpretive and critical approaches within the context of educational research.

Much research, particularly in higher education, is based on positivist principles, testing a hypothesis for its truth, e.g. (Chickering and Ehrmann 1996). But in many studies sample sizes are small, and there are many external variables that may be playing a part in the results, the findings can often only be said to apply to a specific situation, and extrapolating to a larger population may not possible, e.g. (Eijl et al. 2005). Current research into the applications of IT in supporting learning has more in common with research into information systems, it is suggested that the information systems community can offer much insight into designing learning environments, to help learning (Alavi and Leidner 2001).

	Normative	**Interpretive**	**Critical**
Area of study	*Society and the social system*	*The individual*	*Societies, groups and individuals*
Size of research study	Medium/large scale	Small scale	Small scale
View of behaviour	Impersonal, anonymous forces shape behaviour	Human actions continuously shape social life	Political, ideological factors, power and interests shape behaviour
Model	Natural science, objective	Non-statistical, subjective	Ideology critique, action research, collective
Researcher involvement	Conducted from outside	Personal involvement of the researcher	Participant researchers, researchers and facilitators
Interpretation	Generalising from the specific	Interpreting the specific	Critiquing the specific
Purpose	Explain behaviour, seeking causes	Understanding actions/meanings rather than causes	Understanding, interrogating, critiquing, transforming actions and interests
Acceptance of present	Assuming the "taken for granted"	Investigating the "taken for granted"	Interrogating and critiquing the "taken for granted"
Concepts	Macro: society and institutions, norms, roles, positions, expectations	Micro: individual perspective, personal constructs, negotiated meanings, definitions of situations	Macro and Micro: political and ideological interests, operations of power
Stance	Structuralist	Phenomenologist, symbolic interactionist, ethnomethodologist	Critical theorist, action research, practitioner research
Interest	Technical	Practical	emancipatory

Table 2.0.2 A comparison of the main paradigms for studying behaviour (Cohen, Manion et al. 2000)

2.2.5. Pluralism or multi-methodology

Whilst interpretive researchers may reject positivist research for social systems, such as information systems and education, they acknowledge that there is a place for pluralism or multi-methodology in some studies, so that the rigour of a scientific approach can be tempered by the exploratory findings from an interpretive or critical approach (Mingers 1997).

This position is supported as both possible and desirable by Hirscheiem (Nissen et al. 1991), in particular for educational research (Hmelo-Silver 2003), and there is some evidence of successful multi-paradigm research, by combining quantitative and qualitative methods (Kaplan and Duchon 1988; Bharadwaj 1996). According to Mingers (1997) many believe that it is impossible to research from both paradigmatic stances, because researchers are taking opposite stances and are probably looking at different phenomena, and asking questions for different purposes, and even if looking at the same phenomena, will arrive at different findings. It is more acceptable to combine quantitative and qualitative methods in research, for example as proposed by Jones (2004).

2.2.6. Chosen paradigm

Within the fields of information systems and education positivist approaches have recently given way to interpretive (post-positivist) approaches, with their ability to promote understanding of phenomena, within a specific context, rather than proof of a phenomena and variables leading to an effect. This research is looking at students' reactions to using a software tool to help with their learning, within the context of team working, so, although an information system is the primary artefact to be implemented, it is not the verification of the software that is being investigated, but the ways in which the students used the tool to support a learning activity. Hence the research is an information systems investigation but situated in an educational context.

Whereas a positivist approach could have been taken to verify the implemented information system, this approach might prove its efficacy, but would omit consideration of why and how the tool plays a part in the students' learning. For this

research an interpretive approach was chosen, so that a greater understanding of the ways in which tools are used to support learning, was possible. This research is small scale, looks at individual human actions in a social context, does not employ any statistical analysis, aims to understand meanings rather than cause and effect relationships, and so investigates a "taken for granted" situation in a practical manner, through direct involvement of the researcher. This research is not aiming at any emancipatory outcome, or critique of power relationships, so is not critical research.

Having identified a stance relevant to the context of this research, it is necessary to identify a research strategy capable of eliciting appropriate data, which can be analysed to answer the research questions. In the next section research methods are considered, leading to a choice for this research, followed by tools for obtaining data and analysis, and consideration of quantitative and qualitative methods, with a description of the chosen tools.

2.3. Post-positivist research

Although positivist research has dominated in information systems and education, there are arguments in favour of using interpretive methods for fuller richness and understanding (Galliers 1992). Qualitative research in information systems is typically aligned to interpretive research, such as case study, action research, ethnography, and grounded theory.

Ethnography is based on anthropological fieldwork, where the researcher becomes closely involved with the subjects being studied over a long period of time, and data, so obtained, may be very rich for that setting, and analysis may enable a measure of generalisability (Silverman 2000). Grounded theory is a research method, but called a theory because the researcher should be able to develop theory from the data gathered; it was developed as a reaction to quantitative research methods in the 1960's, and involves systematically verifying a theory as data is collected, rather than starting with a theory to be tested. These methods will not be explored further.

According to Orlikowski et al. (1991) case study research is the most common method of research in information systems. Also action research is a particularly suitable approach for research by practitioners, where close interaction with subjects

is possible. These will be described in the following sections. Other approaches to research, such as critical research, actor-network theory and phenomenology, will not be discussed further, as none of these is to be considered for this research.

2.3.1. Case study research

A case study method involves studying a phenomenon in a real-life situation, often used when research and theory are at an early stage of investigation, and informative descriptions of the phenomenon are required (Bonoma 1985). They are useful for questions of "how?" and "why?", where there is limited control over the environment, and the focus is on events at a particular point in time, to identify patterns or features (Yin 1994:6). In particular, information systems research is concerned with exploring and explaining information systems in an organisational context, concentrating on the social implications rather than technological issues, so a case study is an obvious choice (Benbasat et al. 1987).

Case study is used to contribute to knowledge of individual, group, organisational and other phenomena, and can take a number of forms: theory seeking, theory testing, story telling, picture drawing or evaluative case studies (Bassey 1999). It is commonly used in the social sciences and in education, as well as information systems.

Case studies involve multiple sources of data, so results are often found from triangulation of data. For example the study by Kaplan and Duchon (1988) combined qualitative and quantitative methods in a case study investigation.

In carrying out case study research a general strategy for analysis is suggested at the outset. This might be:

- Following a theoretical proposition that led to the case study, to answer how and why questions and lead to alternative explanation to be discussed;
- Thinking about rival explanations, resulting from other influences, and discussing these;
- Developing a case description, which might highlight relevant causal links to discuss (Yin 1994:21).

Selecting a case for investigation depends upon the type of investigation, paradigmatic viewpoint of the researcher and availability of subjects (Saunders et al. 2003:139), or a case study might be used in combination with other methods. Although selecting a confined case to study may limit the generalisability of any findings, post-positivists are more interested in forming theories, so the exploratory nature of case study makes it a suitable interpretive method. Findings from a case study are bounded within a specific context, for example the paper by Markus (1983) demonstrates the importance of context on an investigation. But putting a boundary around the context does not preclude proposing a form a generalisation from the findings, such as:

> "*In some cases it may be found that…"* (Bassey 1999:12)

The approach adopted for case study research can be just as rigorous as other methods, because it includes stages of identifying the questions to be asked, stating any propositions, considering units of analysis to provide boundaries, linking the data to the propositions and identifying criteria by which the findings will be evaluated (Yin 1994:20). There are four strategies for case study: single case or multiple case and holistic case or embedded case. Whereas multiple cases are used to establish whether the findings of one case are relevant to other cases, single case research is used where this particular case has some unique quality about it, which is of interest to the wider community as well as the researcher. A case study is holistic if it is looking at the organisation as a whole, but is embedded if it is concerned with a particular sub section of the organisation (Saunders et al. 2003:140).

Case studies may be subjected to the same criteria as other forms of research for determining the quality of the end result, validity and reliability. Indeed four tests for evaluation are advocated by Yin (1994): construct validity, internal validity, external validity and reliability. Construct validity has been criticised because it is difficult in case study to establish criteria for testing results, and data collection may be subjective. Construct validity can only be applied if it is possible to select specific changes to measure, and to demonstrate that these measures do reflect any changes observed. Internal validity is shown if there is "*a coherent and illuminating description of and perspective on a situation that is consistent with detailed study of that situation"* (Schofield 2000:71). In case study there is a need to take care with

making inferences, as there may not be sufficient data to state facts, so cause and effect cannot be stated. Yin suggests eliminating all rival explanations, in order to be left with those inferences remaining. Internal validity indicates the extent to which the interpretation of the researcher is consistent with the findings (Yin 1994:34).

External validity is more widely discussed in terms of whether the findings are generalisable to a wider population, from the particular case being studied. Critics say that a single case cannot be generalised, but critics are often relying on analytical (or statistical) generalisation, where particular results generalised to a broader theory. Bassey (1999), on the other hand, talks about "fuzzy generalisations", which gives an outcome along the lines *"it is possible, it is likely or unlikely that findings from a particular case will be found in similar situations elsewhere".* Reliability is a measure of whether later studies would generate the same results as the case study, showing that there are minimal errors or bias in the methods used by the researcher.

Klein and Myers (1999) advocated case study as a form of interpretive research and suggested a set of principles for evaluating a case study investigation:

1. The fundamental principle of the hermeneutic cycle – switching between an holistic and partial view;
2. The principle of contextualisation – the importance of the context of the situation under investigation;
3. The principle of interaction between the researchers and the subjects – social construction of data between researchers and subjects;
4. The principle of abstraction and generalisation – interpretation of the details of the research to general concepts;
5. The principle of dialogical reasoning – awareness of contradiction between theory and actual findings;
6. The principle of multiple interpretations – sensitivity to different interpretations of data;
7. The principle of suspicion – awareness of possible bias or distortions in the subjects' narratives.

On closer inspection, these do correlate with the four tests for evaluation of case study, suggested by Yin (1994).

Critics of case study research point to possible bias as researchers interpret the data in their own way, and consider this research as only an exploratory part of other research methods, such as field studies. But within limited domains, and with structured interviews, researchers can gather much reliable data pertinent to specific research objectives. Even though case studies may not be generalisable in a scientific sense, they can be used to add to experience of a domain, and improve our understanding of the context under investigation (Stake 2000).

2.3.2. Action Research

Action research is informed by a variety of intellectual traditions, and rests in an interpretive philosophical framework. The seminal work of Kurt Lewin (1946), Carr and Kemmis (1986) and Reason and Rowan (1981) gave rise to action research as an accepted method in the post war years, though it fell out of favour in the 1960's. Since the 1970's action research has once again been accepted in research, particularly as applied to information systems and education especially as the daily work of practitioners, e.g. teachers, involves face to face contact with community groups. This interaction may provide opportunities to acquire insights into social worlds, and to help in formulating effective solutions to problems in their lives. Action research methods are clinical in nature, and encourage the researcher to take the role of helping the organisation under investigation, and have become established as a primary methodology in organisational development (Baskerville and Wood-Harper 1998).

Action research is now being accepted in educational research as well as IS research, as it combines action learning and reflecting on and in practice (Stringer 1996; Mumford 2001). One application of using action research is in educational practice, as a reflective tool for practitioner researchers (Atweh et al. 1998). Another aspect is its use in IS research, for systems development, such as the critical perspective advocated in (Baskerville and Wood-Harper 1996).

Action research may be regarded as a model for and a process for research (Akdere 2003). In action research the methodology as a model should provide rich knowledge about a framework of linked ideas, in the context of an application area, following a methodology, which helps people in that situation to bring about change as an improvement, Figure 2.2 (Checkland 1991). As a process it is based on a cycle of

systematically getting data, analysing it, feeding the results back in and evaluating in an iterative process. The researcher has a process to follow, which involves close liaison with the subjects being studied, using multiple cycles of change and reporting, to improve the situation for the research group. Again it is necessary for careful interpretation, if the findings are to be generalisable (Avison et al. 2001).

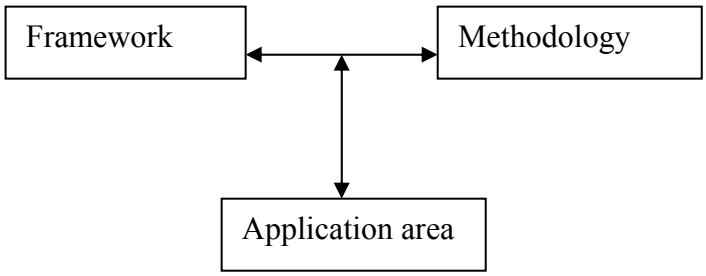


Figure 2.0.2 Relational model of action research

In the context of education or information systems research, there are different formats that action research can take: technical, practical and emancipatory (Zuber-Skerritt 1992), indicating the aims of the research. Emancipatory action research is particularly linked to critical social research, one of the aims being to free the participants from perceived constraints of their existing social order (Carr and Kemmis 1986). Technical and practical action research places more emphasis on effectiveness or efficiency of an educational practice, together with an understanding of the practice and practitioner development (Zuber-Skerritt 1992).

Action research is characterised by a cycle of Plan, Act, Observe, Reflect, repeated a number of times (Zuber-Skerritt 1992), or of Diagnosing, Action planning, Action taking, Evaluating, Specified learning, partly cyclic and partly influenced by a Waterfall systems development lifecycle (Baskerville and Wood-Harper 1996).

Cummings and Worley's model of action research has the following steps:

Problem identification;

Consultation with a behavioural science expert;

Data gathering and preliminary diagnosis;

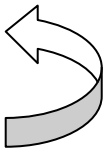
Feedback to client;

Joint diagnosis of a problem;

Joint action planning;

Action;

Data gathering after action.



Iteration

The main characteristics of action research are:

Collaboration through participation with subjects;

Building up knowledge

Helping social change in the situation being studied;

Contributing to empowerment of subjects.

In action research there are two outcomes: solving a real world problem, and learning about the situation (Oates 2006), so action research accomplishes more than simply prototyping a proposed system, because knowledge about the situation is gained whilst considering the implications of the system in use.

2.3.5. The chosen approach

In choosing a method for this investigation, action research was a possibility because a proposed software system is to be tested with students, using cycles of prototyping, and at the same time eliciting an understanding of the interactions between students as they use it. However, the researcher is not participating with the students in their learning, so it would not be regarded as true action research, and the intention is not to change the social system under investigation, but to observe it. The cycles of steps used in action research have however been used to drive the prototyping, data collection and intervention design steps.

Information systems research has further considered the application of computer artefacts within business and social contexts. The recent trend has been towards interpretive methods to identify theories relevant to the social situation, using critical

or actor network theory research methods. Much of the current research is into new artefacts, within a business context, which often cannot be compared to previous working practices, so developing new theory is appropriate.

The application of technology, as an information system, to higher education, cuts across IS and education research. The difficulty is choosing an appropriate method that will give plausible results, without losing the richness from the debate on the impact of the technology upon social systems.

Educational research has been rooted in studying the social context of learning, and in the past research has been dominated by positivist methods, attempting to prove given theories, aimed at improving the social lot of learners, or empowerment. Even today many research papers consist of statistical data analysis in order to prove a causal relationship. But the pedagogical reasons for particular teaching methods are now becoming more important in improving the experiences of learners, particularly in post-compulsory education, and by taking a more interpretive stance, greater insight may be gained through interpretive studies (Hammersley 1993).

Since this investigation is to be carried out in a particular environment, and context, and the proposed intervention of a tool is to be applied in a particular learning context, a case study research approach has been chosen as the most appropriate method to adopt. Some recent studies in higher education have been based on case study research, for example the study by Issroff and Scanlon (2002) on introducing technology for discussion with students, uses a case study method to draw out the student perspective, online teams for learning were investigated by Johnson et al. (2002) with a case study, and a case study involving several schools and teachers was successfully used to investigate the design of learning activities to foster collaborative activity (Lakkala et al. 2005).

Of the main interpretive approaches that may be adopted, case study was chosen for this research, because it would enable the researcher to investigate the phenomenon in close detail, but from an outsider perspective, whilst retaining a clear boundary within which the planned interventions could be observed. Case study typically generates considerable data about the situation under investigation, and the next section looks at

possible means of obtaining the most relevant data to answer the research questions, and how this data may be analysed and interpreted.

2.4. Research instruments and Interpreting data

In carrying out research various instruments and tools can be used to gather and interpret data, in order to formulate findings. In this section the different tools are examined, to justify the choices of tools used for this research. Collecting data and analysing it to formulate and verify a hypothesis are important stages in any investigation. Researchers typically favour different methods depending upon their philosophical stance. Quantitative or qualitative methods may be the preferred choice of positivists or post-positivists respectively, but as will be explained in a later section, both quantitative and qualitative methods may be applicable to investigations concerning information systems and education, a point made by this quote from Fielding and Schreier:

> *The philosophical perspective determines the appropriate method of research, positivists preferring quantitative methods, post positivists preferring qualitative methods. The research method is a strategy of inquiry leading to choices of research design and data collection. There is said to be a dichotomy of qualitative or quantitative methods, reflecting the polar extremes between a positivist or post-positivist paradigm, but the distinction is blurring between using any one specifically for a particular paradigm (Fielding and Schreier 2001).*

In all research validity and reliability are important, validity is the extent to which the results can be trusted to have measured what they were supposed to measure, whereas reliability is the extent to which repeated experiments will produce the same results. A positivist view is that validity means a result is indeed accurate, and some would advocate that only quantitative results could be regarded as valid (Maxwell 1996). But in the context of interpretive research, validity is taken to mean that data was elicited through honest, deep, rich and appropriately scoped methods (Cohen et al. 2000). Although positivist research may ensure reliability through methods that are repeatable and giving the same results (Williams 2003), reliability of interpretive research through replicability is unlikely to be possible, because situations under

investigation are often unique, and subject to change, meaning that the original conditions may never occur again.

The aim of interpretive research is to produce findings that have been honestly arrived at and plausible, in the particular situation investigated. In many cases both qualitative and quantitative methods of data collection are employed, and triangulation of data used to offer different perspectives on the results, in order to provide a measure of reliability to the findings. In the following section different means of gathering data are explained, finishing off with a description of the tools to be used for this research.

2.4.1. Qualitative or quantitative methods

Although qualitative and quantitative methods are associated with the different paradigms for research, many of the tools for gathering data may be used for obtaining either type of data. Choices of methods to use for research depend upon the field of research, as well as the underlying paradigm. The researcher must be aware that different methods inherently bring assumptions and these have implications for their use. The main objective is that a method should be appropriate for helping to provide a good understanding of the particular area of the research. A variety of methods may be employed, each for providing different forms of evidence for a particular facet of the area under investigation (Flood and Jackson 1991).

Quantitative research is concerned with deriving facts, originating from the natural sciences, based on mathematics and statistics, analysis uses statistical methods to give a result that has a prescribed degree of correlation between variables. When results are derived from a representative sample of the population, the effect is said to be applicable to the whole population. On the other hand, qualitative research is concerned with deriving meaning, the how and why of effects, which may not necessarily result in findings that can be extrapolated more widely to the whole population (Brown and Dowling 1998).

Positivist research in education and information systems typically takes the form of experiments or quasi-experiments, either in the field or in laboratory settings. Experimental research relies on the control and manipulation of variables enabling the effects or differences to be measured. This represents a cause and effect model used in

the natural sciences. The main difficulty with this approach is being able to isolate the dependent variables (Bright 1991). Quasi-experiments are in the "field", so experiments are in the working or learning environment, rather than in a laboratory. This overcomes the bias of choosing particular subjects for the experiments. However, there are ethical considerations in experimenting with subjects as they work, particularly if a control group are deprived of a facility that disadvantages them (Robson 1993).

One feature of the positivist approach is that results are empirical and that the procedures clearly state how results were arrived at and would enable another scientist to follow them and, hopefully, arrive at the same conclusions, i.e. validity (Crossan 2003). Whereas positivist experimental findings may be reproducible in the laboratory, it is less likely that experiments in real life situations will be reproducible, as variables that cannot be controlled may play a part.

The debate is whether we should search for results in the laboratory or in the field, i.e. in strictly controlled conditions or in the day to day workplace, and this centres on the validity and reliability of the research. In the laboratory the variables can be controlled, but the environment is not natural, so dealing with human subjects in a laboratory setting may not be realistic. The alternative of field experimentation will not yield quantitative results free from extraneous variables, but the findings may provide qualitative data, which can make the research more relevant. The context within which the experiments take place is also important, it may not be possible to extrapolate the results to a different context, and much of the research into team working has been based on teams of students in the college setting, assuming that findings there are applicable to the business setting, e.g. (Alavi 1994; Gatlin-Watts et al. 2007).

Research concerning new technology has been rooted in the positivist paradigm, e.g. Jones and Marsh's investigation of trust development using computer supported collaborative working (Jones and Marsh 1997). Computing artefacts have been proved to "work" satisfactorily according to technical specifications using quantitative methods. Only recently has the effect upon users of these systems been considered, spawning the area of study of Human Computer Interaction and refining information

systems development methods (Bellotti and Blandford 1996; Agre 1997; Alm 2003). Within IS research Kaplan and Duchon (1988) advocate a move from quantitative to more qualitative methods, although positivism might be regarded by some as superior (Fitzgerald and Howcroft 1998), because it is more readily verified.

There are examples of positivist educational research, although mainly in schools, which use quantitative methods almost exclusively (Gomm and Woods 1993; Paulus 2005), or a study into group working, which is quantitative (Bahli and Buyukkurt 2005). Brown and Dowling (1998) suggest that educational research should be reflexive and interrogative, and suggest "3 R's" of educational research: Reading, Processing and Writing. Their work is essentially positivist, following quantitative methods. However, a combination of quantitative and qualitative was used for a study in the HE sector on building online learning communities (Hill and Raven 2000). The issue of using solely quantitative methods in educational research is now being questioned, e.g. by Eisenhart and Towne (2003).

A post positivist approach can use quantitative and qualitative methods, sometimes called critical multiplism, being rigorous, precise, logically reasoned and supported by evidence, but not just what can be observed (Shaw 1999). Multiple perspectives help define goals and research questions, define methods and analytical techniques and interpret results (Fielding and Schreier 2001). There are now several studies where positivist research has been applied to operationalise the variables, then interpretive methods used to consider the variables in context, e.g. (Schrire 2006), so combining quantitative and qualitative methods is now acceptable research practice.

Surveys, questionnaires, interviews, focus groups, and observation can have a quantitative and qualitative component, and may be used for any data gathering activity. Whereas quantitative methods do play a part in some social research, such as market research, they are of limited use where the sample size is small, as is often the case in information systems or educational research. The results of quantitative questionnaires may not truly represent the whole population if one were to try to extrapolate the results. However, the results from such questionnaires may provide useful information, when combined with other means of collecting data as in

triangulation, which is explained in section 2.4.3. The tools for gathering data that were considered for this research and their features are outlined in the next sections.

2.4.2. Questionnaires, interviews and focus groups

Interpretive research relies on data collection, to provide facts and rich meanings for the situation under investigation. Survey tools are used to gather information from people about their knowledge, attitudes and opinions on a topic. Although a survey is associated with quantitative data, survey tools can be designed with a qualitative element, so can be used for interpretive research, such as case study, depending upon the type of data to be collected. The process of using survey tools requires a clear outline of the objectives of the survey, designing the instrument, administering it, then managing and analysis of the data, to provide results that are reliable and valid. Survey tools include questionnaires and interviews, consisting of closed and open questions, a review of written, oral or visual records, observation in an experimental situation or focus groups (Fink 2003). An outline of the tools used for this research is given next, followed by justification for those chosen.

Questionnaires

Questionnaires are usually paper based or electronic and distributed to a target audience en masse. Usually self-administered, respondents answer the questions and return the completed questionnaire to the researcher. Response rates may be low, and this may result in some bias, as for example only interested respondents complete and return the document. Within a questionnaire, a variety of question types may be incorporated, such as nominal, ordinal or numeric, and their choice depend upon the data sought. Closed questions ask for a response from predetermined choices, whereas open questions enable the respondent to state views in their own words, whether they write the responses themselves or the interviewer writes the responses down.

When used in social science research, questionnaires may be descriptive or relational, i.e. finding out about a situation or comparing variables in a situation (Bright 1991). After conducting the questionnaire, responses from closed questions may be analysed statistically, to prove the hypothesis, or responses to open questions may be analysed textually, to provide rich data supporting different views. The design of appropriate questions is important, if results are to have a bearing on the research questions, and

to prevent interviewer bias (Oates 2006:221). The questions must be understandable because the researcher will not be available to explain or prompt.

If requiring quantitative data the selection of an appropriate sample of respondents is important. The sample is a proportion of the relevant population, which is assumed to be representative of the entire population. Often a convenience sample is taken, respondents who are readily available, and these may not be representative. When using the data for qualitative purposes rather than quantitative purposes, it is more important that the sample of respondents chosen are able to provide a wide variety of reflective feedback, covering the relevant issues, than truly represent the population as a whole.

Interviews

Interviews are a form of survey, usually carried out face to face, by the researcher, or agent, asking respondents for answers to set questions, and recording the responses. Although the main purpose of an interview is to ask open questions, where respondents are given the opportunity to respond in any way that they choose, closed questions are used to obtain factual data from respondents, for example to ascertain the typical ages of respondents. Open questions, when asked with an open mind and encouraging the respondent, can give very detailed opinions, contributing to interpretive research. There are two types of interview: standardised, such as used for market research purposes and exploratory, used to gain insight into the topic (Oppenheim 1992). The essence of an interview is to understand the experience of respondents and the meaning they make of it (Seidman 1998). Interviews have had to be face to face in the past, but telephone or video conference interviews are also possible. An interview may be to individuals, but also group interviews are possible, when the views of the whole group are sought.

A semi-structured interview allows the respondents to elaborate on ideas and provide more detail in response to open questions. However, the researcher conducting the interview needs to take care not to influence the respondent and introduce bias, or to allow their professional role, their age, gender or culture to affect respondents' willingness to provide open answers (Oates 2006:188).

Focus groups

The use of focus groups has a long history in market research, for obtaining opinions from a number of people in a cost effective manner (Morgan and Kreuger 1993). They are a means of enabling organised discussion, as a collective activity, where the resulting opinions are based on interaction within the group, so that triggers from individuals may spark comments by others (Kitzinger 1994; Powell et al. 1996). A group of individuals are selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research, also known as a discussion group (Flick 2006). It is a form of interviewing, but instead of using set questions, there is an open style of eliciting statements, through prompting from the facilitator and the respondents themselves. The idea is to draw upon the respondents' attitudes, feelings, beliefs, experiences and reactions to the topic, and elicit a multiplicity of views and emotions. Focus groups are particularly useful when there are power differences between the participants and decision makers or other professionals, or when one wants to explore the degree of consensus on a given topic (Morgan and Kreuger 1993).

Drawbacks of using focus groups include possible bias from the facilitator, who may pose leading questions, or in a way that begs a specific answer. Provided the facilitator is not the researcher this can be avoided, but the facilitator must know sufficient about the research topic to prompt for more detailed comments. In some cases a facilitator is not necessary if the dynamics of the group are trusted, as the group interact to correct views that are not socially shared or correct, so statements are validated by the group (Flick 2006:190). Focus groups, where members are self-selected, are more likely to be comprised of people who are interested in the topic, than a representative sample, but again it is more important that respondents are articulate, and able to provide comments on a wide range of issues. Data from these will provide insight into a range of issues, but not the extent of the issues, which would have to be derived quantitatively. However, the ability for individuals to react to others provides for richer feedback than could be achieved through an individual interview (Williams 2003). Errors in recording, transcribing and interpreting the comments made in a focus group session are possible. Even when tape recordings are taken of a session, utterances from respondents may be brief, and not in complete sentences, leading to misinterpretation by the researcher (Silverman 2000:187).

2.4.3. Triangulation

Triangulation is a term borrowed from geometry, where a point can be positioned by reference to three other points. In the same way the interpretation of a research project may be positioned by reference to three (or more) sources of data, although Brown suggests that this is likely to result in incoherent results, as it will lead back to the original problem (Brown and Dowling 1998). Any claims made from the research must be justifiable in the empirical setting of the research, considering the preconceptions and biases inherent in the research. So we need to consider whether triangulation might be appropriate in the educational technology setting. Bonoma (1985) suggests that collecting data using different methods will give a variety of types of data covering a wider range, which may increase the robustness of the research. The different forms of data will also provide a richer, contextual basis for interpretation, giving cross validation (Kaplan and Duchon 1988).

In both positivist and post-positivist approaches triangulation of results may be used to confirm findings from a different perspective. Using several methods, such as questionnaire and focus group, may add colour to the results, makes for more validity, with the associated rigour that positivists desire. Similarly using several methods to view interpretive findings will provide more evidence for findings (Fielding and Schreier 2001). It is often useful where there are several research questions or to improve the reliability of qualitative findings. Silverman (2000) urges caution in using triangulation, because social reality is constructed in different ways, and the different tools may only be applicable to a particular perspective (Fielding and Schreier 2001).

When participative methods are involved, the researcher becomes too close to the problem, bringing in anecdotal evidence and bias and leading to a lack of reproducible results, also results are often not generalisable (Crossan 2003). So triangulation with other data collection methods will add validity to the results. However, some researchers argue that there are limits to the extent of possible interchangability (Nissen et al. 1991). Cupchick sees the two strategies as inter-related, quantitative research used to identify relevant processes, and qualitative research allowing for the "thick description" of them (Fielding and Schreier 2001).

2.4.4. Chosen research instruments

Within the iterative cycles of testing the prototype system, questionnaires comprising closed and open questions were chosen to give some quantitative data, which could be used to give an indication of the usefulness of the system, together with some qualitative data in the form of feedback on the students' perceptions of its usefulness. Interviews and focus groups were also used to provide qualitative data, to build up a picture of the situation being studied, to what extent and why the system affected the students' performance. By using triangulation a richer picture of the situation would be achieved, with individual responses from students supporting other statements to give a fuller understanding of this particular case.

2.4.5. Analysing and interpreting data

Quantitative data can be analysed by counting occurrences of a response, and if the sample is large enough, calculate statistical significance of the result. But qualitative data consists principally of words, which although certain words could be counted, this would not provide a result with any significance. Methods for analysing textual data may be subject to different interpretations by individual researchers, but rigorous handling of this data can ensure the findings are reliable (Silverman 2000). The qualitative data gained in a case study research activity is textual, so analysis can be dependent upon the researcher's questions, and may be subject to bias due to the researcher's perspective. The essence is to present the data in an imaginative manner using some form of data display that clearly shows the reader the purpose of the data (Miles and Huberman 1994:79).

According to Oates (2006), after carefully recording the origin of each item of data, analysis of qualitative data should begin with reading through the data to separate out textual comments with no apparent relevance, general descriptive comments and the comments that seem to be most relevant. The relevant comments may partly support existing theories, derived from the literature (deductive approach), or may provide new ideas (inductive approach). These comments can be analysed by putting into a table, where themes and interconnections may be identified. Finally, the researcher attempts to explain the patterns, looking also for contradicting evidence.

Case study research can be analysed in several ways, to enhance the external and internal validity of the research: pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis. Pattern matching is based upon comparing the findings with predicted findings, and so identifying threats to validity, which leads to repeated comparisons. Building an explanation about a case helps to identify causal links, and this can be an iterative process. Time series analysis and logic models are used for studies where time or sequence is significant to the investigation, comparing the past with the outcome of the research (Yin 1994:122). These last two methods of analysis are not appropriate in this case, because at each iteration a new set of students are involved, there is no element of the participants changing sequentially. Explanation building appears to be the most suitable for this research, because the analysis carried out from each iteration of the prototyping helps to guide the next cycle of testing, and build up the rich description of the why? and how? of the case. As Miles and Huberman (1994) suggest, there are no prescribed methods for analysing qualitative data, but the outcome should be plausible.

The suggested method of analysis provided by Oates (2006) was followed. Starting with reading through the data, and separating out textual comments with no apparent relevance, and general descriptive comments from the comments that seemed to be most relevant. The relevant comments were compared with issues that had been identified from the literature review and grouped together, other comments were grouped into themes relating to implementation, to directly address the research questions, and any remaining themes were grouped together as providing additional interesting information.

2.5. The researcher's stance

The researcher's intention was to carry out interpretive research, following a post-positivist stance. Case study research was chosen as the most appropriate research method, because this interpretive method would enable the researcher to gain a deeper understanding of student team project work, within the bounds of a particular instance of team working. This research was based on designing and implementing an artefact to help students with their team project work, so it was an evaluative and exploratory case study. The method chosen for design and implementation was prototyping, because the requirements of the users were not clear at the outset, these would be

refined as the research progresses. Although it was a case study, the cycle of interventions was borrowed from action research to inform the prototyping method for developing, implementing and testing an information system for use with students. Qualitative and quantitative data collection tools, including questionnaires, interviews and focus groups were used to gather data, and this was interpreted through themes that emerged from the data.

2.6. The process of this research

In this section an outline of the procedure followed in this research is given. The broad problem area to be investigated was provided in Chapter 1: to investigate the application of a software tool to help co-located students to get started on their team project work. The research started with an investigation of the relevant literature to:

- Investigate the part played by student team projects in developing team working skills;
- Identify issues of student team working in higher education;
- Compare these issues with the team issues reported for organisational teams;
- Find out the part played by allocating tasks and agreeing ground rules in co-located teams.

From this literature review, issues of team project working that arise in organisational settings were identified, and compared with issues that have been identified in student team working in higher education. In particular the impact of task allocation and agreeing ground rules were highlighted.

A case study was chosen, described in detail in Chapter 4, of students undertaking co-located team projects in the information systems discipline. Particular issues concerned with the maintenance roles and getting started on the team project that have already been raised were identified, from analysis of some documented reports associated with the team projects of this case. This stage is followed by an evaluation of software and technology available for supporting students in their team project work, including software aimed at organisational team working and software provided for students in higher education. Intelligent systems and agent-based software were considered, to determine whether any of these might be adaptable or offer a partial solution to the issues of team working identified.

A software system for automating the process of allocating tasks and agreeing ground rules, was developed and implemented, using an incremental prototyping method, adding additional functionality and content at each iteration of prototyping. The prototypes were tested, in a series of cycles, with the student teams form the chosen case. This testing was to:

- Identify changes to the current implementation that can be incorporated into the next prototype;
- Evaluate the suitability of the pre-programmed content in each version of the system.

After completing the cycles of prototyping, analysis of the research findings were used to find out:

- In what ways does output from the automated system to allocate tasks and agree ground rules helps students to get started on their team project work, and impact upon relationships between students?
- How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working, and how suitable is the software perceived to be for online student teams?
- Which other functions could be incorporated into a support system that would help students with their team project work?

In this way the overall research question was addressed:

- How useful is online software support in the first stages of co-located student team project working?

So the system was evaluated in terms of usability, helpfulness and potential as a tool to help with getting started on a project for co-located student teams, and the research evaluated how students used the output from the system, how useful this was, and why students behaved in the ways they did in this case.

2.6.1. Methods adopted for this research

As stated previously, iterative cycles of prototyping were employed to test and modify the software support system, with students from the case study. These students were studying the same module, Team Project, but were drawn from three different years of

three different undergraduate degree programmes: Business Information Technology, Business Information Systems and E-Commerce. Further details of the case are given in Chapter 4. At the same time feedback from students was gathered to provide answers to the research questions posed. It is important for methods used to be reliable, so that readers may be assured that the results obtained represent the true picture, and so that any researchers in the future may carry out identical studies and obtain the same results. Although it is difficult to reproduce qualitative studies identically, efforts can be made to minimise variations in participants, interviewer technique and potential bias, to maximise reliability (Silverman 2000). In this section the methods adopted for this research are introduced to indicate how attempts were made to ensure a degree of reliability. In Chapter 5 (beginning on page 109), where the cycles of prototyping are described, there is a fuller description of the specific data collection methods employed for each cycle of prototyping.

As suggested by Silverman, generalisability from a case study may be achieved through using qualitative research methods, combined with quantitative measures, with appropriate sampling techniques, and careful analysis to tease out structures in basic social order (Silverman 2000:102). The aim of this research was to test the usage of the artefact with a sample of students, in order to generalise to a wider population, and to identify factors affecting their performance.

Questionnaires, focus groups and interviews were used to gather feedback from the students. The questionnaire (Appendix 3) was used for each cycle of the prototyping, as a primary means of gathering feedback from as many as possible of the students involved in the testing, to discover views of the concept of an agent system as well as their opinions of its functionality. It was designed with both open and closed questions. Closed questions were used to ascertain its usefulness, whether the interface was easy to use and self-explanatory, and whether respondents thought that this sort of system would be useful for online students as well as co-located students. Open questions were used to enable the respondents to provide more details, such as suggestions for additions, changes or other functions the system could provide. There was also an opportunity to report difficulties they have observed in team project working (Appendix 3 includes the two versions of the questionnaire used). This questionnaire was administered over a two-week period, immediately after the teams

had completed their use of the output from the system, which took about three weeks. The questionnaire was designed to provide quantitative data upon which decisions on continuing with the research could be taken, as well as qualitative responses to enable the researcher to elicit how these students used the system.

After students had used the first prototype system, a focus group session was conducted. This was timed for after the output from the system had been used, because feedback from all of the students was important to gauge the success of the system, and to elicit suggestions and opinions from the team members. A mixture of team leaders and team members participated in the focus group, thus providing a balanced view of the system. A focus group is a useful way to promote discussion between the participants, whereby ideas from one member may trigger suggestions from another. The researcher attended the session to type the comments from students as the session progressed, but the facilitator, who was an experienced colleague, was able to conduct the session in a manner that was free of researcher bias. A similar focus group session was held after the first trial of the final version of the prototype, and on this occasion the focus group session was tape recorded, and transcribed within a week by the researcher. The researcher was present in the second session, and a different facilitator conducted this session, and who was briefed on the purpose beforehand. Although the presence of the researcher, who was also a team tutor, may have prevented the kind of open discussion required, the researcher was present for practical reasons, and it was thought not to limit useful discussion, which can be a criticism of the focus group technique (Oates 2006).

Starting from the second prototype system, interviews were used as a means of gathering more detailed feedback on how the students used the system, from the perspective of students who took the role of team leaders. There were no interviews carried out after students had used the first prototype system, because it was apparent that the implementation and interface had provided some difficulties, which prevented the students from using the system to its full potential. Apart from the first two questions that were to ascertain whether the team had actually used the system, and whether it was successful, the interview script consisted of open questions, to enable the respondents to provide as much detail as possible to justify their responses. The researcher's experience and ability to probe for further elaboration of points made was

useful, and given as justification for the researcher conducting all of the interviews herself, even though there is a possibility of researcher bias in the manner in which questions are asked, and responses interpreted. The interviews were conducted after the teams had been able to make use of the output from the system in their team working, and were carried out, by appointment, at mutually convenient times in rooms near to the team working areas.

The following table (Table 2.3) summarises the student teams from the case study involved with the research, the stages of their projects that questionnaires were administered, when interviews with team leaders were completed and when the focus groups were held. The cycles of prototyping comprised three different versions of the student support system, with the final version being tested for a second year with different student teams.

Year of trial	**2002**	**2003**	**2004**	**2005**
Programming language used	Version 1, coded in Prolog	Version 2, coded in Java + MySQL	Version 3, coded in PHP + MySQL	Version 3, coded in PHP + MySQL
Delivery method	Internal network	Intranet	Online	Online
Number of teams using it	7 2 of these Sem 2	7	7 in Sem 1 5 of these Sem 2	10
Total number of teams	29	28	24	22
Interviews with team leaders and dates	No interviews	Nov and Dec 2003 Team 20 Team 1 Team 10 Team 5 Team 21 Team 9 Team 27	Nov and Dec 2004 Team 13 Team 15 Team 17 Team 7 Team 9 Team 2 Team 8	Nov and Dec 2005 Team 10 Team 14 Team 9 Team 11 Team 2 Team 13 Team 5
Questionnaires to all team members returned and dates	36 from 7 teams in Sem 1 (Weeks 4 and 5) 14 from 2 teams in Sem 2 (Weeks 4 and 5)	22 from 4 teams in Sem 1 (Weeks 4 and 5)	12 from 3 teams in Sem 1 (Weeks 4 and 5)	35 from 5 teams in Sem 1 (Weeks 4 and 5)
Date of focus group and number of students present	Oct 2002 (Week 6) 8 students	No focus group	March 2005 (Week 15) 9 students	No focus group

Table 2.0.3. Summary of research tools used for the cycles of prototyping

It should be noted that the team projects are run over a full academic year, from the end of September to the end of April. Although the system was used at the getting started stage of the team projects in the first weeks of the projects in Semester 1, some

teams chose to use the system again at the beginning of the second semester in February, because their project had changed in scope or their team membership had changed.

2.6.2. Analysis of data

In this research the data obtained from the questionnaires included some quantitative and some qualitative data. To analyse the quantitative data, occurrences of various responses were counted and entered onto a spreadsheet. This data was used to give the researcher a feeling for the extent of satisfaction with aspects of the system being tested, rather than to provide statistical significance measures, so the limited sample size was not important.

The qualitative data from the questionnaires were analysed in accordance with the methods suggested by Oates (2006), and full details of the methods used to analyse the data is given in Appendix 4. In the first instance the comments related to each question were extracting from each questionnaire returned, and put together on a spreadsheet, first in teams, and then sorted by version of the prototype. These were then copied and pasted into a Word document, showing the questionnaire comments sorted by question. Responses to the final question asked about difficulties in team working the students observed, were further divided into those associated with the maintenance roles and those associated with the task roles of team working, as identified from the literature. Appendix 5 gives a table showing the sorted responses.

The interview transcripts were analysed firstly by question, retaining a common structure for all of the interviews, by copying and pasting into a new Word document. Next the comments were separated out according to a number of the issues identified from the literature search, such as team cohesion, culture and skills development, which were related to the getting started stage of the projects and their relationships (first research question), e.g. *"See all gradings for everyone. So if low mark can put with more confident person"*. Other comments were divided into those related to task allocation or ground rules, which were the functions specifically tested for (second research question), e.g. *"Ground rules used to establish a contract"*. Also comments relating to the interface, instructions on using the system and its future potential were separated out (third research question), e.g. *"more awareness, needed guidance and a*

lecture to introduce it". All of the comments were coded to a theme and entered onto a table listing all of the themes and all of the comments from each year of the trial (Appendix 6).

The comments from the focus groups were treated in a similar manner, coding all comments from the transcripts according to themes identified from the literature, those relating to task allocation and ground rules, and those concerned with the interface and implementation, and these were entered onto a table where the comments from both focus groups were put side by side (Appendix 7).

When discussing the findings in Chapters 6 and 7, it was found useful to bring the comments on particular themes together on one page. Each comment is unique, but it was possible to identify issues that were commented on more frequently than others. In this way descriptions and explanations for phenomena observed in this research could be examined and used to answer the research questions.

2.6.3. Practical and ethical considerations

Any research should be designed and carried out in an ethical manner, i.e. that it is methodically sound and that data is gathered from participants without causing them any detrimental effects. This is particularly important in the educational setting, where the researcher and tutor is often the same person, because students may feel a need to participate in order to gain an improved grade for assessments, and may feel a need to provide answers that the tutor is looking for.

Throughout the research, another individual, the team project module tutor played an important role in assigning students to teams. The module tutor appointed team leaders to the teams, based upon students' previous experience and desire to play a leadership role, also attempting to arrive at balanced teams with respect to gender, ethnic origin and ability. The researcher was one of approximately 15 team tutors, taking responsibility for one of the teams, which may have inadvertently led to undue pressure being placed upon the researcher's own teams to participate, but efforts were made to keep this research separate from the tutor role, by keeping the conversation to the interview questions and not discussing any other matters at the same time as

discussing the research, in this way preventing bias and ethical conflict (Silverman 2000:200).

Although the first versions of the prototype system were implemented and feedback gained from the students without formally gaining ethical approval, from 2004 informed consent was gained from all students who took part (Version 3). A form explaining the purpose of the research, and asking individuals to indicate their consent to be a part of this research was distributed to all participating students (Appendix 2). The form also gave the opportunity for an individual to refuse their consent, and used standard wording to request why they chose not to participate, if that was the case (Section 5 of Appendix 2). This was merely intended to inform the research, but when considering the application for ethical approval, the ethical committee felt that this might put individuals under undue pressure to participate (see the letter granting ethical approval in Appendix 1). It should be emphasised that no formal records were kept regarding non-participation and that this would have no bearing on their study. Nevertheless, the ethical committee were satisfied with the approach taken, and granted retrospective ethical approval for the research in 2007.

2.7. Summary

In this chapter an examination of the paradigms and methods available to researchers was described. Methods used for information systems and educational research, have been discussed, and justification for the choice of the most appropriate method to be followed was made. Finally, the range of possible data collection methods was described, and those used were identified.

The author has declared the approach to be taken for this research, giving the boundaries for the work to be undertaken. An interpretive investigation was planned: designing, implementing and examining the impact of this artefact on the social situation of the users, and evaluating the findings in the educational context where it is to be used. This research fits the definition of "instrumentalist research" proposed by Clarke (2000), in that an artefact is incorporated into a social process (applied research), and problem-oriented research because the artefact is being devised to solve a problem. The emphasis is on usability and usefulness to the pedagogical aims of the

environment, rather than empowerment of individuals as in critical research, although the aim is to improve the situation for students in this context.

This research is multi-disciplinary, concerned with examining the implementation of an information system in an educational context. The research has been informed by the literature on team working in organisations, combined with that of educational research and information systems research, but in the context of student team working, as shown in Figure 2.3.

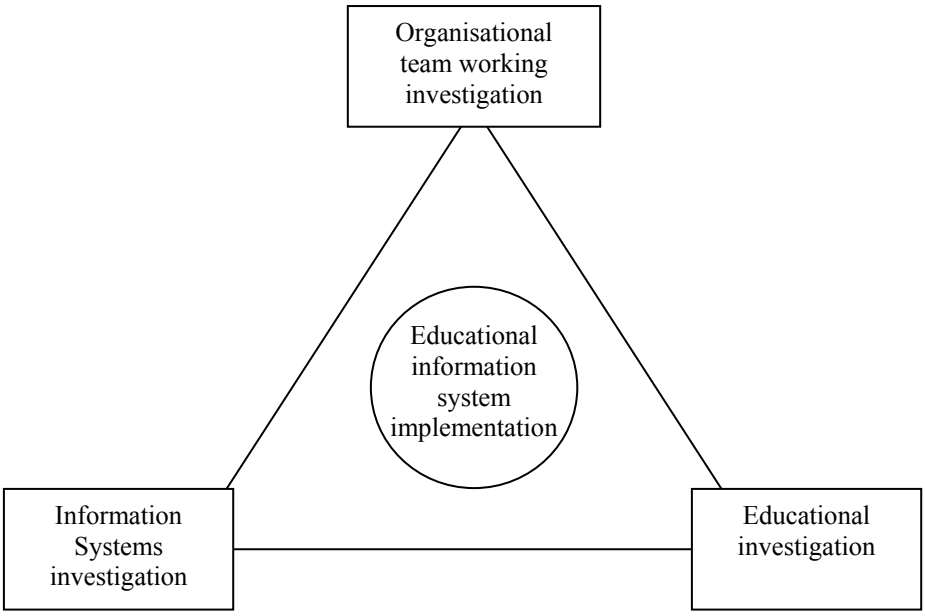


Figure 2.0.3 Position of this research at the centre of three investigations

In the next chapter the first part of the literature review will be presented, covering theories of team working and ways in which student team working, as a learning activity, can contribute to development of team working skills.

3. PROJECT TEAMS AND LEARNING

In the last chapter methods for carrying out research in education and information systems were presented. The context of this thesis was established to be information systems research within an educational context, and the broad problem area to be examined was introduced as the difficulties students experience in getting started on their team projects, which is to be examined through a case study.

This chapter presents some of the literature on learning in higher education, the part played by student team projects in developing team working skills, theories of team working and how student team project working differs from team working in organisations as portrayed in the research literature.

3.1. Learning in Higher Education

The subject of this research is within the context of students in higher education, so in this section, a summary of learning theory is given, to provide the context for the team projects as learning experiences, within which students may gain team working skills. Although the term "learning" in difficult to define, most learning theorists agreed that learning is "*a process by which behaviour is changed, shaped or controlled"*, (Knowles 1990:13), but Bruner went further to suggest that learning is *"...growth, development of competencies, and fulfilment of potential"*, (ibid:13), which places more emphasis on intellectual development and acquiring skills. Learning is not seen in itself, but the products of learning are observed, in what people say, write or do. Education is "*activity undertaken… to effect changes in the knowledge, skill and attitudes of individuals, groups or communities"* (Knowles 1990:10). Knowles definitions apply to adults, so as higher education is aimed at post-compulsory participants, mainly adults, who may have entered university directly from school, or may be more mature (defined as over 21 years of age), these definitions are taken to apply to this research.

Learning is far more complex than any of the early theories suggest, but a framework of theory, such as one proposed by Dyke at al. (2007), based on the characteristics of learning may be helpful. They summarised the theories in a framework, including behaviourist, cognitive, constructivism (cognitive and social), experiential (activity

based) and situated learning, of which constructivism, experiential and situated are most relevant to the learning experience of a team project. Constructivist learning is under the control of the learner, and emerges in terms of the setting and purpose of the learning, a major component of adult learning (Vygotsky 1978). Experiential and situated learning theories emphasise the importance of the context in learning, and making use of previous experience of learners upon which new knowledge can be constructed.

Learning may also be viewed as bipolar, comprising two metaphors for learning: learning as acquisition or learning as participation (Sfard 1998). The acquisition metaphor refers to learning facts, usually related to the context of the learning, whilst the participation metaphor refers to learning as being a part of an activity, in order to gain experience of using learned material. Hodkinson and Macleod (2007) add construction (or formation) and becoming as a desired outcome of the learning process. However, much of the learning of humans takes place in a social situation, and observing others is one way of learning rules, skills, strategies and so on, the basis of "social cognition", or cognitive learning (Schunk 2000:24). Thus imitation of others to reproduce the observed behaviour, as in apprenticeships, is applicable to learning about using practical skills, which can be effected in student team projects.

Constructivist learning is based on building up new knowledge onto existing knowledge, through practical activity, such as problem or discovery based learning, and was first recognised by Dewey (1944). Learners build up their own mental structures as they progress, so all learners will have unique cognitive structures. This takes place within a particular environment, and other proponents have emphasised the social context within which the building of cognitive structures takes place, and the significance of collaboration to build up knowledge. So relationships between others help to shape the structures, and communication is important for developing or constructing knowledge (Dyke et al. 2007).

Experiential learning is not always recognised as a separate theory of learning, but does form a separate category in the framework by Dyke et al. (2007) In this theory previous experience is a foundation for learning, and experience is transformed into knowledge, skills, attitudes and emotions. Within the context of problem based

learning, there is activity and reflection to bridge the gap between an individual's experience and their development relating to the activity. Students in higher education bring varying amounts of previous experience to the learning situation, depending upon their state of maturity, so collaboration between students is a means of sharing experience in relation to the problem to be solved. Hence this is applicable to learning about using practical and social skills within a particular context. The following summarises ways in which experiential learning may be applicable to learning design:

- Learning builds upon that which has been learned before, and stimulates a desire to learn from new challenges;
- Learners construct their new experiences by active construction of ideas upon previous experience;
- Learning is not simply cognitive, but also involves emotions and free will;
- Learning is influenced by others, through social and cultural norms of acceptable outcomes (Knowles 1990).

So learning, rather than being an isolated activity, is dependent upon the social context, including motivational support from others (Alexander and Boud 2001). It is the collaborative or co-operative nature of learning that distinguishes learning in higher education from learning in children.

A team project is an excellent opportunity for students to experience constructivist, experiential and situated learning, within the confines of the higher education learning environment, where reflection, peer reinforcement and encouragement play an important part in participation and acquisition learning. Teamwork activities that are well designed will encourage the learners to gain in expertise in the subject matter and experience in team working processes, whilst learning through social cognition.

In the next section the rationale for this research will be expanded by looking at the literature supporting the desirability of students to develop team working skills, in preparation for team working in the workplace.

3.2. Team Working and Transferable Skills

Including certain key skills in the teaching curriculum has been recommended by government bodies since the 1950's, in the guise of "core skills", "key skills" or "general skills", aimed at preparing people for the world of work. These include

literacy, numeracy and information technology, and are enshrined in compulsory education (Hyland and Johnson 1998), but other skills such as "working with others", "presentation", "problem solving" and "managing own learning", were added after the Dearing review of post-compulsory education in 1996. Hyland and Johnson (1998) argue that these latter skills are context specific and so cannot be taught as generalised or transferable skills, but that opportunities or experiences are the best way to help learners to acquire abilities to act in an acceptable manner towards others in certain circumstances. Any definition of acceptable behaviour in team working is outside the scope of this research.

The reflective nature of personal development planning (PDP) is of increasing importance in higher education, but based on feedback from graduate employers, Edwards (2005) suggests in terms of the process rather than the resulting portfolio of evidence. So an ability to reflect on the experience of the learning activity is just as important as the actual product, and this can be adopted for student team working, to provide for greater learning of individuals engaged in team projects.

Higher education institutions are being encouraged to play their part in preparing students for work, by teaching skills associated with employability, such as team working (Yorke and Knight 2003; Prichard et al. 2006; Dacre Pool and Sewell 2007). Hordyk (2007) suggests the benefits for the employer of teaching employability skills include competitive edge, performance and profitability, but acknowledges that team working in the student context is different to in the work environment. Over the past few years, the Quality Assurance Agency for Higher Education has produced "benchmark statements" for bachelor's degrees with honours, which describe the nature and characteristics of these programmes (http://www.qaa.ac.uk/academicinfrastructure/benchmark/honours/default.asp). The computing, general business and management and librarianship and information management subject areas all include elements of team working, for example, from computing:

> *"the ability to work as a member of a development team, recognising the different roles within a team and different ways of organising teams." (Education 2007);*

from general business and management:

"effective performance, within a team environment, including leadership, team building, influencing and project management skills" (Education 2007);

and from librarianship and information management:

"Work in groups or teams as a leader or participate in a way that contributes effectively to the group's tasks" (Education 2000)

Using Hyland and Johnson's mantra (1998), these benchmark statements provide the context within which team working skills should be enabled. For example in the computing domain, an experience of working as a member of a team developing software is to be provided. Individual reflection will then form the basis of encouraging students to think about the ways in which they operated in this experience, and how successful it was, in order to be able to articulate about the experience later (Edwards 2005). A team project in the computing or information systems context encompasses certain practical skills as well as the softer skills of team working, such as negotiation and compromise. QAA and BCS cite team working skills as learning outcomes, but Joy (2005) suggests that only skills such as programming in a particular language or web site design can be assessed as learning skills against given criteria, the softer skills cannot be readily measured.

A trial by Dunne and Rawlins (2000) of a series of modules to promote team working skills at university, in conjunction with the company BP, has shown that structured training in team skills provides a "safe" learning environment, and as students become responsible for their own learning through team working, they are better prepared for lifelong learning. Skills for co-located team working are well documented, e.g. (Johnson and Johnson 1997; Beranek et al. 2005), but more recently consideration of the essential skills for virtual team working have dominated the literature, and there is acknowledgment that the skills required are different, and need to be learned by virtual team workers (Maznevski and DiStefano 2000).

Graduate employability is a term than encompasses several elements, such as knowledge and skills and personal self-esteem. Generic skills also known as transferable skills have varying listings, but most commonly used lists include for example: working in a team, creativity, planning and communication (Dacre Pool and

Sewell 2007). An example list of skills that a team needs to exhibit to be successful is that provided online by Canterbury, Christ Church University:

- Be well led and managed;
- Communicate well;
- Make best use of its resources - most importantly the skills of the team members;
- Establish the means to evaluate how the team is performing.

The flip side of this list is the skills individuals should acquire for successful participation in a team:

- Exercise leadership skills, if necessary;
- Negotiate;
- Be assertive, to put over your points without aggression;
- Manage people and resources;
- Understand how others feel or might act (Canterbury 2003).

All of these are typically expected to be developed to a greater or lesser extent in team project working. Dacre Pool and Sewell (2007) also use the term "emotional intelligence", which links together an awareness of others with personal reflection as a factor of employability and also suggest that work experience or projects for clients will play a part in developing employability skills. However, Hyland and Johnson (1998) argue that transferable, generic, core, key skills cannot exist outside of a context, but should be replaced by talk of curriculum experiences. Any suggestion of a general skill should be closely related to the context with its associated body of knowledge.

Team skills are clearly regarded as important for team working, so it could be argued that experience in team working, where skills can be developed should form a part of the preparation for team working. There are many sources of guidance for students to help them to learn team working on campus, e.g. (Fellers 1996; O'Sullivan et al. 1996; Drew and Bingham 1997).

The desire of employers for graduates with transferable skills in team working has driven much of the curriculum development in the past 20 years, but defining skills

and how they can be learned is problematical. In the context of information systems or computing, team working encompasses various practical skills, such as programming, design, analysis and project management, as well as softer skills such as people management, negotiation, listening and communication. Providing the opportunity to gain experience of team working, and practice these skills is the primary purpose of student team project working.

In the next section there is a discussion of student team projects as a learning activity to develop team working skills alongside practical skills.

3.3. Using Team Projects in Learning

In the context of this research a team project is a learning activity where a small group of between three and fifteen students are engaged in problem solving activity, in a real world scenario. The project may last for anything between two and twenty or more weeks, depending upon the scale of the tasks involved. Team projects and problem based learning, particularly in the computing and information systems disciplines, are a good way to promote constructivist learning and team working in an experiential learning environment (Griffiths and Partington 1992). Students benefit by learning about team working at the same time as learning about the subject matter. The team or group project is a useful tool for teaching, as it taps into the requirements of learning through experimentation and learning by doing. It is particularly useful where classroom instruction needs to be supported by practical work, such as in teaching programming (Poindexter 2003).

The design of a team project as a learning activity gives the learners an opportunity to interact with the learning material in a way that embeds it into a typical working scenario, which Quinn called “engaging learning” (Quinn 1997). Making a learning experience engaging involves interactivity and embeddedness, qualities noted in different learning preferences, so the range of experiences afforded by a team project makes learning accessible to different types of learners, and provides the practice and reflection elements of an experiential learning cycle, to complete the process. Reflection on the learning and the processes of team working form a part of the PDP reflection, valuable for applying for employment upon graduation.

Small team activities serve a number of purposes, such as encouraging dependent and competitive students to develop a more independent or collaborative style and a move towards more interactive, cooperative learning through dialogue (Pask 1976; Tiberius 1990). Approaches to constructivist learning, take the form of negotiating knowledge, linking it to reality of the current setting, and is very often achieved by collaborating with others in carrying out simulated real world projects in a small team (Hmelo-Silver 2003). Individuals develop skills and learning not simply by being told facts, but also through experience of practice. Working in a team gives learners an opportunity to discuss their understanding of the subject with their peers, as they apply the theory to practice (Sharan 1990). Working in teams may benefit individuals as they learn from each other, pool their resources, make decisions, share ideas or create an artefact in a mutually supportive environment (Jaques 1984:80).

Various internal factors affect learners, such as the learner's current capabilities, personal disposition and information processing preference, together with various external factors, such as the mode of instruction and support for learning, impact upon the effectiveness of instruction. Factors of the learning environment, such as the task, authenticity, recognition, grouping, evaluation and time are also significant (Schunk 2000). The effectiveness of learning is measured in terms of the outcomes from the learning, including intellectual skills, verbal information, cognitive strategy, motor skills and attitudes, many of which can not be measured easily.

In the ideal case learners benefit from teamwork by sharing ideas, learning from the experience of others, less isolation, gaining moral support and combining individual competencies. In addition any tendency for differences through gender specific interpretation may be reduced (Montgomerie 2003). But the reality is that students experience difficulties when engaged in teamwork that detract from the anticipated benefits, such as conflict and lack of commitment on the part of other students (Felder and Brent 1994). In a study by McGraw and Tidwell (2001), based on a course designed to help students prepare for team working, results showed that the course did help the students to reflect upon the process part of team working, such as team dynamics, balance of work, leadership, interpersonal skills, conflict resolution and time management, albeit in a normative way, by legitimising certain behaviours. In some cases the benefits are not recognised by students immediately, but become

apparent at a later date in the workplace, also the skills required in a student team project are not the same as those required in organisations, so additional help from tutors would be appropriate, to fill this gap (Hordyk 2007).

Collaborating with peers is an important means of learning, which may range from discussing issues in class to problem based learning in a team (Boud and Feletti 1997). According to Mergendollar (2006), team projects are a form of problem based learning (PBL) in which learners are self-directed, assisted by guidance or coaching from tutors, in their pursuit of a solution to a problem, but Livingstone and Lynch (2000) suggest that team projects need to be structured if they are to provide maximum benefit to students, which is contrary to pure PBL activities. In the context of this thesis the emphasis is on team projects in the computing or information systems disciplines, where a combination of collaborative and co-operative working is involved. These will be described in the next section, followed by considering the rationale of team projects as learning activities from a learning theory perspective.

3.3.1. Co-operative and collaborative learning

Collaborative learning may be defined as *"a situation in which two or more people learn or attempt to learn something together* " (Dillenbourg 1999). The number of people involved may range from two to several hundred, learning may be a joint activity or reading material together, and the activity may be face to face or online. Cooperative means "*working with others for a common end, purpose or benefit*", and collaborative means "*working together in an endeavour, in a joint intellectual effort*" (http://dictionary.reference.com). McConnell (2000:15) defines co-operative learning as *"...learning involving working together on some task or issue in a way that promotes individual learning through processes of collaboration in groups*". Many academics use the terms collaborative and co-operative interchangeably, when referring to student team working.

Co-operative learning is enabled through tasks that involve students working in teams to accomplish a common goal, under conditions that include the following elements:

- Positive interdependence. Team members are obliged to rely on one another to achieve the goal. If any team members fail to do their part, everyone suffers consequences.

- Individual accountability. All students in a team are held accountable for doing their share of the work and for mastery of all of the material to be learned.
- Face-to-face promotive interaction. Although some of the team work may be parcelled out and done individually, some must be done interactively, with team members providing one another with feedback, challenging one another's conclusions and reasoning, and perhaps most importantly, teaching and encouraging one another.
- Appropriate use of collaborative skills. Students are encouraged and helped to develop and practice trust-building, leadership, decision-making, communication, and conflict management skills.
- Team processing. Team members set team goals, periodically assess what they are doing well as a team, and identify changes they will make to function more effectively in the future (Johnson et al. 1991).

Co-operative learning can be regarded as process driven, but requiring attention to social processes in order to achieve the goal (McConnell 2000). Problem based learning and project based learning may be considered to be forms of constructivist and collaborative learning, allowing several students to work together on a problem, and learn from each other as they co-construct knowledge. They are engaging in collaborative as well as co-operative working, in combination to permit development of synthesis and application skills. They may also be considered co-operative learning, because individuals rely on each other to perform their allocated parts of the project. Typical PBL or team projects will include activities such as design, development, writing reports, and preparing class presentations, as suggested by Felder and Brent (1994) for engineering students. In these activities individual students will between them be exposed to a wider range of issues than would be likely if they worked alone (Boud and Feletti 1997). Thus co-operative working in a team includes collaborative elements, as well as interdependence and group processes, but parts of the work may be accomplished individually, each held accountable for their tasks (Johnson et al. 1991).

Gibbs (1995) suggests that there are “project teams”, who are task oriented towards completing a task, or “learning teams”, who are process oriented towards support and

learning. In the context of this research, task-orientation is an essential element of co-operation towards achieving the outputs, whereas process orientation arises when team members engage in reflection through collaborative discussion. So a project, in the workplace or in higher education, may be cooperative and involve a project team, with an element of learning to improve performance in the future, but also collaborative as a learning team or community of learners. The concept of a "learning community" was described by Visser (2001) as a vehicle for the discourse necessary for learning, whereby people communicate with each other to help each other to learn through collaboration. Lave and Wenger (1991) describe a community of practice (CoP) as a loosely bonded collection of like minded individuals, which has a long life, and accepts newcomers as apprentices, who learn from the community through active participation. Learning in this case involves informal learning of the socio-cultural practices of the community, through sharing. McDermott at al. (2001) suggested that developing a community of practice helps cross-functional teams to share and improve performance, as an essential part of the learning process leading to nurturing the "learning organisation". Online tools enable students to form themselves into online CoP as a means of support and learning from each other, e.g. (McMurray 2003).

Berge (1998) regards a project team as a small learning community, whether in the workplace or in higher education. But within a student team there would be no idea of one student being apprentice to another as in a CoP, but the notion of sharing knowledge as suggested by Manville and Foote (1996), is suitable if we consider that students are professionals to a certain extent:

> *"..a group of professionals informally bound to one another through exposure to a common class of problems, common pursuit of solutions, and thereby themselves embodying a store of knowledge".*

This definition suggests sharing of knowledge so that all members gain increased knowledge, and again, experience of sharing within knowledge management is a growing area of use for IT in organisations, in developing a "learning organisation".

3.3.2. Developing transferable skills

Given the complexities of teamwork, an important skill to gain from undergraduate programmes should be the ability to analyse issues that arise in working relationships

within teams, so that graduates can apply this skill acquired when beginning their working life (Yorke and Knight 2003). McDermott et al. (1998) suggest that

> *"teams must receive training/ development in teamwork skills such as team communications, team goal setting, team problem solving, team decision making and team facilitation."* (McDermott et al. 1998).

A team project provides opportunities for students to develop cognitively, learning about the subject matter, and practising skills in argument, also psycho-metrically, learning practical skills, such as using software tools and programming. Finally the affective domain is manifested through students learning about team working, reflecting on their attitudes and relationship with each other.

There is some debate concerning the extent to which team projects in an educational setting can prepare students for team working in the workplace (Dunne and Rawlins 2000). In the field of health teaching, a study comparing the effectiveness of PBL and team projects, did cast doubt on the extent that PBL can help to develop transferable skills suitable for project working in the workplace (Mennin 2007). Further, it is noted by Hordyk (2007), that there is a need for further understanding of the differences between project team working in the workplace and in the educational setting. Hyland and Johnson (1998) say that any skills learned can only apply to that context, suggesting that there is no such thing as a transferable skill. Although other studies, carried out in higher education, suggest that the results may be transferred to the workplace, e.g. problem solving skills (Murthy and Kerr 2003; Lou 2004; Banks and Millward 2007; Mennin 2007).

In the next section the literature on team working is examined in order to identify features of team working that signify successful outcomes, which are subsumed into theories of team working, used as a basis for evaluation of a system developed to help team working processes.

3.4. Team Working Theories

The significant contribution of the work of teams within organisations has become recognised, and there has been considerable research into means of improving their effectiveness. There is also much advice on team working now available, particularly for co-located teams, based upon findings from the literature. Group dynamics is the

study of team working, and various researchers suggest structures and factors that influence the working of teams, which will be outlined below. There is a need for coordination of the work of individual members of any team, if the team is to work together successfully, and achieve its objectives. A successful team is referred to as a "cohesive" team, but not all teams are successful, and various problems may lead to less than optimal results from teams (Johnson and Johnson 2006:100).

Research into team and group working has been aimed at identifying some of the causes of poor group dynamics, so that training can be directed at preventing dysfunctional teams in organisations. The traditional theories of team working are based on work with co-located teams, within a broad range of discipline areas, and there are guides, aimed at the business community, on building successful teams, e.g. (Adair 1986), acknowledgement of the various roles of team members, e.g. (Belbin 2000), and recognition of the importance of communication between team members, e.g. (Hartley 1997). Much of the more recent research into team working is concerned with online, virtual or global team working, e.g. (Henttonen and Blomqvist 2005); a summary of recent virtual team research is provided by Powell et al. (2004), and an outline of the implications for future working environments is given in Lipnack and Stamps (2000). This area of research is further muddied, because many researchers use student teams for their studies, who do not necessarily represent typical workers in organisations, e.g. an experiment using email for discussion (Gatlin-Watts et al. 2007), or an experiment comparing face to face and online communication for conveying and converging types of decision making, using students as surrogates for business users (Murthy and Kerr 2003). Other researchers openly use students in an effort to find out more about organisational team working, e.g. (Last et al. 2002).

The following sections concentrate on co-located team working, and provide a summary of the main success factors for team working, and disruptive factors, moving from literature on organisational team working to student team working.

3.4.1. Success factors for teams

Teams may be arranged to be short lived, brought together for one particular job, or dynamic, changing composition and enduring, where new members arrive and existing members leave at various times, and the team continues onto different

projects or tasks and never disbands (Syer and Connolly 1996). Teams being convened for specific jobs, may be different from those recognised as devices for organisational motivation.

Although there are different types of teams, the ideal picture painted through team working guides, is that most teams consist of similar features to form a structure that leads to success: a common purpose, division of labour between members, expectations of acceptable behaviour, shared mental models, development of trust, accepted means of communication, means of managing conflict, and adaptation of the members to the cultural and social situation it is operating within (Mathieu et al. 2000; Johnson and Johnson 2006:14), and the concept of a team player is described by Driskell et al. (2006). When these are not fully embraced, teams experience difficulties and may fail to achieve their objectives, e.g. different forms of conflict (Appelbaum and Shapiro 1998; Jehn and Mannix 2001; DeChurch et al. 2007), cultural differences (Aranda et al. 1998), perceived control (Ezzamel and Willmott 2001) and leadership failure (Tubbs 1995; Gil et al. 2005). Starting with theories of team structure, team development and the Johari Window, as foundations for describing team working, the features of team structure outlined at the beginning of this paragraph are expanded in the next section.

3.4.2. Team structure

A number of people have talked about the different theories of team working in the traditional, co-located, setting and how these might be applied in the workplace. Many of these theories have a lot in common, often distinguished from each other by the name given to processes. Johnson and Johnson (2006:15) suggest that all teams are structured around differentiated roles of members and integrated norms of the team. A role is a form of expected behaviour for performance in a particular position and norms are rules established by the team to regulate behaviour. Team members are individually responsible for different roles they take on, but in a cohesive team the norms unite the team members into a coherent whole.

Many researchers have divided team working elements into maintenance and task roles, e.g. (Hartley 1997), work and basic assumption roles (Bion 1961), task and socio-emotional functions, e.g. (Bales 1970), product and process roles, e.g. (Bion

1961; Belbin 2000; Brown 2000), or task, maintenance and process roles, e.g. (Syer and Connolly 1996). These theories have in common the notion of two (or three) interrelated roles necessary to achieve successful team working, summarised in Table 3.1. All of the different functions of a team have particular purposes, aimed at fulfilling one or other of the two roles, summarised by Jaques (1984) as:

- Team building and maintenance roles, which contribute to the cohesiveness of the team;
- Team task roles, which help the team to perform the necessary tasks.

Author describing these roles	**Team working elements**		
Hartley, 1997	Task role	Maintenance role	
Bion, 1961	Work role	Basic assumption role	
Bales, 1970	Task role	Socio-emotional role	
Belbin, 2000 Brown, 2000	Product role		Process role
Syer and Connolly 1996	Task role	Maintenance role	Process role

Table 3.0.1 Outline of different team working elements

Task roles include analysis, problem solving, decision-making, planning and design or build. Maintenance roles are concerned with individuals' feelings and relationships between team members, continually working towards team cohesion. It prevents negative conflict from arising through polarising of individual desires and beliefs, which would inhibit performance of the team (Syer and Connolly 1996).

According to Adair (1986), the processes of a team are centred around three areas: achieving the task, building and maintaining the team and developing the individual. This forms the cornerstone of my interpretation of team structure, shown in Figure 3.1.

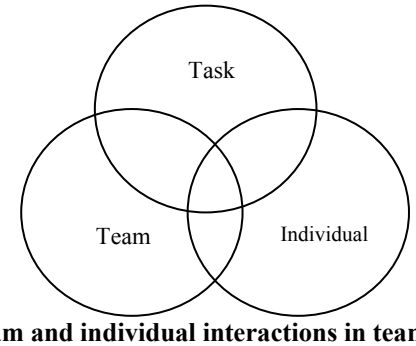


Figure 3.0.1 Task, team and individual interactions in team working (Adair 1986)

3.4.3. Team development

One of the most commonly accepted models of team processes is Forming, Storming, Norming and Performing and (Adjourning added later), coined by Tuckman (1965), as reported by Bion (1961). This model reflects the stages that teams pass through as they work together over a period. The forming stage involves team members learning about each other, getting to know the procedures of the team, conflict may arise in the storming stage, when members confront their differences, but as conflict management is effected the team moves to the norming stage, where there is a greater concentration on establishing norms of working, towards the performing stage. The adjourning stage involves reflection on performance in order to learn for the future, a theme taken up by Peter Senge, who advocated that systems thinking is one of the components that lead to a "learning organisation", along with personal mastery, mental models, shared vision and team learning (Garratt 1994). Although very few organisations live up to the ideals he suggests, because of time and cost constraints, the aspect of knowledge sharing through communication is a part that is possible within teams at work (Smith 2001). There may also be an element of evolving, as the team learns from members, and develop new skills (Syer and Connolly 1996).

Team or social cognition, as advocated by He et al (2007), refers to the mental models held by a group that enable the team to accomplish tasks by acting in a coordinated way, and is necessary for sharing knowledge and information. It helps the team to manage members' knowledge and expertise, and assign tasks to members with most capability, and comprises awareness of expertise location and shared task understanding. Shuffler and Goodwin (2007) note that developing shared mental models is a part of learning, and there is a need for social presence and task interaction to develop the shared understanding upon which trust is based.

One symptom of the storming stage is the blocking, aggression and withdrawing behaviours, observed in studies by Johnson et al. (2002) where it was noted that under performing teams have been found to spend less time on socialising. Other research, on co-located teams in a telecommunications organisation, has shown that providing members of the team with information, training and skills can enhance the common perceptions of their working environment, leading to developing common ground

rules, and performance measures, aiding improved "team wellness" (Groesbeck and Van Aken 2001).

The interacting forces of trust, cohesion, communication, leadership, meetings, and conflict between team members are all established by the time of the norming stage of team working. Ground rules are an expression of shared expectations of membership, also known as norms and standards, representing the culture of the team, which contribute to the norming stage of a team. Setting ground rules may be important for agreeing how the team will operate (Aranda et al. 1998). It is thought that rituals are also an essential part of team processes, for example a celebration for achieving milestones, such as the gift offered to sales people on achieving a target. According to Aranda et al. (1998), these expressive events acknowledge the achievement, and should be encouraged as motivators in teams.

Bion (1961) suggests that the team initially operates at a task level, but as the group progresses towards decision making, emotional issues become more significant. The initial stage of a project may concentrate on tasks in order to develop team knowledge, and a trust of other members' capabilities. Bion further suggests a series of stages through which the team will pass, such as security, protection, boundaries and projection within the life span of a team.

3.4.4. Johari Window

The Johari Window may be applied to team development, such that feedback and self-disclosure enriches a member's knowledge of themselves and of other team members (Figure 3.2). The diagram shows the four quadrants of information, which represent information known or unknown to self and others, such as feelings and motivation. Greater knowledge of each other is evident when the Open/Free Area extends to the right and down, reducing the unknown quadrants. Revealing feelings etc. generally takes place in face to face meetings, but in virtual teams, other means have to be found to expand the known quadrants (Luft 1970). McConnell (2000) uses the Johari window to show similar dimensions of co-operative learning. A trusting environment encourages commitment and freedom to express views and ideas, and promotes concentration on the tasks to be completed.

	Known to self	Unknown to self
Known to others	Open / Free Area	Blind Area
Unknown to others	Hidden Area	Unknown Area

Figure 3.0.2 Johari Window

In addition to feelings and motivation, skills, abilities and preferences may be a part of providing a fuller picture of individuals in the team to each other. Knowing facts about someone is not necessarily the same as knowing someone, but may play a large part in moving from *Us/Them* to *You/I* and to *We.* Newell et al (2007) proposed three types of trust: companion trust, commitment trust and competency trust. Using four cases of a US company working globally, with IT team workers in Ireland and India, they concluded that perceptions of the relationship between the vendor and the client together with low levels of companion trust and commitment trust resulted in team members experiencing difficulties finding help and coordinating the activities involved in the team work.

3.4.5. Common purpose and division of labour

Team cohesion is a measure of how well a team is sticking together, aiming for the same overall goals, and wishing to remain together, an indicator of how effective a team has become (Brown 2000). In a study of trust within co-located teams, Bos et al. (2002) found that there was a possible relationship between trust in teams, allocation of tasks and setting ground rules, particularly relating to the idea of a shared mental model through task allocation (Edmondson et al. 2006). Knowing about each other, individual capabilities and preferences can be a factor in developing trust, for instance a "shared language", understanding, or shared knowledge base (Powell et al. 2004).

> *According to Adair (1986) cohesiveness is a measure of how strong the bonds between members are, also linked to morale, commitment to task and team spirit. Regarding group cohesion in terms of the goals and ideals of the team, provides a picture of members identifying with key features and aspirations of the team (Hogg 1992). The needs of the individual and the team may at times conflict, particularly when an individual member has a different agenda to the remainder of the team. There are various manifestations of this, including*

members not contributing, social loafing, arguments and dissatisfaction with the team processes (Sanders and Schyns 2006; Piezon and Ferree 2008).

Managing conflict is important in maintenance of the team, and Brown suggests that to prevent conflict between team members there needs to be a common objective all members subscribe to, an agreed framework to work within and equal social status of members (Brown 2000: 341). On the other hand, DeChurch et al. (2007) suggest that task conflict should be encouraged through positive conflict management, and relationship conflict should be avoided, as they have been found to cause reduced satisfaction in teams, but trust and roles also influence the task-relationship conflict link.

3.4.6. Communication, shared mental models and conflict

Communication is the most important aspect of achieving any objectives within a team. Meeting together has always been an important form of communication, many researchers agreeing that a face to face meeting is the best way to convey full meaning in discourse, e.g. (Adair 1986; Williams 2002). Even findings from research with virtual teams suggests that face to face meetings are still necessary, particularly at the beginning stages of a team, e.g. (May et al. 2000).

Speaking face to face provides non-verbal cues to understand the meaning, which are often absent online, so online more effort is required to gain full understanding of the other's meaning:

> *"To understand another's speech, it is not sufficient to understand his words – we must understand his thought. But even that is not enough – we must also know its motivation. No psychological analysis of an utterance is complete until that plane is reached*" (Vygotsky 1978).

However, arranging meetings is often difficult (Fellers 1996) and over reliance on face to face meetings may hamper progress on projects (May et al. 2000). Even for co-located teams various forms of computer mediated communication (CMC) tools and groupware are being utilised, but Hiltz et al. (1996) suggest that training is needed if teams are to benefit from using these tools, and Li (2007) maintains that complex

issues need to be resolved through face to face communication rather than using CMC tools. Although meetings are essential at all stages of a team project, knowledge of the team members, acquired during the forming stage, enables the storming stage to be overcome, suggesting the critical need for meetings at the beginning stages of a project. Meetings are also important for communicating stages of the project, ensuring that all team members are aware of the status of the project and motivating towards completing the project (He et al. 2007).

All team members need to have a clear understanding of their own and everyone else's roles in the project: what needs doing, how and by whom. Members also need to have a clear understanding of the ground rules adopted by the team, and communication of these roles and rules is important at the initial stages of a project (Burdman 1999). Hartley (1997) suggests that communication is often ad hoc, unless ground rules are drawn up at the beginning. Williams (2002) also suggests that teams should establish similar values at the beginning, to encourage high levels of trust and respect, and should agree how to deal with task conflict in the middle stages. The importance of ground rules in collaborative knowledge sharing, managing personalities and monitoring and maintaining teams was emphasised by other researchers (Groesbeck and Van Aken 2001; Bock et al. 2006; Driskell et al. 2006). Although Patterson et al. (2005) studied sports teams, they did find a close correlation between cohesion and performance. In particular social norms rather than task related norms were found to help cohesion and performance, but in information systems teams Bahli and Buyukkurt (2005) found that task related norms were more significant than social related norms. Similar results by Liang et al. (2007), on information systems development teams in Taiwan, found that knowledge diversity leading to increased task conflict, which positively affected performance, whereas value diversity led to increased relationship conflict which had a negative effect on performance.

Research into team working suggests that more trust is required if the team is to perform effectively. Trust is described as:

> *"an actor's expectation of the other actors' capability, goodwill, and self-reference visible in mutually beneficial behaviour enabling cooperation under risk"* (Henttonen and Blomqvist 2005)

Politis (2003) looked at self-managing teams of knowledge workers, in high-tech manufacturing, and found that trust was related to knowledge management, and refers to these softer elements as human factors, that rely on faith and confidence. Trust leads to knowledge sharing and collaboration, but at the same time knowledge sharing is needed for trust, so there is a cyclical relationship. Work by Appelbaum and Shapiro (1998) suggests that there is a significant problem of mistrust and miscommunication, leading to conflict in teams.

3.4.7. Culture within a team

One view of culture is that the underlying set of beliefs, norms, values and practices differ according to the country or background of individuals, and this may help or hinder a team's performance, suggesting that to be successful some team members, individuals may need to change the way they behave and think (Aranda et al. 1998). McDermott et al. (1998) mention the need to foster cultural awareness when working in cross-cultural teams, based in different locations or different countries.

An alternative view of culture refers to attitudes, assumptions, interactions of the internal team operations. These are influenced by the external background of team members, as outlined above, and result in common values of what is desirable behaviour within the team. It could be argued that the climate of a team is as important as providing communication tools and a structure to work within, though the terms climate and culture have been used interchangeably, e.g. (McMurray 2003). On the other hand, simply belonging to the same organisation, albeit different departments, can be a contributor to group cohesion, particularly trust (Henttonen and Blomqvist 2005).

Individual members bring to the team different sets of beliefs and values, built up over a lifetime, and these can affect relationships within the team, but diversity of culture and background can also be beneficial to the team. In the next section the role of leadership, and its influence upon team cohesion is examined.

3.4.8. Leadership and cohesion

Leadership of a team influences the degree of cohesion within the team. In this section there is a brief account of research into the impact of leader influence over the team performance.

Team performance is influenced by the ways in which co-ordinating the actions of individuals takes place in the team, and dealing with issues relating to the complex and dynamic environment the team is working in (Zaccaro et al. 2002). These are the specific roles of a leader, manager or co-ordinator, and much of the literature does not make any distinction between these named figureheads, so the author uses the term leader. Teams may have an assigned leader, may self-appoint a leader, or may not have a single designated leader. At one extreme leadership may be imposed from outside the team and, at the other extreme, there may be shared leadership in the team (Aranda et al. 1998). In between there are many alternatives, such as leaders appointed from within to look after sub-team work, or self-appointed team members taking responsibility for particular tasks. In some cases the leader has a hierarchical position within the team, and takes responsibility for the team, alternatively, the leader takes on a co-ordinating role, and has limited authority. In order to achieve the task and maintenance goals of the team, the team and individual needs must be met. Certain functions have to be performed in running the team project: initiating, regulating, informing, supporting and evaluating. These functions could be managed by a leader (Beranek et al. 2005), but this does not necessarily have to be so.

Brown (2000: 85) reports on research into types of leadership. A leader is said to initiate ideas and activities, by influencing others to change their behaviour, but leaders do not necessarily possess all of the necessary qualities of leadership. Their style of leadership may be democratic, autocratic, or even laissez faire, which concurs with Bales' (1970) distinction between task or socio-emotional specialists. The main difference seems to be in the degree of concern for the task and the team, or for the team members, i.e. formal structure versus consideration of individuals. It appears that a "charismatic" style, called transformational, may be more motivating than a transactional style, which is based on reacting to situations, particularly for research type projects (Keller 2006).

3.4.9. Team working summary

In section 3.4 the author has attempted to identify significant factors of team working in organisations. Cohesion arises from trust, shared mental models and ground rules, arrived at through negotiation, and this is a precursor of motivation of individuals to consider the team as a whole as well as their individual interests. But the bond formed by having a common purpose is a strong means of developing cohesion. In addition division of labour affects the task roles, and norms, context, communication, cultural awareness and conflict management affect the maintenance roles. The leader plays an important part in managing the team and individual expectations, both in terms of the task and the maintenance roles, in order to encourage cohesion. The factors influencing the success or otherwise of team working are summarised in Figure 3.3.

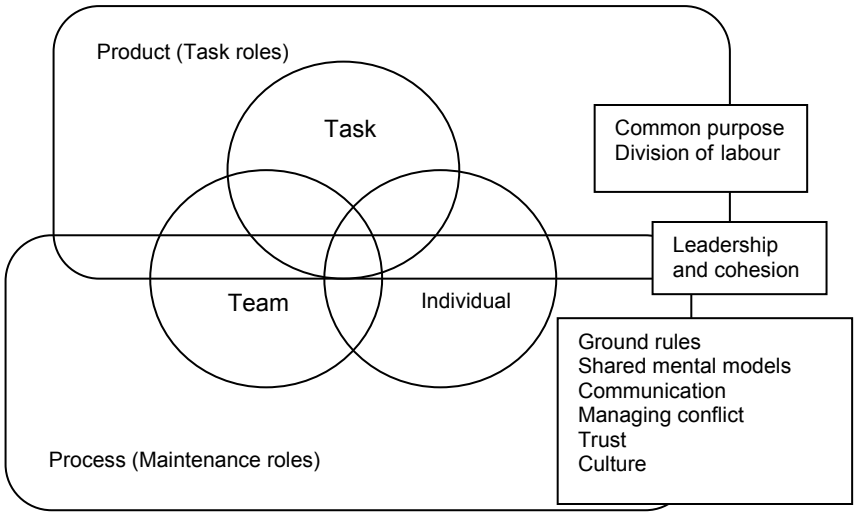


Figure 3.0.3 Model summarising factors affecting team working

3.5. Student teams

In this section student project teams will be compared to organisational project teams, in order to identify issues of team working that pose particular difficulties for students, which may be resolved by additional support, so that learning outcomes may be realised. Although the soft skills of maintenance roles are most often emphasised as learning outcomes, these are the ones that are context specific and less easy to evaluate or assess than the practical skills of the task roles.

3.5.1. Issues of student team projects

Research carried out previously by the author, investigated co-located student project teams at five different institutions (Whatley et al. 1999). Using team interviews during their projects, and questionnaires at the end of the projects, students were asked for their opinions on their team working and outcomes from the projects. The results were analysed to determine what similarities and differences appeared at different higher educational institutions, and so whether there were common issues in team project work, which confirmed some of the findings reported in the literature. The interview data gave information on the general levels of satisfaction as the students were undertaking the projects, and highlighted particular problems the students recognised during the project. Topics covered included attendance and chairing of meetings, use of email for communication, allocating tasks, planning the project, problems and their perceived satisfaction and learning from the project. The questionnaire data gave information on the students' perceptions of specific problems, positives of team working and acquiring particular skills.

The teams in this survey did spend a considerable amount of time on the project, often meeting daily throughout their project, so were probably using the meetings for regular bouts of conveying and converging as suggested by Murthy and Kerr (2003). The students in the interviews did not suggest that arranging meetings was a problem, but only two of the eight teams said that all team members attended the meetings, and the other teams said that it did hamper progress on the project. Questionnaire findings indicated that not all individuals regarded the meetings as useful, disconfirming work by He et al. (2007), which emphasised the importance of frequent meetings. Non-contribution of team members was regarded as a significant problem, sometimes leading to free-riding by some team members, an effect noted by Piezon and Ferree (2008), and arranging meetings did feature as a problem for most teams, as found by Burdett (2003). Most teams appointed a chairperson and/or a secretary for each meeting, and it was usually the same person throughout the project. As these teams held frequent meetings, and the chairperson was the same throughout the project, it could be taken that this individual took on a leadership role, as suggested by Beranek (2005).

Email was not used very often by the teams to arrange meetings, but used by some teams to send work to each other. This is not surprising, because this part of the study was conducted in the late 1990's before email became commonplace among the student population, and these teams were working co-located, so had no need to use email to any great extent. Face to face communication was the predominant means of communication, even though various pieces of software were being used to develop the products of their team projects. Students thought that the teams did develop a level of trust and support, and provided a supportive and trusting environment for their learning, recognised as important by Politis (2003) and Dillenbourg (1999). Students also showed some appreciation of the benefit of explaining work to each other, confirming findings of Eijl et al. (2005), and the benefit of peer support shown by Fellers (1996).

Allocation of tasks within these teams was effected equally by individual preference or by team members' experience of skill areas. In most cases the allocation was adhered to during the project, so individual preference and experience appeared to be acceptable means of allocating the tasks between the team members. This should positively affect the project outcome, according to Drury et al. (2003). Similarly some form of planning was carried out by all of these students, which in most cases resulted in a plan that was stuck to throughout the project. The problems the teams mentioned included lack of time, available software, tutor help, books and even computers, and these may have affected the original planned schedule.

One of the main purposes of working in teams, is to develop team working skills, but the responses showed that students did not feel they developed interpersonal or team skills, such as communication, listening, presentation, leadership and negotiating skills, and did not feel they learned more by working in a team, although some students mentioned gaining knowledge of their strengths and weaknesses. There was an even split between positive and negative responses, in terms of what individuals had got out of the projects, with only a few mentioning "experience of working together" and "teamwork" as positive outcomes of the team project, but more than half of the students mentioned experience of using different software as the main outcome of the project, showing a "task oriented" approach to their projects.

To summarise the findings, not all of the students thought that they had benefited from working in a team, or were satisfied with the outcome of their team project. Many did not think they developed team skills or interpersonal skills. In particular, listening, negotiating, presentation or leadership skills were not always recognised. Learning about individual strengths and weaknesses was lacking, and trust was often not developed within the team. Many students regarded the meetings as very important, but often found it difficult to organise meetings, and get all team members to contribute. Sometimes there was a poor understanding of the tasks involved, some students lacked skills for particular tasks, and help from the tutor was not always satisfactory. In many cases the team project was completed without establishing ground rules at the beginning, and problems that arose were not always addressed, leading to some projects not being completed on time. Five different institutions were surveyed, but the difficulties experienced appear to be similar in all cases. Despite the small sample sizes of the teams who responded to the questionnaires, it is clear that many of the problems suggested by Ann Chadwick (1994) are experienced by students working in co-located teams.

3.5.2. Differences between student and organisational team projects

In the specific context of student team working, the team is brought together to undertake one particular task, after which the team will be disbanded, so a team project is usually short lived compared to some organisational project teams. Other principal differences from work teams are the manner in which teams may be selected and leaders appointed, and the ways in which assessment or evaluation of outcomes of projects is conducted. Many of the other issues of student team working may be similar to those experienced by organisational teams, on the occasions when difficulties arise. But for student teams, these issues may take on greater significance, because of the pressure students are under to achieve good grades for their work. These include the balance of workload, communication and misunderstandings, managing disagreements, the commitment of individuals in the team, emotional factors, the diversity of students and their needs and the sheer complexity of a team project.

Team projects tend to be short term for students, but that does not make them any less critical from the student perspective, because the students' assessment grades depend upon the outcome of their team project work, so trusting other team members to perform their roles is very important (Wilcoxson 2006). Students may themselves choose to work with the same team members for a variety of reasons, such as friendship, convenience of home location and similarity of home commitments, alternatively teams may be assembled by tutors taking experience and skills into consideration. A leadership role may be conferred on one member by the team, in response to a pressing problem, as this problem is overcome the status and power the member had is reduced and another member takes on the leadership role. The more formal learning groups are similarly affected by these influences, but student team members do not take up the option of resigning from the group, and leadership does not usually pass around the team unless specifically organised by the tutor.

Assessing a student team effort is problematical and often leads to student dissatisfaction because of a number of factors, which arise in student teams, and may cause more disaffection than for organisational teams. Jones and Issroff (2005) suggest that process as well as product should be assessed. This issue is not going to be discussed further, except that students are known to be assessment driven, so the form of assessment chosen by the tutor may impact upon the motivation of individual students in the team (Wells 2002). The other issues identified from the literature for organisational teams, which impact upon student teams will be explained next.

One drawback of teamwork is the possibility of being dragged down by weak students, and the phenomenon of "free-riding" also called social loafing (Piezon and Ferree 2008) or unequal contribution or distribution of tasks (Burdett 2003). There have been few studies into the affective or socio-emotional aspects of team working with students, except for Jones and Issroff (2005), who suggest that more longitudinal studies need to be carried out, if an understanding of affective aspects of team working is to be gained. Positive and negative emotions may also affect the progress of a project, and emotions are only a symptom of other aspects of team working (Peslak 2005).

In the workplace developing trust through good team cohesion is important, and difficulties often emerge as a result of poor communication (Politis 2003). In the same way, Hogan and Thomas (2005) found that communication, as well as time management, are significant factors in higher education software engineering teams, because as students are not always present at the same time, team cohesion is harder to achieve, and since students have different agendas for their learning, trust is harder to develop through students getting to know each other.

Conflict arises in the storming stage of the project, because of disagreements and misunderstandings, which are alleviated through communication via meetings, agreeing norms of behaviour and clarifying roles, leading the team to the norming stage, and hence to performing. Communication of information about each other is an important means of filling in the unknown quadrants of the Johari window, in order to develop a shared mental model of other team members. A study by Banks and Millward (2007) with students in a team simulation, found that shared mental models contribute to team processes, which positively impact upon team performance.

In a study with undergraduate students, Cornelis et al. (2006) found that difficulties arose from different levels of motivation to develop good working relationships within the team, and the effect of interpersonal relationships and the fairness of the leader, will affect the project outcomes. Huang and Ocker (2006) found that students working on real world IT projects in partially distributed teams, experienced conflict, not only as a result of geographical distance, but also power and flow of information, which were found to be partly ameliorated by a positive work ethic, the quality of work produced and the media used for communication. The structure of an informal learning group depends upon a mix of power exerted by individuals, the members' orientation towards the task and emotional affiliation between members (McLeish et al. 1973; Gillies 2004).

Trust develops as team members come to rely on other members either to complete what is expected of them, often through conflict, and begin to generate a safe environment for open discussion of team issues (Golembiewski and McConkie 1975; Jehn and Mannix 2001). There is limited literature supporting the extent to which cohesiveness is essential for team working in the educational context, except for

Gillies' study in schools (Gillies 2004). Disagreements and misunderstandings more easily become conflict, and students have limited ability (experience) to overcome them. Project management, running meetings and leading projects are being learnt at the same time as carrying out the project and learning about the subject matter, so students are often overwhelmed by the complexity of the situation (Cornford and Smithson 1996). Studies by Postmes et al. (2001), on students in experimental conditions suggests that the history of a group affects the formation of team norms, and that these norms may tend to be consensus type in a cohesive team, or critical norms in a group where individual and critical thought prevails. However, the teams with critical norms were found to make better quality decisions.

Commitment to achieving goals is high in a team of students working towards a common assessment. In addition accountability in taking responsibility for part of the work, when tasks have been allocated, and learning to work as a team are being acquired along the way. Some learners adapt well to working in a team, whereas others do not. The combination of students with different learning preferences, who react and learn differently from team working, makes for a richer team process, as they ask for clarification, and dispute issues, so come conflict is good for teams.

In recent years the student body has become more diverse. No longer is the typical student a white male, aged 18 to 22, but students may be of any age from 18 upwards, are increasingly female, and can be from different countries and cultural backgrounds. This diversity affects the ways in which our teaching is presented in response to the variety of learning preferences, which may be represented in our student body. As an example, older students who bring work experience to their studies may be more self-directed learners, but, lacking the recent learning experience of younger students, may require more guidance. Women may display a preferred approach to learning, which shows empathy, listening and collaboration. Students from other cultures may vary in ways of learning, for instance students from the Far East tend to prefer to learn by rote, rather than by experiment, and African students prefer to learn in a community (Montgomerie 2003). Researchers into gender in IT have found that gender may be significant in teams allocating tasks to members (Beranek et al. 2005), and perceptions of the team project (Ingram and Parker 2002), as well as learning preferences (Montgomerie 2003).

As well as diverse backgrounds students also have different needs, and are now working more from home than previously (Parchoma and Dykes 2008), so their environment becomes more like that of distance learning students. Alexander (2006) found that students in his study, working in virtual teams, were dissatisfied with the experience. Another study comparing face to face and virtual student teams found that the co-located teams were more satisfied with their team experience (Whitman et al. 2005). Kimble et al. (2001) identified technological barriers, organisational and cultural differences, control and supervision issues and a reluctance to share partly completed work, all of which may affect students as they rely on communication tools to coordinate their team working. Pauleen and Yoong (2001) note that support for student team working is different to that required for work teams in business.

A development model by Johnson and Johnson (2006:19) shows changes over time from a group of individuals, to a pseudogroup, then a traditional work group, to an effective group and then to a high-performance group. Many student teams do not proceed beyond the traditional work group level of being forced to work with others, but with no real interest in the tasks to be completed, because of the time constraints of a short project and the necessity to complete tasks for assessment. Others will become an effective group, having some concern for other members of the team and recognising an interdependence between each other in their efforts, but few student teams would progress to the level of a high-performance team, which also embodies a mutual concern for each others' well being and learning, without considerable help and input from tutors (Heffernan and Poole 2005).

3.5.3. Summary of student team working

Previous research by the author identified difficulties students experienced in their team project working. Some of these difficulties are similar to those they will experience at work, but there are additional difficulties students have to overcome. As a result the student team project can only go so far in providing an experience in team working for developing skills, because of constraints of the context.

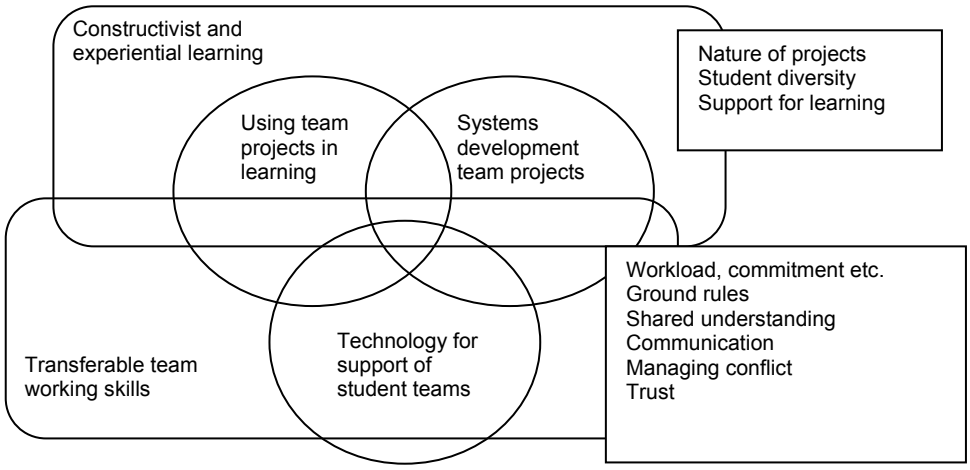


Figure 3.0.4 Model summarising factors of student team working

A model of the factors affecting student team working is given in Figure 3.4, drawn in a similar manner to that of Figure 3.3, which shows organisational team working factors. The main difference between organisational and student team working is the nature of the projects they work on, the diversity of the students and their needs, and the type of support for their learning that is provided. The factors listed in the lower box, are similar to those of organisational team working, and relate to soft (or maintenance) team working skills. In previous studies, students did not acquire many of the soft team working skills, they were often found to be "task oriented", and one area neglected was agreeing ground rules at the commencement of the team project. They also found meetings difficult to arrange, and this will become more of a problem, as students today require more flexibility in their working arrangements.

Another differences between student and work project teams are that student teams are short lived, students are being assessed on their performance and the selection of team members and leaders is carried out differently. In addition student teams experience unequal contribution to the work by members, variable levels of commitment from members, difficulties in communication, diversity in culture and needs and being overwhelmed by the complexity of the tasks to be completed. All of these difficulties lead to problems in developing the levels of trust needed for a cohesive working student team.

There are many sources of guidance to help students to work in teams, and the stages suggested by O'Sullivan et al. (1996) for co-located teams are one such example. From this list it is suggested that "getting off to a good start", "equitable task allocation" and "meetings between members of the team" all play a significant part in keeping the project on track.

In the previous sections identified skills necessary for effective team working include: an appreciation of the factors contributing to group dynamics; recognising the relationship between individual, team and task; activities that build up trust; appreciation of the stages a team develops through and the impact of leadership.

3.6. Summary

In this chapter the literature on student team working as a means of acquiring team working skills has been outlined. This was supported by a brief background to learning theories and to team working theories, which highlighted the main differences between student team project work and organisational team working.

Team projects are a suitable vehicle for teaching a variety of skills, including team working skills as well as practical discipline related skills. Students learn together through a combination of collaborative and co-operative activities, in a constructivist, experiential and situated manner, as they work through team processes to produce an output. There is agreement that team-working skills are important for undergraduate students to acquire, in preparation for working in business. In higher education, problem based learning, in the form of a team project, is one of the best ways to develop a number of skills, such as team working. In this way learning is constructed upon previous learning and experience, and is situated in a real life context, notably in the IS discipline. Learners gain knowledge and experience about team working from direct involvement in teamwork. As they reflect on their experience they are learning about, for example, issues of team cohesion and conflict. Practise through the tasks and products of team working provide for learning reinforcement, as well as gaining team working social skills through reflecting on the process of team working.

In particular, the issues of developing a shared understanding of team members' abilities and the role that establishing ground rules plays in group cohesion is to be

explored. The context of student team projects also depends upon motivation of individuals, and how the team leader can manage this.

Much of the research into teaching students in the past has been based upon research into either therapy teams or work teams, e.g. the work of Bion (1961). There has been much research into teams at work, but a lot of the empirical work has been carried out with student teams, and we have seen that there are several significant differences between student team working and organisational team working.

From the literature it is possible to identify a number of issues that occur in team working in organisations:

Developing a shared understanding and trust between team members;
Norms and expectations of individuals in the team;
Accepting and working with cultural differences between team members;
Allocating tasks to appropriate members of a team;
Managing conflict situations as they arise.

Additional issues that occur in co-located student team working include:

Motivation between members with varying dispositions towards learning;
Developing a sense of commitment within team members;
Eliciting skill levels of individuals;
Difficulties of developing new skill areas through different types of projects;
Conflict arising through assessment of effort on a project.

Although students are known to benefit from team project working, the literature suggests many reasons why students do not perceive these benefits fully, such as their inability to develop a shared understanding of their team members, and to agree ground rules for expected behaviour in the team. These may arise because students do not spend enough time on the maintenance roles of team projects at the initial stages of a project. As a result the researcher chose to concentrate on issues concerned with getting started on the team project, because a good start on the project is crucial for its success.

Students are now relying more on technology to aid their learning, so there is a movement from face to face tuition at universities towards online provision, usually in the form of blended learning for students. Blended learning is a term used for providing learning resources through a combination of online material with face to face material, thus providing more choice for co-located students. There is a need for any proposed support for team project work to be available online, providing a choice for students, in addition to traditional team working support. Any support provided for team working needs to also be flexible, to enable students to work at times and places more convenient for them, and should promote understanding of issues relating to team working, both on campus and in the workplace and virtually.

The next chapter will introduce the case study for this research, and examine the use of groupware as support for the getting started stage of student team project work, and whether intelligent systems, such as software agents, may provide support for student teams. The chapter will conclude with the outline design of the proposed system.

4. TEAMWORK SUPPORT FROM TECHNOLOGY

The literature in the previous chapter suggested several issues, which affect the outcomes of team working, some of which were shown to be factors both in organisational settings as well as for student team projects. The literature also identified several issues that pose particular difficulties to students when they are working on team projects. In considering these issues, frameworks of team working provided in the literature, are useful for identifying the different stages the team pass through. Of these stages, the author has chosen to look at the getting started stage.

In this chapter the case study is introduced, and findings from document analysis of the case are presented, in order to frame the research questions of this thesis. Currently available technology to help students with team project work is outlined, in particular whether groupware and virtual learning environments provide support for the getting started phase. The difficulties the students in this case experience are compared to those found from the literature presented in Chapter 3. Finally technology based on intelligent support systems, such as software agents, are considered as possibly providing solutions to students' difficulties in this case, and the factors that were considered in designing this software support system are outlined.

The functions of task allocation and agreeing ground rules were selected for further investigation by the researcher, because these have been shown to contribute to development of group cohesion and successful planning of the project (Bahli and Buyukkurt 2005; Patterson et al. 2005). A case study was chosen to investigate the issues of team working further, and to try out a software support system to determine its effectiveness in alleviating some of the maintenance issues of student team project work and to find out more about the ways in which students might use such a system in their team working.

The next section introduces the case study, and details how the case will be used in this research. Following this, there will be an evaluation of possible technology solutions for the problems of student team project work, and a description of the initial design of a software system, which will be applied to this case.

4.1. Introduction to the case study

In this section there will be an outline of the case study chosen to use for testing the effect of the software tool developed, and an account of the implementation of the research methods and instruments chosen for data collection.

The case study chosen for this research is the multi-year team project scheme in what was the Information Systems Institute at the University of Salford, later subsumed into the Salford Business School. The projects play an integral part in two undergraduate degree programmes: Business Information Systems and Business Information Technology. These are three-year programmes with an additional optional industrial placement year. Although the degree programmes have different names, in each of the three years there are several modules that are common to both, and the team project module is one of these. Students from the first, second and final years of these degree programmes are formed into teams of between 10 and 15 members. Each team works on a different real life project developed in consultation with a client organisation, and under the guidance of a team tutor (Cooper and Heinze 2007). Most of the school's lecturing staff are designated as team tutors, each tutor taking responsibility for the guidance of one or two teams.

The team project module tutor assigns students to each team randomly, but ensuring that the composition of each team is similar in terms of year of study, programme of study and gender. One of the final year students is appointed as team leader and one of the second year students as deputy team leader, and these are usually based on recommendations of previous year's team tutors. Apart from the designated team leader and deputy team leader, the teams are left to structure their teams as they feel the project requires, and resolve any management problems as they choose, with support from the team tutor. Team membership selection is aimed at achieving a balance of technical ability, managerial ability and gender (Cooper and Heinze 2007).

The clients range from local charitable organisations, local branches of large multi national companies and community projects, to departments internal to the university, such as administrative divisions. The projects these clients provide, represent real life problems to be solved, which is as close to working in an organisation as can be achieved on campus. Projects range in scope from developing database systems or

developing web pages to feasibility studies of proposed systems or research into appropriate systems to solve organisational problems.

Over the course of three years individual students are involved in three different projects, and spend up to a quarter of their time on these projects. Table 4.1 gives a summary of the demographic details of cohorts of students accepted for the undergraduate degree programmes, between 2000 and 2005. This information shows the diverse nature of the students, a large number are mature, bringing previous experience to their studies, and many have not entered higher education from the traditional route of studying 'A' levels at sixth form just before entry to university. Only one third of the students came from outside the local area, either elsewhere in the country, or from abroad. The remaining students lived at home, so had less need for campus facilities, than those studying away from home, however, many also had home commitments that limited their time available for engaging with other students. The nature of the undergraduate degree programmes offered attracted a larger proportion of males than females, resulting in an under representation of females in each of the project teams.

Students in this case	Averages taken from 2000 to 2005 student intake figures
Gender	Over 70% of the students are male
Age	Up to 30% are classed as mature
Qualifications	About 24% enter with only A level qualifications, the remainder have APL or BTech/HND or similar qualifications
Origin	The proportion of the students from the local area was 65%, UK students from elsewhere in the country was about 20% and students from overseas usually amount to about 15%.

Table 4.1 Summary demographics of the students at Salford University

The team tutor for each team is responsible for giving advice as required, and for the assessment of the team project. At the time of this research, assessment is 50% for a team mark, and 50% awarded for individual effort. Assessment is based upon an interim and a final academic team report, which details the work achieved for the team project, an interim and final report for the client, and a team presentation at the

end of each semester. Each team member also provides a peer review at the end of each semester, in which they rate the other team members against given criteria.

At the beginning of the second semester (January), the team constitution changes a little, as the final year students take on the role of consultants, and do not contribute to the project, except as advisors as required by the team. From this time the first year students have to play a fuller role in the team project, rather than the shadowing role they took in the first semester. The deputy team leader becomes the new team leader, and the team chooses a new deputy team leader.

An area of the computer laboratory is allocated to each team for a limited time each week, and students are expected to complete much of the work on these projects at other times. The Blackboard VLE is used to support the team project module, providing team areas for file exchange, and a repository for the team project related documentation. Space on a local file server is also provided for each team, so that they can try out possible solutions for clients' system problems.

This case has been chosen because it is readily available to the researcher, and because it exhibits some unique characteristics, which cause particular issues of team working to be more pronounced. The main characteristic is that the students are drawn not from a single year of study, but from all three years of study on an undergraduate programme. This means that the team members are not all in the same peer group, so do not always have prior knowledge of each other, making getting started more difficult. As Silverman (2000:107) says, using a "deviant" case may provide a test of the team working theories that may not be provided in other cases. The random composition of each team also means that in selecting a sample of the teams to investigate, any results could be generalised to all of the teams.

4.2. Document analysis of case

As a part of regular reviewing of modules at the University of Salford, several documents have been produced, which highlight deficiencies in the ways in which the team project module operates. This section provides a summary of some of the findings from these module review processes, which relate to difficulties students

experience in undertaking their projects, and which have informed the consideration of possible solutions to these difficulties.

The documents consulted for this analysis included a report entitled "Information for a review of Team Projects at the ISI", produced by the Equality Advisor of the school, in conjunction with the Student Advisor of the Student Union. The report, "Team Projects Review Report – 2006", is a summary of findings from several previous years reflection on the team projects, compiled from questions answered by members of the academic staff involved in the role of team tutor. A summary of the main findings from these reports is given in Appendix 8. Although these reports were written in 2005 and 2006 respectively, they report on staff and student feedback arising over several years, and overlapping with the trials of the Guardian Agent system. Many of the issues raised related to assessment and to sub-cultures resulting from the diversity of the student body. In this context the term sub-cultures refers to small groupings of individuals, often based on gender, ethnic origin, language or religion, which support each other, and may have needs contrary to the rest of the student team. Of particular relevance to this research are the following points raised:

- There is a need for more preparation for students and staff;
- Peer assessment was sometimes found to be a source of bullying;
- Some students lacked the confidence to raise difficulties with team tutors or team leaders;
- Students should be informed of potential conflict and provided with help for dealing with it;
- Stress the importance of honesty in peer assessing;
- Need to balance team composition, but avoiding sub-culture influences;

In this case a VLE is used to support the team projects module, and students use email and discussion forums to communicate outside of classroom sessions, but it is evident that in this case the technology adopted has not provided help with these social issues. Other developments in technology may provide a possible solution to the problems that students encounter in their team project work. For example groupware is used extensively to support teams in organisations, virtual learning environments are used to support aspects of learning in higher education and intelligent tutoring systems are used for personalised learning activities for students. In the following sections these

technologies will be discussed, to determine whether any of these could be adapted to provide a partial solution for alleviating students' problems in the maintenance roles of team working.

4.3. Technology for online teamwork in business and learning

In this section the currently available technology support for working in teams is discussed, beginning with Groupware, Content Management Systems, then looking at Virtual Learning Environments for students and intelligent tutoring systems, followed by software agent technology. The notion of affordance as it applies within a human computer interaction context is discussed, and the gaps in the field are identified.

Groupware and knowledge management systems support CSCW activities (Computer Supported Co-operative Working). Virtual learning environments and learning management systems have been designed for supporting learning activities. The activities involved in working in a work team are somewhat different from those involved in working in a learning team, as experienced by undergraduate students. In addition to carrying out tasks to achieve goals, such as communication for sharing information, students are learning how to communicate, share information and work as a team in order to carry out the tasks involved in their project (Rosenberg 2001), so the tools used to support students should reflect the differences, for example providing preparation for team working, and addressing the specific problems of student teams.

Improving communications, using Computer Mediated Communications (CMC), has been a growth area for a number of years, and a variety of tools are now available to support synchronous and asynchronous communication, together with a number of commercial groupware products and virtual learning environments (VLE) to wrap these individual tools into a single suite, as described for example in (Ciborra 1996). Providing tools is one thing, but helping students to make the most of the tools is also needed.

Technology tools range from communication tools, such as email, discussion forums and file exchange, to groupware designed to simplify the sharing of information within teams. Tools designed for the business environment may not provide suitable

support for students in higher education. Groupware and knowledge management systems are typical business applications, but virtual learning environments and intelligent tutoring systems are often used to provide campus and online support to learners.

4.3.1. CMC tools for synchronous and asynchronous communication

In the following table (Table 4.2) we summarise some of the features of communication methods available for traditional and online working. The characteristics of each form of communication represent an affordance available to the user, who will weigh up the suitability of a tool according to value it will give for the effort to be applied (Hill and Raven 2000). Not all of these tools offer the same functions, and some are easier than others to use, similarly some functions will be perceived by some but not by other users. It can be noted that in the cases of face-to-face meetings and telephone conversations there is no record of the message, except for manual minute taking, or audio recording, whereas with email and discussion forums the message can remain for future reference if not deleted. More mental effort goes into preparing a written or online message, in some cases careful wording is encouraged, so that irrelevant and wasteful conversation is reduced.

	Synchronous (S) Asynchronous (A)	possible to ask more immediately	needs thought with wording	non verbal signs	mental & physical effort	informal	record of message
Face to face	S	*		*		*	
Telephone	S	*				*	
Telephone conference	S	*				*	
Email message	A		*		*	*	*
Written post/fax	A		*		*		*
Virtual classroom	A	*	*		*		*
Video-conference	S	*		*		*	
Discussion forum	A	*	*		*	*	*
Chat	S	*		*		*	*

Table 4.2 Comparison of synchronous and asynchronous tools (* indicates feature is present)

Synchronous media enable the recipient to read or hear the message immediately, but with asynchronous media there is a time delay between the sending and receiving of the message. Many of us have become accustomed to using email, in preference to using the telephone, when an immediate answer is not required, but the choice of medium depends upon the purpose of the communication, and the perceived affordance of the media, i.e. "will the tool provide me with an easy means of achieving the objective of my communication?" The more informal media have a place particularly in the socializing aspects of online working (Salmon 2000; Bos et al. 2002; Zheng et al. 2002), but face to face communication is the richest and will capture non-verbal cues that may be missed with telephone usage. Non verbal cues may also be limited with video conferencing, and unless specifically recorded there is no record of the conversation for later verification (McDonald 2002), which is also true of telephone and face to face conversations. Co-located students are using online asynchronous communication when organising meetings proves difficult, but relying solely on asynchronous communication has the effect that it can take longer for individuals to understand other team members preferences, and to agree methods of working together, than if using face to face communication.

In the context of co-located team project working, each of these media will have their application, according to the circumstances and the purpose of the communication (Detienne 2006). Some communication tools may be more appropriate at different stages of the project team processes than others, or more appropriate for transmitting task or maintenance parts. Often the difficulty is knowing under which circumstances particular tools are most appropriate, and students need experience to enable them to choose the tools to use in their project work (Dalsgaard 2006). It has been observed that providing a variety of communication means, for team members to choose from according to purpose, helps to generate a sense of community within online teams, and perhaps also for co-located teams (Haythornthwaite et al. 2000; Chapman et al. 2005). Laurillard suggests that many technologies, such as audio, video and computer conferencing, only support discussion between students rather than true collaboration (Laurillard 1993:173), and further suggests that CSCW (Computer Supported Collaborative Working) is better at supporting descriptions, providing feedback and reflection. Combining a number of technologies to provide a balance between

different learning activities is better, but it is what students make of the activities, including collaboration, that provides the benefit.

In the next section some of the tools for supporting team working are discussed, and their possible roles as solutions to issues of co-located student team working.

4.3.2. Groupware and knowledge management tools

Groupware systems have developed from the Group Decision Support Systems (GDSS) of the 1980's, also known as Group Support Systems (GSS), Collaborative Group Technology (CGT) and Electronic Meeting Systems (EMS) (Aiken et al. 1991). These typically involve combining computer mediated communication tools in various configurations, with client-server database networks, within a standardised interface (Khoshafian and Buckiewicz 1995; Corbitt and Martz 2003). CSCW (Computer supported collaborative/cooperative working) is a term often used in place of Groupware, though, as the name implies most communication within CSCW is directed towards work tasks (Olson et al. 1993). Although Khoshafian and Buckiewicz argue that even social communication may be concerned with work tasks, as a means of developing group cohesion and trust (1995). Groupware usually comprises a suite of programs to help team members to carry out their work tasks, including database access, document management systems, calendaring and planning systems and communications, both synchronous and asynchronous, e.g. email, discussion, conferencing. Also schedule coordination aids, collaborative authoring tools, team concensus-reaching and decision making tools and support for face to face meetings are often provided (Oravec 1996).

Groupware was designed to help "goal directed group work" (Jessop and Valacich 1993), with the main emphasis on enriching meetings on team projects. Indeed some of the literature agrees with the view that groupware supports mainly the task parts of team projects, e.g. (George and Jessop 1997). Corbitt and Martz (2003) go on to say that task processes are supported by such technology, but they question whether the more social aspects are similarly supported, e.g. developing trust and openness . Other evaluation studies on groupware products suggest a limited capability of these systems to support the collaborative activities, necessary for team working processes,

such as discussing preferences, e.g. (Stewart 1998; Attaran and Attaran 2002; Salo and Kakola 2005).

Linking together various asynchronous and synchronous communication tools enables team members to communicate easily, share files and jointly author documents. In addition, linking together databases enables all team members to access relevant data, and share their knowledge. These tools, called knowledge management systems, or content management systems, play an important part in encouraging the "learning organisation" through sharing collected knowledge, leading to a shared understanding (Garratt 1994). Decision support systems provide for storing the history of decisions made and reasons behind them as part of the groupware functionality (Khoshafian and Buckiewicz 1995). These systems are intended to help organise the increased amount of data and information being held in databases by organisations, which leads to "information overload", when users cannot easily find and deal with the information they need for a project (Papanikolaou et al. 2002).

Managing codified knowledge, so that it can be shared is a process that should be supported by groupware systems, as a means of developing organisational memory (Salo and Kakola 2005). Salo and Kakola (2005) also suggest that communication, coordination and collaboration support for the early phases of new product development in teams is problematical, and agree that the task processes, such as administrative and operational ones have been successfully incorporated into groupware design, but that knowledge sharing and integration are more difficult to design. Salo and Kakola were concerned with the design of groupware for business use, but groupware for student use may have similar characteristics, and require similar design considerations (Collings et al. 1995).

In conclusion, business groupware is being used to support teams in communication, document sharing and authoring and sharing knowledge, but it is acknowledged that many systems offer little support for developing team cohesion or social communication at the getting started stage of a project. These groupware systems were designed for organisational team working, rather than student team working, so support is not necessarily specific to students' needs. One of the best-known, commercial groupware products is Lotus Notes. In recognition of its limited

suitability for educational use, Lotus have produced the Domino educational version, a form of virtual learning environment, but it is still a task oriented system. The specific role of virtual learning environments is discussed next.

4.3.3. Virtual learning environments

The term "Virtual Learning Environment" (VLE) has a range of definitions, from web sites that include simple static pages of course material etc., to more elaborate offerings, including multimedia, 3D images etc. However, the most accepted definition refers to commercial learning support environments, such as Blackboard and WebCT. The design of VLE's comes from groupware products, providing learners with access to databases, file exchange, calendaring, as well as education specific functions such as submission of assignments and grading. Added to these there may be portals, which are personalised doorways providing selected links to appropriate material (Schneider et al. 2002), multimedia applications, instant online communication with peers or access to simulations comprising still and moving images to explain a topic (Conole and Dyke 2004).

These products have been designed to encourage interactions between learners and tutors, by providing tools for communication between students and with their tutors, and students are encouraged to co-construct the virtual space as their learning progresses. VLE's may have been developed with distance learning in mind, but are equally appropriate for supplementing campus based learning activities (Dillenbourg 2000). However, these VLE's do not specifically help students prepare for team working, or encourage the sort of activity that promotes trust and cohesion in a team. The next section considers the extent of support from these products for student team project working.

4.3.4. Specific support for team projects

Supporting team working in business is enabled by Groupware and other suites of collaboration and project tools, these may by recognised as first generation products (Khoshafian and Buckiewicz 1995). As indicated earlier, these products do not always provide the support needed for student team working in the educational context, where the aim is not solely the product of collaboration, but also the specified learning outcomes concerned with acquiring team working skills and competencies. Dalsgaard

(2006) recognised the limitation of these systems if they are used simply to manage learning content, and suggested that using the systems to encourage social networking, would fit a social constructivist approach to developing self governed learning in students. O'Hara (2004) also endorsed designing collaboration into e-learning systems.

CSCL (Computer Supported Collaborative/Co-operative Learning) is a term applied to collaborating with the aim of learning, as students do in teams, so the term is used to refer to a range of tools for supporting team working for learning, such as CMC tools (Fowell and Levy 1995; Edwards and Clear 2001), and purpose built systems such as TAGS (Allison et al. 2001) and BSCW (Stahl 2002). McConnell (2000) suggests that CSCL is primarily for distance learners, but the current trend is for regarding computer support as applicable for co-located learners as well. Typically, these systems offer communication support similar to that of groupware systems, but specifically aimed at students.

Research into CSCL is concerned with investigating learning through collaboration, supported by technology. Meier et al. (2007) suggest that researchers in CSCL should be asking about the aspects of collaboration processes that promote successful collaboration, and how these aspects can be observed to add to knowledge of collaborative learning. Of the processes within collaboration some are concerned with deriving meaning from a learning situation, adding knowledge to a collective common ground, as well as understanding the processes of learning (Suthers 2006). In addition CSCL research has looked at ways in which the technology can mediate or support this learning (Suthers 2006). However, in common with groupware systems, research has shown a positive effect of CSCL systems for task oriented parts of team working, but has not hitherto proved whether any of these systems help with the maintenance roles of team working (Valcke and Martens 2006), nor provide help specific for getting started on a project.

Hugo Fuks (2000) recognised that the metaphor of the classroom, currently used as a representation of the tools within virtual learning environments, may not provide an adequate simulation of the working environment, so a groupware based support environment called AulaNet was developed to give a more realistic simulation of

using groupware for learners. Student teams may also require to use project management systems, which provide such functions as scheduling, cost control, allocating resources, quality management and documentation, e.g. Microsoft Project. Training for its use in the business setting is well established (Williams 2002), but in the educational setting is limited (Wilcoxson 2006). In addition, the importance of immersing students in technology and tools for knowledge management is stated by Rae et al. (2006), where they describe a collaborative learning approach, which encourages students to learn through using knowledge management tools. Learning to use technology tools now also becomes an employability skill connected with team working (Edwards and Clear 2001). Tiwari and Holtham (1998) suggest that groupware does need to be designed for specific support for software engineering projects, and that learning how to use groupware is a valuable side-effect.

A variety of software tools are available to support organisational teams, but these do not provide sufficient support for teams of students, who are also engaged in a learning process. In the next section intelligent software tools and agent technology are briefly examined, to determine whether these may provide the sort of support student teams require to support the maintenance roles of team project working.

4.4. Intelligent support, tutoring systems and software agents

The previous sections described some of the available group oriented technologies for helping team working in business organisations and in higher education. In this section a brief history of intelligent tutoring and online support for student team working is outlined, some of which is being developed with AI (Artificial Intelligence) principles, finally, the concept of software agent technology is introduced, which is based on AI principles.

Artificial intelligence has been the Holy Grail of computing for several decades, the possibility of automating activities that require some human intelligence, so that results are more consistent and we can spread expertise wider. Except within a few small domains, such as Eliza or geological surveys, the emergence of practical applications of the resulting Knowledge-Based Systems (KBS) or Expert Systems has been disappointing. These systems have been successful, but have cost a lot to

produce and only operate within a small area of expertise. However, there has been some success with Intelligent Tutoring systems, which are capable of learning something about the user, in order to provide material in an appropriate format to be best suited for an individual learner (Farr and Psotka 1992; Hwang 2003; Negoita and Pritchard 2004).

Intelligent tutoring systems (ITS) aim to provide user specific instruction to learners, based on their preferences and past experience and performance. They have developed from computer aided instruction/learning systems (CAI or CAL), which were programmed learning systems leading learners through a series of pre-determined learning activities (Farr and Psotka 1992). Expert systems can add some adaptation to learners, by analysing learner experience, ability and preference, and selecting appropriate format of teaching material. Such a system learns from the user about their previous knowledge and preferences, using a rule-based system, applies this knowledge to a search for appropriately formatted material to present next, sometimes also known as programmed learning, e.g. (Hatzilygeroudis and Prentzas 2004), or WITNeSS, which applies fuzzy logic to reason with the uncertain data characteristic of the complex nature of student support (Negoita and Pritchard 2004).

These systems have been designed for individual learning, and are useful for providing online tutorials for on demand learning. However, learning through collaboration within small teams of learners, building up knowledge between them as they work on projects, with advice and help from a tutor, require a different design of intelligent tutoring system, which would be more complex (Strijbos et al. 2004). In the next section software agent technology, and multiple agent systems are considered, as a possible support tool for students in teams.

4.4.1. Intelligent software agents for learning

The emergence of intelligent software agents was proposed to be an "acceptable" form of AI that would more closely mirror the ways in which humans work, and would be more usable. The name "agent" was chosen for its definition as:

"something that acts for or on behalf of someone by their authority".

or:

> *"An agent is a self-contained, concurrently executing software process, which encapsulates the current state in terms of knowledge, and is able to communicate with other agents through message passing"* (Wooldridge 1995).

The concept of an agent originates from human agents that provide services, such as estate agents and travel agents. These agents have specialist skills, access to relevant information, contacts for obtaining information and are focused on a particular task. In the same way software agents are autonomous systems that work on behalf of a user. They exhibit the ability to recognise what the user needs to accomplish and reacts to the user's input.

Over the past decade there has been considerable debate over what a software agent actually is (Franklin and Graesser 1996). A working outline is that an agent should be:

- autonomous, so that it operates without much human intervention,
- social, in that they interact with other agents and humans (who may also be called agents),
- reactive, and able to react to a stimulus from the environment and respond to changes,
- proactive, not only responding but also taking the initiative (Knapik and Johnson 1998).

These qualities certainly denote an agent as having intelligence in certain areas, and using it appropriately. However, the present state of research is such that there is no way that agents can be developed to operate in broad domain areas, they would be much too big, and would probably grow out of hand, as they learn new information (Bradshaw 1997). Agent systems are likely to remain within narrow domains for the foreseeable future, but in certain circumstances can be designed to be more reactive than a rule based expert system (O'Leary 1998). Some notable applications of agent technology are in knowledge management (Ferneley and Berney 1999) and Internet searchbots (Lieberman 1997), e.g. Phibot (Henninger 2002) or MySpiders (Pant and Menczer 2002), which all facilitate knowledge sharing and searching.

The influence of robotics in software agent technology is evident as developers choose to include some form of character to the agent, similar to the animated paperclip of Microsoft word, also known as an avatar, as a means of personalising the agent to the user. Examples can be found in a workshop proceedings edited by Aylett (2001).

A software agent may operate in isolation, working on behalf of an individual, but their power derives from an ability to communicate with other agents to fulfil tasks they would be unable to complete alone (Ferber 1999). Several agents linked together, all playing their part in a particular task are called multi-agent systems. These multi-agent systems are the main thrust of much recent research, and have become possible because of the massive global infrastructure of networks now available, embodied in the Internet (Aldea et al. 2004).

Lesser (1999) suggests that the power of several agents is greater than the power of each individual agent, so that each agent could be a local knowledge based system with a specific narrow field of expertise, and by combining several agents together, each field of narrow expertise is combined to solve more complex problems. The power of their action lies in their ability to communicate between individual agents, by broadcasting messages or specifying recipients of messages (Soller and Busetta 2003).

Given the working outline of an agent, provided above, it would suggest that a software agent system could well be applied to the area of online learning, as observer, information processor or proposer (Boy 1997). There have been some developments of software agent systems for learning, such as enabling students to navigate through virtual environments (Nijholt 2001), EduAgents (Hietala and Niemirepo 1996), and I-Help to form a network of students who are willing to help each other (Vassileva and Deters 2001). Research is ongoing into the benefits of using software agents for learners, such as the ADE Project, which has combined course management on the server side with intelligent tutoring on the client side to support individual learners by helping them to connect with tutors and other students (Johnson and Shaw 1997). None of these are aimed at team project working, but demonstrate the potential of software agents for providing tailored help to students.

If an agent can support an individual learner, then several software agents linked together as a multi-agent system, can model the types of connections that exist between several learners linked together, as in a team. A multi-agent system could enable sharing between the individual team members that each agent is working on behalf of, e.g. in learning about community care (Beer et al. 2003). At a conference keynote, Corkill (2003) outlined the future potential for multi-agent systems in learning, supporting the possible benefit of this research to unifying a team of learners (Whatley et al. 2001). One example of a multi-agent system for supporting team working is I-Minds (Soh 2004), which works on assessing team working.

Although there has been considerable development of technology to provide support for learning and for team working, most solutions support the task roles of team projects, and there are no applications specifically for support of student team projects. Software agent technology has much potential for personalised individual learning, but also in combination as a multi-agent system, for supporting teams of learners. Providing technology tools to help communication is a growth area, but as will be apparent from the next section, users can vary in their acceptance of tools, either through a reluctance to learn how to use a tool, through an overload of tools, or simply not finding the tool as useful as developers intended. A recent study suggests that there is greater acceptance of a text only agent system over agents with an avatar, because it is more important that the system is well designed so that it does not detract from the learning (Hershet Dirkin et al. 2005). The affordance of technology tools for learning is discussed next.

4.5. Affordance of technology for learning

Development of technology is providing more and improved tools that can be used to aid communication between team workers, both in organisations and in higher education. However, in an educational setting, not all learners perceived the same affordance as each other (John and Sutherland 2005), and users may not perceive the affordance planned by the designer, and learners may have their own perspectives, which are different to the teacher's (Conole and Dyke 2004). Perceptions of the usefulness of a tool play an important part in whether the tool is adopted for use, and the mood of the individual was found to affect its use (Djamasbi and Strong 2008).

This aspect of human computer interaction (HCI) has been little studied in applications of team support tools.

In using team working as a learning activity, self-directed learning is being encouraged, and systems to help learners must be flexible and open, so that students are free to choose how or when to use the tools provided (McConnell 2000:48). Technological affordance provides opportunities, which give students freedom to choose which tools to use, although within the context of a team of students the choice of tool may have to be made for all team members, by mutual consent, perhaps by agreeing ground rules on use of tools (Brereton et al. 1998).

Gibson first used the term "affordance" to refer to the properties offered by something to an individual, real affordance as planned by the designer, within a context. For example a flat surface affords support to a dice, but not a ball, so is specific either to the action capabilities of an actor or the actor'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 actor to determine what affordance the item provides for an individual (McGrenere and Ho 2000). Table 4.3 summarises the differences. Gibson's interpretation is that affordance is fixed at design, contrary to Norman, who suggests that affordance depends on the user's experience and knowledge, and that there may be degrees of affordance.

Gibson's interpretation of affordance: • 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.
Norman's interpretation of affordance: • 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.

Table 4.3 Comparison of Gibson's and Norman's of definitions of affordance (McGrenere and Ho 2000)

McGrenere and Ho (2000) argue that clearly defining 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. 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. They also proposed a grid to evaluate intended and perceived affordance, in categories of intended and perceived, perceived but not intended and intended but not perceived affordance. 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 possible affordances 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, so Norman's definition of affordance is more useful for systems development purposes. Although, as Albrechtsen et al. (2001) point out, the icons on the desktop are not the affordance, but they signpost the functionality behind the action possibilities; the information system is independent of what is visible on the screen, but comprises the software affordances as well as the users' perceptions of afforded functions.

At Durham University, support for software engineering team project work is provided in the form of BSCW, incorporating email, file exchange, version control and meetings (Drummond et al. 2001). They found that students did not use all of the functions designed in the system, the affordance was provided, but not perceived by all students, suggesting a need to educate co-located students in the potential for this type of groupware support, an observation supported by Patterson (Patterson et al. 2005).

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. I will return to this aspect in chapter 6, when evaluating the acceptance of the proposed software system by the students of this case.

4.6. Informing the development of the support system

The literature on software systems as tools for supporting organisational teams and learning teams shows a shortage of developed tools for supporting the maintenance roles of student team project working. Tools are available for supporting the task roles, and for encouraging communication between team members, but not specifically aimed at the getting started stage of team projects, part of the maintenance roles. Neither is the design of available tools specific for students in higher education carrying out team projects, where learning outcomes include the process of team working as well as the product of the team work.

This last part of this chapter is devoted to explaining the design process for a partial solution to the lack of support for student teams, i.e. to support the starting stage of student team projects. The literature points to the importance of the starting phase of a student team project, i.e. the forming and storming stages of Tuckman's model. The storming phase is the period when team members come to know each other, through conflict and negotiation, aided by the role of a leader. The literature suggests that leadership, conflict, negotiation and knowledge play a part in helping the team through storming. It was proposed that agreeing allocations of the tasks at the forming stage might help the team to negotiate work tasks in the knowledge that individuals have been allocated appropriately. It was further proposed that agreeing ground rules at the forming stage would help the team leader, in particular, to overcome some of the conflict that may arise in the storming stage (Figure 4.1). In this way a greater shared understanding of team members would be developed.

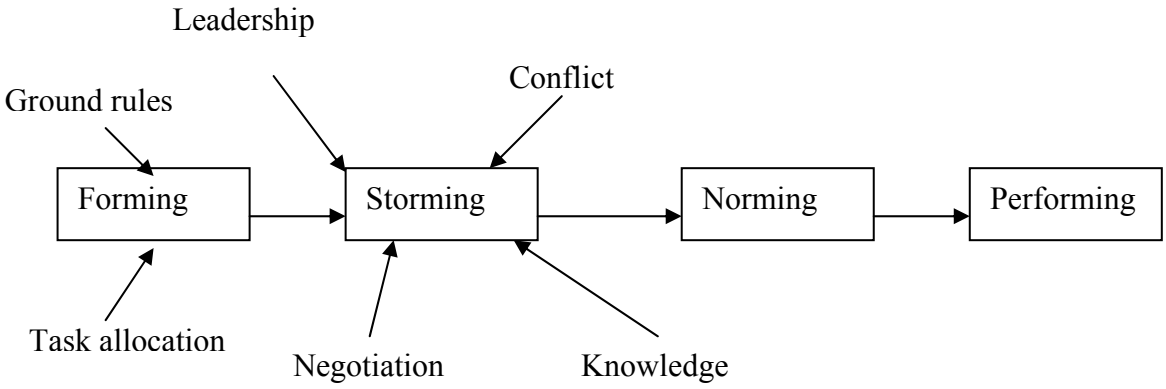


Figure 4.1 The stages of a project from Tuckman (1965)

4.6.1. Functions to support student team projects

Allocating tasks to individual team members is one of the crucial activities in the planning stage of the team project. Allocation of tasks involves defining the roles needed for the project and ensuring the skills are present in the team. This function was chosen as the first to be developed in this student support system, because this would serve to help team members to identify their abilities and preferences, and communicate them to the rest of the team.

When the tasks of the project have been decided upon, the tasks could be allocated to the team members according to their preferences and abilities or previous experience. Students already possessing particular skills, and expressing a preference, could be allocated to certain tasks, and any skills that are lacking in the team would then be identified, and training could be offered to fill the gaps. This would be a first step in developing group cohesion, based upon trust, within the team, because all team members would appreciate that a team member undertaking a particular task was the most appropriate choice, and would be more likely to succeed in producing a good quality result within the time allowed. In providing an automated system this should speed up the team leader's job of finding out team members' preferences and eliminate any negative group dynamics that inhibit the fair allocation of tasks to individuals.

Previous literature indicated that ground rules are often not considered as students start on a team project (Whatley et al. 2001), so the proposed system will include a means of suggesting appropriate ground rules to the team, as a basis for coming to agreement between the team members on acceptable behaviour within the team, to promote good group dynamics, leading to trust. Bos et al. (2002) noted the significance of ground rules for trust formation, and McAlister (2006) suggested a need to establish rules of communication as part of project management. In providing an automated system for team members to use to communicate their preferences for particular ground rules, and see whether other team members agree with their preferences, that agreement on the ways in which the team would work together can be established more quickly.

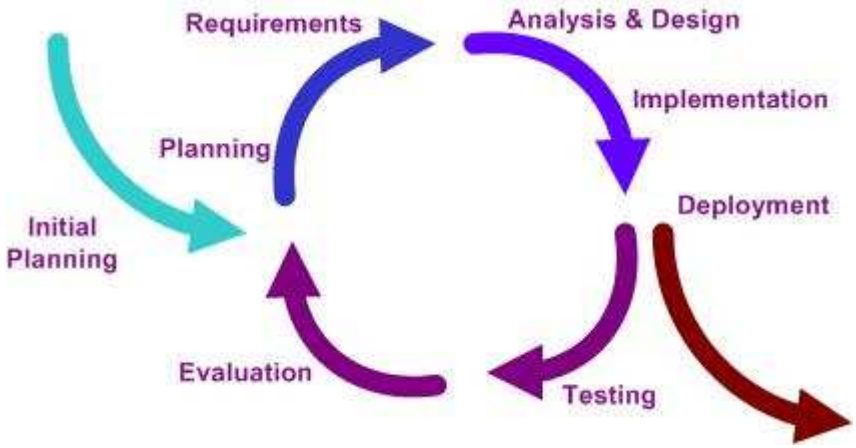
4.6.2. Using prototyping to develop the system

An incremental prototyping methodology was adopted for developing the software system, because this would allow each cycle of the prototype to build upon the findings of the previous one, gradually adding functionality to the system (Figure 4.2). This prototyping approach to the development is regarded as similar to the approach used in action research, in that an intervention is designed and implemented in a series of cycles, to be tested by students through the iterations.

The prototyping approach adopted, used repeating cycles of:

- Diagnosing problems through analysis and fact finding;
- Planning and designing an action or intervention;
- Implementing and testing the action;
- Evaluating the results of the action;
- Learning from the action to inform the next cycle.

A software system to help students with task allocation and agreeing ground rules was developed, using this incremental prototyping process. Through repeating cycles of planning, redesign, implementation, testing and evaluation, the system was tried with volunteer student teams undertaking information systems development projects as part of their undergraduate programme of study, forming this case study.



http://en.wikipedia.org/wiki/Image:Iterative_development_model_V2.jpg

Figure 4.2 Prototyping methodology

4.6.3. Testing the first prototype

Student teams comprising the case study were asked to volunteer to try the prototype system, through their team leaders and team tutors. These student teams were asked to

test the software solution, and report their opinions so that the software could be modified, in an iterative way, through the prototypes. Team leaders were the main source of feedback, but team members' feedback was sought through focus groups and a questionnaire. The views of the team project module tutor were also elicited, to give the tutor perspective on the suitability of the tool to help the students, compared to the intended outcome; the tutor was also used for generation of ideas for the design and as a sounding board for suggestions.

The questionnaire, interview questions and focus group prompts are presented in Appendices 3, 13 and 14. The focus group sessions took place a few weeks after the questionnaires were administered and the interviews conducted, giving the teams a chance to reflect on the progress of their projects since using the system.

Data analysis included reviewing the transcripts of the questionnaires, interviews and focus groups, and coding the feedback into themes. The themes showed commonalities in responses between teams using a particular prototype, and between the different prototypes. A similar method was used to good effect by Lucas and Kline (2008).

The prototypes were to be tested in a series of cycles, with the student teams from the chosen case. This testing would:

- Identify changes to the current implementation that can be incorporated into the next prototype;
- Evaluate the suitability of the pre-programmed content in each version of the system;

At the same time the survey tools of questionnaires, interviews and focus groups would be used to gather data with which to answer the overall research question:

- How useful is online software support in the first stages of co-located student team project working?

4.7. Summary

Most co-located students use a variety of CMC tools to support their team project working in different ways, but often lack the training to use them optimally, and they sometimes try to circumvent face to face meetings through the use of technology, for

instance when they experience difficulties organising meetings. Current provision of groupware for students provides support for the task roles of team projects, but is not adequate for supporting the maintenance roles of team working, in particular at the getting started stage of a team project. The intended and perceived affordance of any software tools provided contributes to the degree of acceptance of the technology support for students.

In this chapter the case study was introduced. Some documented material reporting difficulties observed for this case was analysed to identify issues that correlate with the literature on team working, and issues specific to this case. The main issues relevant to this research were the need for preparation for students and staff, the balance of team composition and its cultural difficulties, and the influence of peer assessment on individual confidence, conflict and honesty. Next there was an evaluation of possible technology support and affordance of systems already in existence that could be used for supporting maintenance roles of student team project working, including groupware, virtual learning environments, intelligent tutoring systems and software agent technology.

Through the cycles of different versions of the prototype system, the students were to be aided in their team project work by the support tool, in the hope that there would be some improvement in the ways in which the students worked and organised their team projects. Empowerment of the students would be through providing them with additional help, not previously available, which would provide team leaders and team members with a better understanding of some of the issues of team working, and allow the ability to adjust their behaviour accordingly.

The following chapter describes the design process in detail, leading up to the first prototype system, which was tried with a cohort of students undertaking team projects on campus in the 2002/3 academic year. In all, three versions of the prototype were implemented, with planning, redesign, implementation, testing and evaluation to inform each revised version. The final version was evaluated over two successive years, 2004/5 and 2005/6.

5. THREE CYCLES OF PROTOTYPING

The previous two chapters outlined the literature informing the rationale for the proposed software system to support the getting started stage of student team project working. This chapter relates the detailed design of the three cycles of prototype implementations, together with an evaluation of each prototype, with these purposes in mind:

- Identify changes to the current implementation that can be incorporated into the next prototype;
- Evaluate the suitability of the pre-programmed content in each version of the system.

Figure 5.1 provides a schematic diagram of the prototyping process. The outline design was informed from the literature and problem identification related in chapters 3 and 4, then implemented as the first prototype, for trying with the students of the case study. The first prototype includes task allocation only, with a single list of skill areas, the second prototype includes the function to help agree ground rules as well as an extended list of skill areas, and in the third prototype the skill areas are divided into generic ones for all projects, and skill areas specific to particular projects, together with the ground rules function. The table in Appendix 9 provides a summary of the main features of each version of the system.

This chapter is divided into three sections each describing a cycle of the prototype development through planning, redesign, implementation, testing and evaluation. The methods used for data collection and analysis are described as they have been used for each cycle of the prototyping. As well as the team project module tutor, the students engaged on team projects were an integral part of this procedure; their co-operation and feedback informed the design of interventions, in an effort to improve the functionality of the system for their benefit.

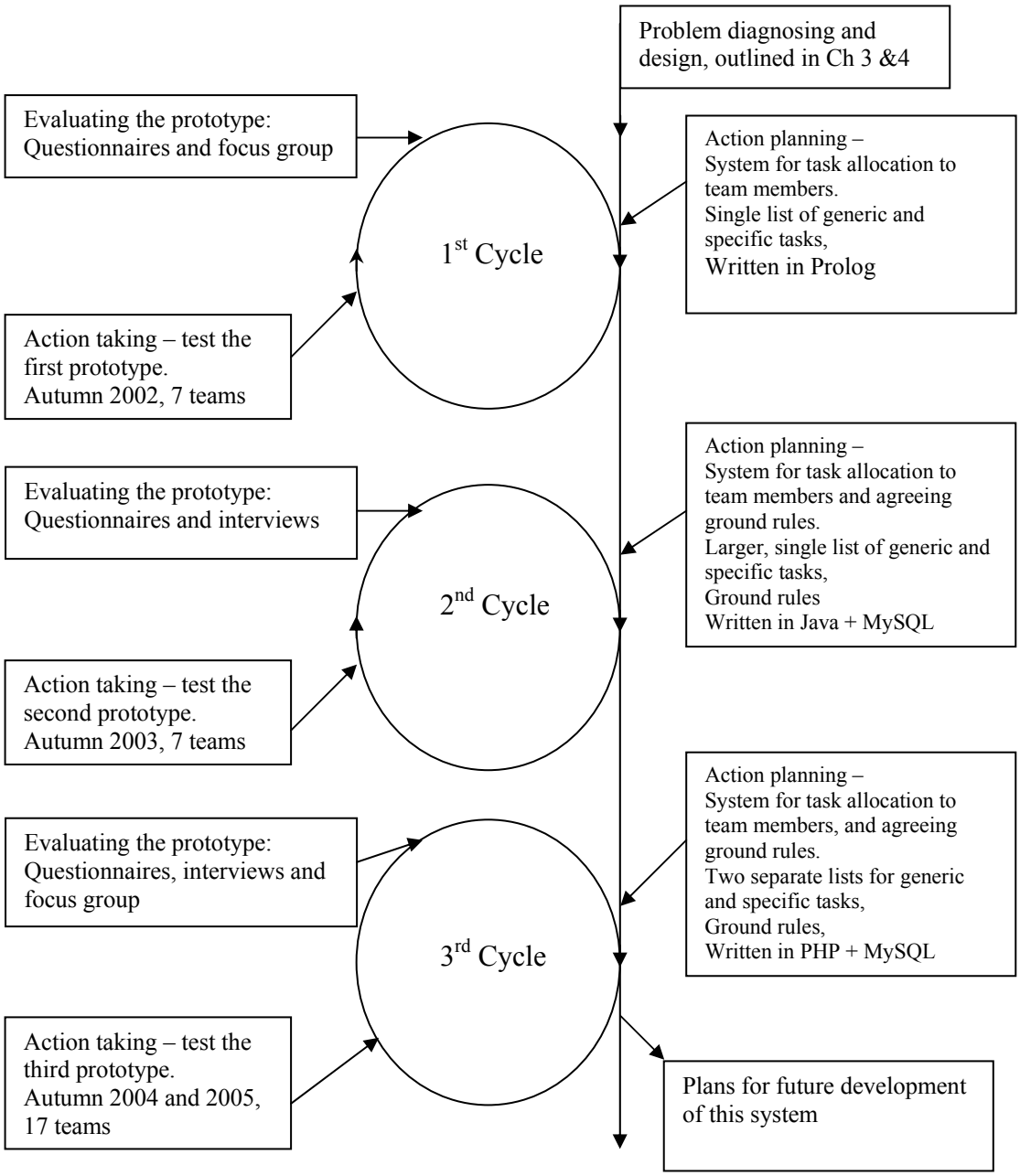


Figure 5.1 Spiral diagram of the prototype testing iterations

The next section provides a description of the design of the first prototype, providing screen shots, showing the content and selection windows forming the interface. Finally, the suitability of the content of the system is evaluated and students' suggestions for changes to the design and implementation of the system are detailed. These suggested changes would be evaluated for possible subsequent incorporation into the second and third versions of the prototype.

5.1. Design and implementation of first prototype

This version of the system included a function to automate the process of allocating tasks to team members, according to their stated preferences. The proposed support system needed to elicit information on each student's abilities and preferences, store these, then use rules based on ability and preference to determine the most appropriate students to undertake each task.

In summary the functions the first prototype system included:

- Obtaining from each team member their preferences and abilities for each task;
- Monitoring the posting of abilities and preferences by all the team members;
- When all of the team members' preferences have been posted, running the rules to allocate tasks;
- Outputting the suggested allocation of tasks to the team;
- Maintaining a record of the tasks allocated to individual team members.

The initial design was based on a multi-agent software architecture, whereby individual students had a copy of the software agent on their computer, which monitored and helped that student, similar to the arrangement used by Johnson and Shaw (1997) to request data, search data and remind the student of tasks to be completed. Because of its supportive role, the prototype agent system was called a Guardian Agent system, contrived from a Guardian Angel, who looks after an individual.

Utilising the software agent paradigm for designing a support system has a number of potential advantages, including the ability of agents to learn about their users, and so store facts about previous actions, to inform advice given to the user, the ability to compare plans with current activity and the possibility of educators (tutors) being able to adjust the rule-base in line with desired learning outcomes (Baggetun et al. 2001). The design meant that all facts would be stored centrally, on a server agent, and each student's agent would have access to these stored facts. Such a design is not without difficulties in the educational environment, such as conflicting roles of the agent, and choosing an appropriate pedagogy model (Mahmood and Ferneley 2006). This design

was chosen because the support system could provide other functions to provide support through the duration of the project, and could become personalised to the individual, giving it potential for long-term pedagogical benefit over the period of an undergraduate programme (3 or 4 years). The future potential of this design is to be explored later in the discussion chapter (Chapter 7).

The design of the Guardian Agent System consisted of three core components, a user interface, a rule base and database implemented in Prolog, and agent functionality for communication. Each team member interacted with the system through the interface function, to input his or her preferences, and to read the output from the analysis. The system also provided capability to communicate this information to all of the other team members, through a Server Agent, which also stored the main database (Figures 5.2 and 5.3).

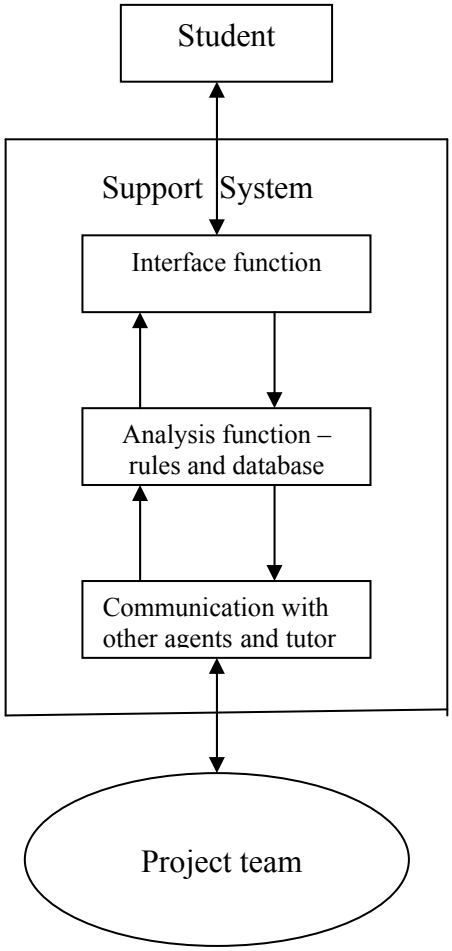


Figure 5.2 Software system functions for each agent

In the chosen system structure, each student communicated with the agent system by means of their individual Guardian Agent. Each agent would have a similar structure when the project began, with interfacing capabilities for communicating with its student, reasoning capabilities for monitoring and analysing the current situation, a knowledge base personal to its student and communication capabilities for communicating with other students' agents. All communications between agents was through the server agent, allowing for a knowledge base to be built up for the particular project the students were working on (Figure 5.3). However, students could still communicate with each other directly, and would not be constrained by the system.

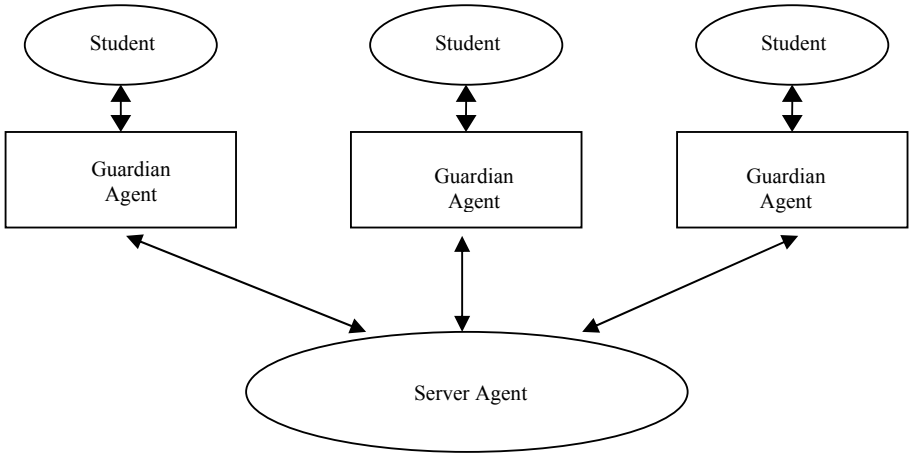


Figure 5.3 Communication between students through the Server Agent

Several tools for agent development were considered, including Zeus (from BT), JAT, SDML, Java and Prolog. Some tools were dismissed as being purely for modelling and research, rather than capable of sustaining a practical implementation that would be portable enough to be installed by dispersed students on their own computers. The final choice was Prolog, as the author had experience of programming in this language, and it was envisaged that its declarative nature would best lend itself to the concept of an agent as an autonomous acting entity, capable of dealing with unpredictable events[1].

[1] A question to the discussion forum supported my choice of Prolog as a suitable tool for building software agents, but there was universal agreement that the design process was more important than the language used for implementation, and other languages such as Java and Lisp have been equally used in agent system development.

The initial prototype for the Guardian Agent was developed in LPA Prolog, using their Agent Development Kit (Logic Programming Associates 2000). This tool enabled the developer to code the interfacing aspects of the agent without worrying about the technicalities of the agent communication, which was dealt with by the tool. The declarative features of Prolog were used for handling facts and rules, which could be passed between each student's agent and the server agent. The program for the agent system was produced as run alone Prolog files, incorporating a series of User Agents linked to a Server Agent, similar to a Client – Server architecture.

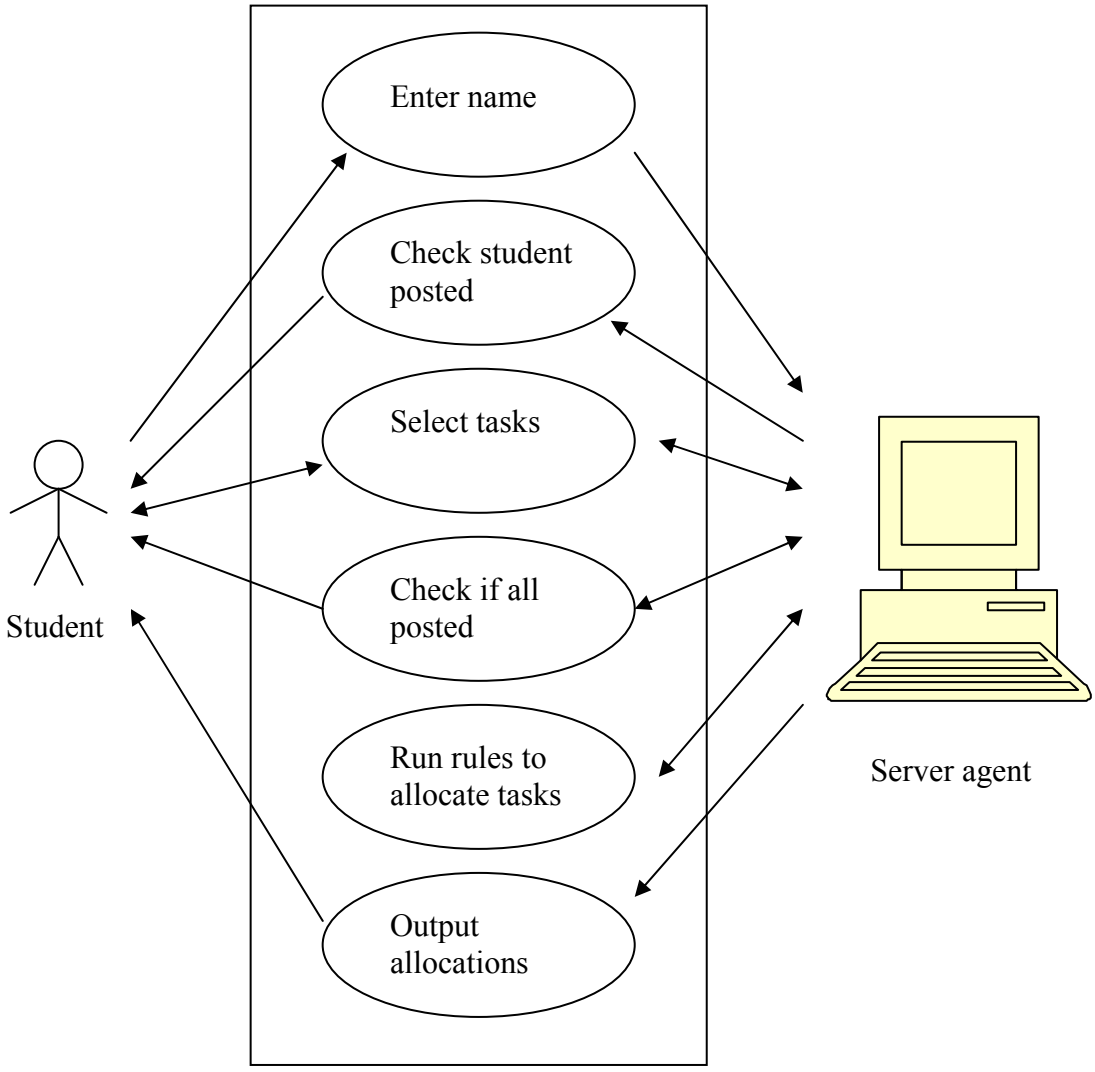


Figure 5.4 Use Case Diagram, showing interactions with the Guardian Agent

The Artisan design tool was used to draw up a models of the proposed system, and a simplified use case diagram is given in Figure 5.4, to show the range of interactions the student would have with the agent system and the processes involved for each

interaction. This is a simplified diagram in terms of the interaction, used solely to identify all of the possible dialogues that the user may have with the system, to facilitate programming the interface. The diagram represents a deterministic model of communication between the student and the system, which does not capture any of the social interactions, which will inevitably take place as well, and does not consider any unintended consequences of use.

To explain Figure 5.4 in more detail, the process of allocating tasks began with the agent asking its student to enter details of their abilities and preferences, so each student first of all identified him or herself, by using a predetermined login script. The system checked whether this student had already posted preferences, and if not, that student was presented with a list of tasks for the team project, from which they could choose the tasks they are good at, not very good at and like or dislike. These preferences were added to the database, and the system checked whether all of the students had posted their preferences. This process continued for all of the students in a particular team, until all the students had posted their preferences.

Once all of the students in the team had posted their abilities and preferences the agent system applied a set of rules to the facts, to provide suggestions of which tasks of the project could be allocated to each student. The agent system maintained a record of the suggested allocations on the server agent. As students returned to the team project support system, the agent presented the allocations that had been suggested, so that all of the students could consider and discuss them with the other students on the team project. Any allocations proposed by the agent system were subject to negotiation between the students, the allocations were simply suggestions, based on preference and ability.

A shell program was then written to allow for all anticipated cases of interaction between the student and the Guardian Agent, and storing the status of students' use of the system. This program worked by consulting the server agent to determine the status of the project, then continuing as the team members interacted with the system to input preferences (Appendix 10). The interface design was kept simple, using dialog boxes to interact with the users, without use of an avatar.

The agent system was programmed to work with three levels of allocation, using the following rules:

Rule 1: Allocation of task -

If studentA likes X and is able at X

Then studentA could do X.

Rule 2: Allocation of task –

If studentB is good at X and has not expressed a dislike of X

Then studentB could do X.

Rule 3: Allocation of tutoring -

If studentC likes X, but is unable at X

Then studentC could be offered tutoring in X

The choice of these rules for allocation of tasks was influenced by requirements of the team project module tutor, findings from previous work, which found that students allocate tasks according to ability and preference (Whatley et al. 1999), and by feedback from student team leaders, who answered some brief questions on the ways in which they have allocated tasks in the past (Appendix 11). So Rule 1 states that a student can be allocated to a particular task, if he/she has indicated that they like that task and are good at that task. This rule follows students' existing practice for allocating a task. Rule 2 is a fallback rule to allocate a student to a particular task if he/she has said that they are good at a task, but although they have not said they like that task, they have not indicated a dislike of the task. This rule was included, following the suggestion of the team project module tutor, that students may record that they are good at a task, but do not like that task, but could still carry out the task. Finally Rule 3 allows for a recommendation for tutoring in a task area prior to being allocated to that task, if the student has said that he/she likes that task, but has also said that they are not very good at the task. Again this rule was included because the team project module tutor was keen to encourage learning of new skills through the project. It was anticipated that having these three rules would eliminate the possibility of the system not returning any allocations for some tasks, and give the team greater freedom to negotiate task allocations using the suggestions from the system.

The system was implemented with pre-programmed task/skill areas, which would be appropriate for most of the typical projects undertaken in systems development. From the students participating in this study, those who had been acting as team leaders were asked for help to identify the task areas appropriate for the team projects they had been involved in previously. Appendix 11 gives the questions team leaders were asked and a summary of their responses. The findings suggested that most projects fell into one of two categories: web design or database design. The most cited skill was documentation or report writing, but also modelling, project management, HCI (Human Computer Interaction), prototyping and MS Access skills were suggested. Programming, word processing, graphical design, analysis of networks, evaluating others were also each mentioned by one of the team leaders. These suggestions were sufficient to arrive at two preliminary lists of task areas, one each for web design or database design, which were programmed into the first prototype.

5.2. Using the first prototype

The objective of testing and evaluation of the first prototype was to determine whether the chosen software agent architecture worked technically, as well as establishing whether the function of task allocation was of benefit to the student teams. This would decide whether it was feasible to continue with the research in this format, and if the system was deemed to be feasible, then changes and improvements to the content and the operation of the system could be included in the second prototype.

Figure 5.5 Interface for asking which tasks this student is good at.

The software was installed onto several computers in the areas used by the teams who had volunteered to help. Each team member was given a login name with which to

start the dialogue with the system. The teams were asked to use the system in the first two weeks of their team project, instead of a face to face or written skills audit. Each team member selected the tasks that they are good at, using the interface as shown in Figure 5.5. A similar dialogue window appeared for the remaining options, tasks each student is not good at, those that they like and those disliked, which were displayed in sequence.

When all of the team members had input their preferences, the team leader could run the allocations program. The system was programmed with the two rules to allocate tasks to individuals, and one rule to identify training needs, as outlined in Chapter 4. When the system had allocated the tasks, a typical output window was displayed, shown in Figure 5.6. This information was then available for all of the team members to look at, to provide them with some information about the other team members' preferences. In addition the team leader, in discussion with all of the team members could use this output of suggested allocations, as a basis for discussion and negotiation of the actual tasks each member could undertake.

A brief guide to using the system was provided for the team leaders, who were also shown how to use the system by the researcher. Team leaders would then be able to show their team members how to use the system (Appendix 12).

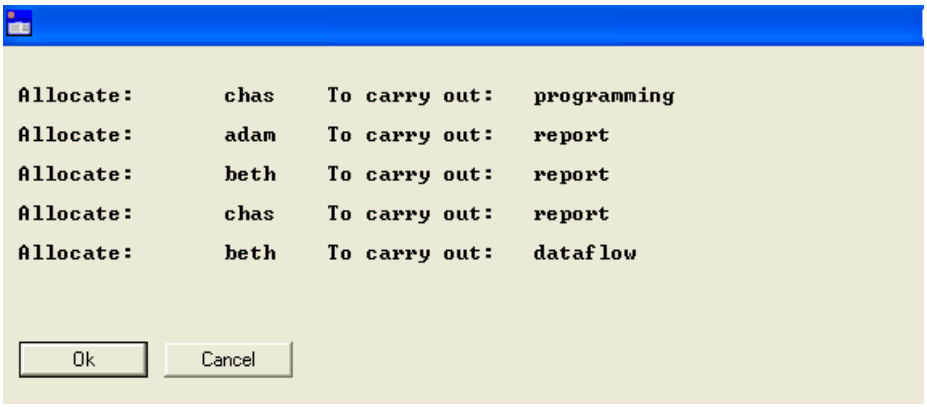


Figure 5.6 Suggested allocation of tutoring for tasks

5.2.1. Data from the first prototype trial

Six team tutors, and their team leaders, and through them the team members, volunteered to try out the agent system on their teams. One extra team leader also

volunteered. The size of each team varied from 7 to 12 members from the second and final year students. The first years were omitted at this stage simply to keep the numbers down to a manageable level, as it was not clear whether the server agent would cope with the number of accesses from student agents.

The system was made available in week 1 of the teaching semester, at the end of September 2002. The seven teams used the system over the following three weeks, to enable team members who were absent in the first weeks to also use the system. During weeks 4 and 5 of the semester, all of the students who used the system were asked to complete a questionnaire, giving their views of the concept of an agent system as well as their opinions on its functionality. The questionnaire and introduction to the research are given in Appendix 3. Copies of this questionnaire were given to the team leaders to hand to their team members to complete, and the team leaders were asked to collect the completed questionnaires, for returning to the researcher. All participants were hence given identical instructions, and the questionnaire was self-administered, to prevent any bias from the researcher.

A focus group was arranged for week 6, to which all team leaders and team members were invited to give feedback (the invitation, with the purpose of the session and the questions are provided in Appendix 13). The focus group was held in a small lecture theatre, equipped with a computer and Powerpoint, so that the questions could be displayed as the session progressed. In the event eight individuals participated in the focus group, some of whom were team leaders, and some team members. A colleague, experienced in running focus groups, and who had been briefed on the purpose of the focus group in advance, facilitated the focus group session. Open-ended questions were used for the focus group, as prompts to ensure that all of the purposes of the session were achieved (Appendix 13). The facilitator was able to ask quieter participants to add comments to ensure everyone participated to some extent. The researcher typed the responses from the participants in full directly into Word, which was visible to the participants on the screen, and in this way the facilitator was able to refer back to previous comments. In order to prevent bias, the researcher only commented when asked to clarify any issues. Analysis of the focus group comments consisted of separating the comments according to themes, aligned to the questions asked. The resulting list of comments is included in Appendix 7.

Although the original conception of a focus group, as a tool for market research, is based on individuals who are unfamiliar with each other (Marshall and Rossman 1990), the participants did know each other in this case. However, this enabled the questions to be progressed faster, and provided for individuals to respond to others' comments in a more reflective manner. Often in a focus group the discussion can go off on a tangent, which is good for furthering the generation of ideas, in this case if the comments were not related to the questions, they were not recorded.

Two of the team leaders requested that they be allowed to use the system again at the start of semester 2, when they realised that the project scope would change, and a fresh allocation of tasks would be desirable. The same questionnaire was administered to these team members in the two weeks following generation of the output from the system.

5.2.2. Analysis of questionnaires and focus group from the first prototype trial

Of the seven teams who volunteered to help with the first prototype, all attempted to use the software in the first semester, and two of the teams in the second semester. However, as the names of team members were fixed at the start, it sometimes took several weeks before all of the team members had posted their preferences. This led to some of the team leaders using alternative means to allocate tasks, in order to get the project under way. In some of these cases the team leader used the results finally obtained from the system to compare with the allocations chosen manually a week or two earlier. Some team leaders had tried to use the system as prescribed, but were frustrated by the failure of the system to work correctly first time on some occasions, leading to time delays in obtaining output from the system.

The first questions of the questionnaire asked how useful the system was to these student teams, and whether the system would be useful for online as well as campus based students. These closed questions were analysed by counting the number of yes and no responses, and entering the figures on a spreadsheet. The results from these questions are given in Table 5.1. Responses to the open questions were in the form of brief comments, and these were typed into the same spreadsheet, to be considered later.

Just over 50% of the respondents thought that the system was useful to them, and that they would like to use such a system. A higher number thought that it would be useful to online students, and would use it in that case (80% and 70% respectively). As a result of these figures a decision was made to continue with the development of the Guardian Agent system.

Guardian Agent	**Summary of Questionnaire results**								
Prototype version 1, coded in Prolog, 2002 (50 responses)	Was this agent facility of use to you in your team project?	Did you find the interface easy to use?	Did you find the interface self explanatory?	Would you like to see a character or embodiment for this agent?	Do you think an agent, something like this one, would be useful to students working on group projects: Online?	Do you think an agent, something like this one, would be useful to students working on group projects: On campus?	Do you think students would like the concept of an agent to work with them: Online?	Do you think students would like the concept of an agent to work with them: On campus?	Would you personally like this sort of agent (Y/N)
Number answering No, or no answer given	24	9	14	42	10	22	15	22	24
Number answering Yes	26	41	36	8	40	28	35	28	26
% answering Yes	52	82	72	16	80	56	70	56	52

Table 5.1 Responses to closed questions, Version 1 prototype

The open-ended questions included in the questionnaire, asked for suggestions of differences, additions or changes, which might improve the usability and usefulness of the current version of the prototype. The questionnaire comments collated on the spreadsheet are provided in full in Appendix 5, but those relevant to this prototype version are extracted here in Table 5.2, along with the relevant focus group comments (from Appendix 7), and have been divided into those issues concerned with the interface and those concerned with the content. Although most students thought that the system was easy to use and self-explanatory (Table 5.1), there were several criticisms of the interface, leading to suggestions for improvements, given in Table 5.2.

In terms of the interface the system operation needed more explanation, and instructions for using it should be on screen, rather than an accompanying document. Highlighting the chosen option did not really work satisfactorily, as the default entry was often selected without realising it, so the suggestion of using check boxes instead, was made. The output from the system should also be printable from the interface, so that the team leader had it readily available for discussion. The need for some additional help, perhaps by hovering over the selected item, was noted.

In terms of the content, there was agreement that the skill areas included were not broad enough, and should include management skills as well as a wider range of technical skills. The possibility of grading a student's ability level, to indicate the extent of their ability was suggested, and the output should include the reason why an individual was allocated to a task, by recounting the rule triggered by the system. Students noted that the system might allocate too many team members to a particular task, and none to others, so the system should identify these conflicting allocations.

	Suggested improvements from questionnaires	Suggested improvements from focus group
Interface issues	• Larger text and windows • Easier to follow layout and clearer interface • Improved user instructions and explanation • More colour and more appealing • Ability to edit input later • Error capture when wrong name input • Tick boxes or check boxes for choices • Quicker in operation • Operation over Internet • More GUI buttons • Improved format of the outputs	• Not well explained, purpose, introduction screen • Explaining the purpose, so team members understand it is there to help them • Problems interacting with the system, not very intuitive • Need more instructions • There was a default line selected that user had to change, and some did not notice • Perhaps use checkboxes • Need a printable output • Help would be better in a cursor over box
Content issues	• Management skills needed • More technical roles • Help with management issues • More choice of tasks and skills • Grading, to indicate extent of ability	• More skill areas needed • What if too many members allocated to the same task? • No difference between theory and practical work • Agent should give more information as to why a task was allocated to a particular member

Table 5.2 Summary of suggested changes to the system, extracted from questionnaires and focus group.

In evaluating the usefulness of the first prototype, issues concerning the scalability of the system, integration of the system into a user interface and portability of the system

to other platforms were considered to be important in the eventual acceptance of a software system (Rubens et al. 2005). The first prototype was used by seven of the teams, about 55 students in all, but they did not all try to access the server agent at the same time, as some arrived to the team meeting at different times, or were absent in the first week. A further observation was that there was a delay in obtaining the output from the system until all of the team members had used the system, because the system had been set up for all of the students on the module list, and invariably some students do not attend sessions in the first few weeks.

This prototype was running in the programming environment, so the interface was slower to operate than it should have been, leading to some dissatisfaction for the students. However, the speed of message passing between the Guardian Agents and the server agent was acceptable on this scale of implementation, using the internal network.

5.2.3. Summary of first prototype outcomes

As a result of the evaluation of the first cycle of testing the prototype, decisions were taken between the researcher and the team project module tutor on how to improve the system for the second cycle of testing. The amendments considered for implementation in the second prototype system are given in Table 5.3. In addition the second prototype was planned to include a function to agree to a set of ground rules for team working.

• Larger selection of skills and tasks; • Ground rules; • Improved interface for selecting options, e.g. checkboxes; • Improved instructions for using the system; • More accurate list of members in each team; • The system could indicate which rule was triggered to provide the allocation; • Faster operation, portability to support greater numbers; • Operation over the Intranet.

Table 5.3 Modifications to the first prototype, arising from the evaluation

Of the feedback from the focus group, two comments stood out as instrumental in suggesting further division of task areas, which gave rise to the expanded list of tasks in the second prototype. One student recognised a need for dividing tasks into groups so that they could be more specific:

"Make it more focussed so that can allocate specific tasks rather than generic tasks" Focus group, 2002,

and another comment supporting a need for different types of tasks:

"Nothing to distinguish between theoretical work and practical work" Focus group, 2002

Other feedback that was related to the interface, provided similar suggestions to those from the questionnaires, and further analysis of this data is given in Chapters 6 and 7. The next section describes the design process for addressing these issues in the second prototype system, and the feedback on the implementation obtained from the second iteration of the research.

5.3. Design and implementation of second prototype

Clearly, from the trial of the first prototype, there were a number of design issues that needed to be addressed to improve on the first prototype, also a number of issues that were desirable in the next version of the system, as detailed in Table 5.3. Taking the amendments in order, the implementation of these changes is detailed in this section, leading to the trial of the second prototype.

Taking into consideration the feedback from students and issues of portability and speed, it was decided that the second prototype should be developed in Java, rather than continuing with the use of Prolog. The programs for the agents were produced as Java executable files, incorporated into web pages, and an improved user interface was designed for the system. A server running a MySQL database, in which the facts were stored, replaced the server agent. This version could be accessed over the Internet, enabling students to work from home as well. Programming in Java would also provide for improved interfaces for input and output, which were more familiar to the students, than the interfaces generated by the Prolog programming tool.

The limited set of skills, included in the first prototype, was deemed inadequate to represent the full range of skills students require for their team project work. In consultation with the team project module tutor, additional skills were selected to include in the design, to cover the range of projects undertaken in this case. The team project module tutor was also concerned that students did not give enough

consideration to the needs of the project, and routinely implemented a team structure, comprising administration, technical and research sections, based on previous custom and practice. In an effort to overcome this limitation, team leaders would be encouraged to use the new system to gain a broader perspective on the range of team working skills needed for their project as well as the specific practical skills. Using the new system the team leader would be able to select the practical skills they thought would be needed for their particular project, thus customising the display for their team, an example of the task selection interface is given in Figure 5.7.

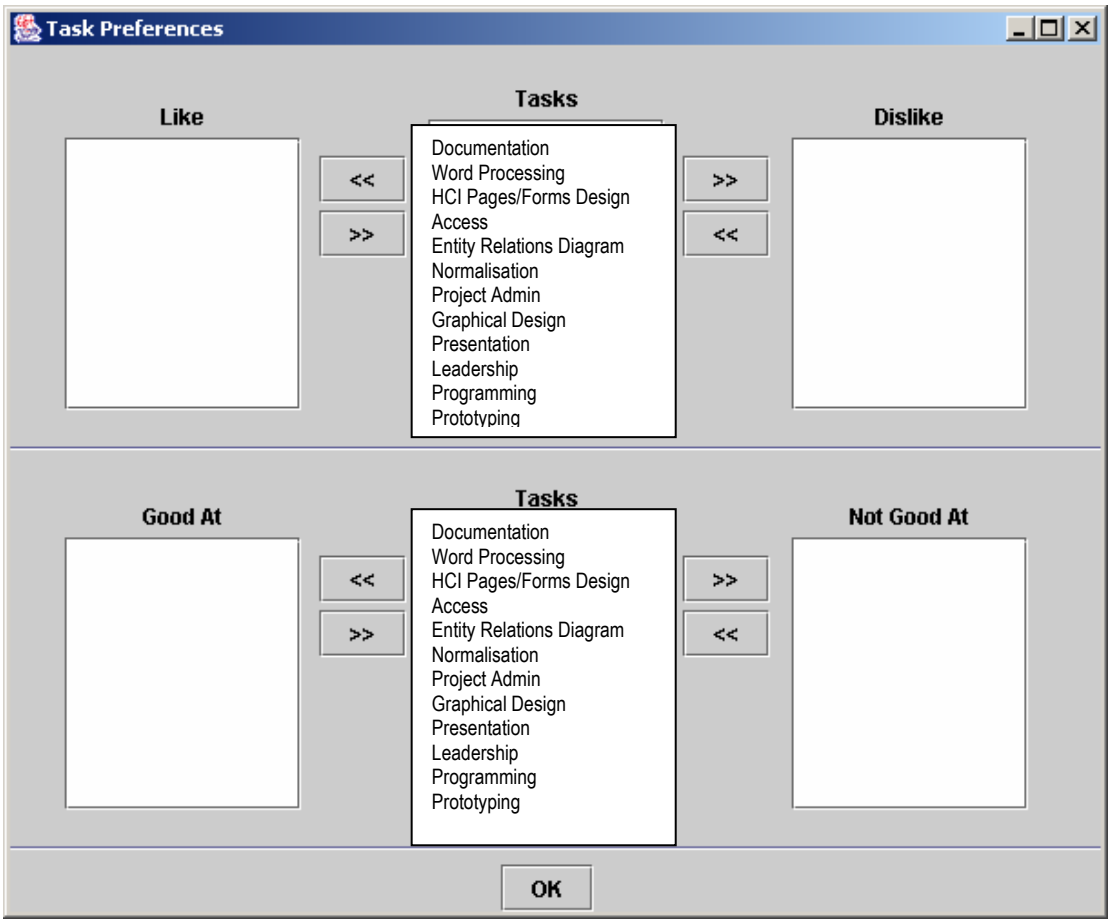


Figure 5.7 Example of an input form for selecting preferences

The ground rules the agent system was programmed to use were:

> If all team members say they think a rule is important
> Then it is suggested for acceptance;
>
> If more than half of the team members think a rule is important
> Then it is recommended to be considered.

The choice of 50% as the trigger for considering a rule for including was arbitrary, because at this stage of the research it was thought to be more important to find out about the students' perceptions of using ground rules in their team projects. Any suggestions returned by the Guardian Agent were subject to consideration by the team leaders and members, and could be rejected. It was proposed that the resulting discussion on which ground rules to agree upon for the team would prevent conflict arising between the team members. The list of ground rules included some associated with attendance and some with behaviour at meetings, and were drawn up in consultation with the team project module tutor, based upon those suggested by O'Sullivan et al. (1996).

Each team member would select from a list, the ground rules they thought were important for the team members to adhere to during the project. Again, the designated Team Leader was able to edit the rules included in the selection list. An example of the ground rule selection interface is given in Figure 5.8.

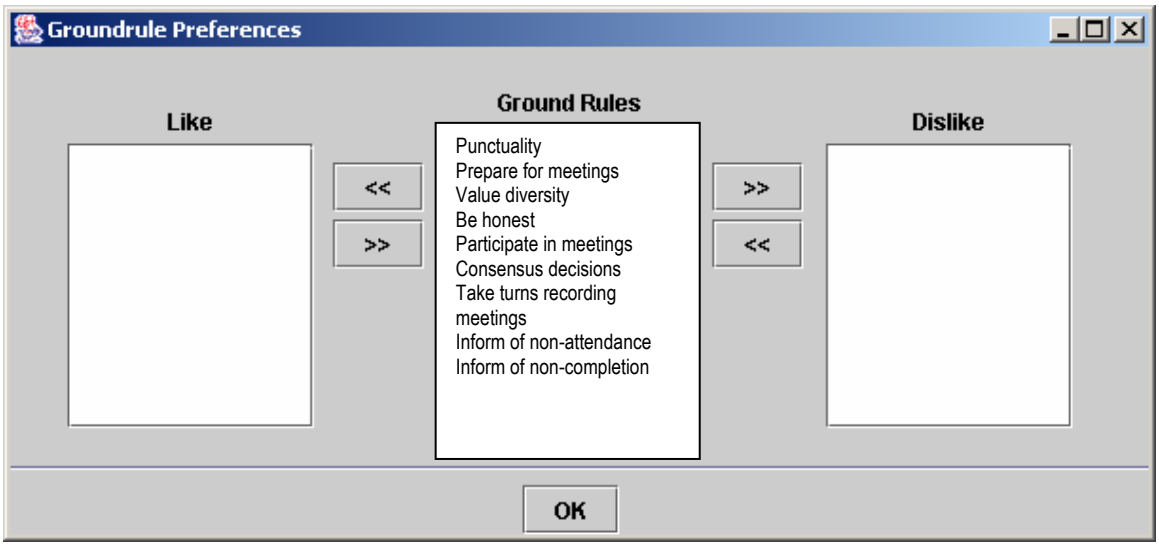


Figure 5.8 Example of input form for selecting ground rules

A further modification to this version of the prototype is that the team leader should be able to enter the names of the team members on the system, and allocate them a login name. This would prevent the team leader from having to cope with the problem of team members who are down on the list for a team, but who do not appear in the first weeks of term, giving them more control over their team.

Using Java as the programming language, produced an interface with a different appearance, and selection was now by highlighting and moving a choice across to the left or the right according to preference. This interface was chosen in preference to checkboxes, and there was still no provision for grading an individual's ability level.

As for the first prototype, the team leaders were given printed instructions for logging onto the system, setting up tasks and ground rules for their project, and adding their team members to the list. Team members were likewise given printed instructions for logging onto the system and choosing their preferences for tasks and ground rules.

The whole system was set up on the internal network, so that it could be accessed from the computers on campus. A system coded in Java and accessing a MySQL database should be faster in operation than the first prototype turned out to be. All of the team leaders were given a login to the system, and instructions, sent by email, and available on the Blackboard area to support the team project module. The designated team leaders were therefore free to choose whether or not to use it for their team project. The researcher was on hand at each team session in case there were any queries on using the system, and to solve any immediate difficulties with using it.

5.3.1. Data from the second prototype trial

Again, the system was made available at the beginning of the teaching semester, at the end of September 2003. Of the 28 project teams in that academic year, there were seven teams that attempted to use the system. These teams used the system over the following three weeks, to enable team members who were absent in the first weeks to also use the system. During weeks 4 and 5 of the semester, all of the students who used the system were asked to complete the same questionnaire as used in the previous year, to give their views of the agent system and their opinions of its functionality (Appendix 3, version 1). Again, the questionnaires were given to the team leaders to hand to their team members to complete, and the team leaders were asked to collect the completed questionnaires, for returning to the researcher. The results were collated and typed by the researcher into the same spreadsheet that was set up in the previous year.

Instead of running a focus group, the researcher interviewed the team leaders from these seven teams, to gain feedback on how the system was used by their teams. The interviews were structured, following the questions shown in Table 5.4, which were open-ended to allow for free responses from the interviewees.

1. Did your team use it?
2. Was it successful, in terms of your project?
3. How did you use the outputs? Allocations? Ground rules?
4. What did you think was good about the agent? functionality? interface? implementation?
5. What did you think was bad about the agent? functionality? interface? implementation?
6. What other functions do you think it could have to help your team project?
7. What did you think of the task areas pre programmed in the agent?
8. What did you think of the ground rules pre programmed in the agent?
9. Have you any other suggestions for this agent?
10. Do you think overall the agent system did help you as Team Leader?
11. Would you like to have the agent system available for Team Projects?

Table 5.4 Questions asked in the interviews, October 2003.

The interviews were carried out, after the teams had made use of the system, in weeks 9 and 10 of the semester, by the researcher, who is an experienced market research interviewer. Each interview was conducted at a mutually convenient time, either in the researcher's office or an empty room near to the project areas. The researcher wrote the individuals' responses down onto blank sheets with just the interview questions on them, so that none of the questions would be omitted. A similar wording was used as an introductory text for the interviews, which is given in Appendix 14, thus approaching each interview in an identical manner. The transcripts from the interviews were typed up immediately afterwards into a Word document.

Although some researcher bias is possible in this case, because the researcher conducted the interviews, this was outweighed through the interviews being conducted by an experienced market research interviewer, alert to the possibility of influencing the responses of individuals. However, it is not known the extent to which the researcher being a lecturer may have affected responses from students. Students may have provided answers that they perceived the researcher was looking for.

5.3.2. Analysis of findings from the second prototype trial

A summary of the responses to the closed questions is given in Table 5.5. Again, just over half of the respondents thought that the system was useful to them (59%), but fewer felt that they would personally like to have such an agent system (32%), although they recognised its potential for online students (64%).

Guardian Agent	**Summary of Questionnaire results**								
Prototype version 2, coded in Java, 2003 (22 responses)	Was this agent facility of use to you in your team project?	Did you find the interface easy to use?	Did you find the interface self explanatory?	Would you like to see a character or embodiment for this agent?	Do you think an agent, something like this one, would be useful to students working on group projects: Online?	Do you think an agent, something like this one, would be useful to students working on group projects: On campus?	Do you think students would like the concept of an agent to work with them: Online?	Do you think students would like the concept of an agent to work with them: On campus?	Would you personally like this sort of agent (Y/N)
Number answering No, or no answer given	9	4	8	17	8	12	13	14	15
Number answering Yes	13	18	14	5	14	10	9	8	7
% answering Yes	59	82	64	23	64	45	41	36	32

Table 5.5 Responses to closed questions, Version 2 prototype

Some teams had difficulties because of absences of team members, which led to delays in planning the tasks of the team project, so once again an alternative means of allocating tasks was used by these team leaders instead, such as face to face interviews and entering skills onto a spreadsheet. However, these team leaders did agree that the eventual allocations from the system matched very closely the allocations they made manually, and one team leader said that it was used as a guide for discussions between the team members, another said that it highlighted skills in other areas. One of the team leaders did say that he wished he had used it sooner. Team leaders are under considerable pressure to get on with the work, knowing how much needs to be achieved during the ten weeks of the term.

Responses to the closed questions suggest that the interface was easy to use and self-explanatory (82% and 64%), it was found that some of the changes included in the second prototype did not improve the interface issues students experienced with the first prototype. The frustrations can be seen in the feedback received through the questionnaires, leading to the suggested changes that could be made to the system, listed in Table 5.6. This table combines the comments from the questionnaires with those from the team leader interviews, and again they have been divided into the interface and the content issues. The full list of questionnaire comments, from which these have been extracted, is given in Appendix 5.

	Suggested improvements from questionnaires	Suggested improvements from interviews
Interface issues	• More colourful, more appealing • More user friendly, animations • More colours, more options • A little note to explain each section • Easier to understand, not sure if have to select all tasks • More user friendly, better use of HCI principles • Results displayed more clearly because currently are hard to read • Printout is non stop writing, too much to take in, looks funny once printed out • Facility to save print out of results • Some buttons weren't self explanatory, add consultative text for buttons • Ability to save data to external file and print	• Change the display so that it shows allocations for each person. • Display an account of how many liked X, especially if there are too many, rather than read out and count, e.g. if you have 5 people who like X. • Automated login within Blackboard.
Content issues	• More tasks available, add own tasks specific for a project • More project oriented skills, or specific help with added features • Remove vague questions, allow more scope, more specific details on what is involved in tasks	• Feedback on carrying out documentation, what is expected, roles, responsibilities. • Examples of reports, what is involved in jobs such as administration. • How to handle problems, what has happened in the past, as a guide • Some skills missing or vague. • Not sure what some mean. • Add more detail on skills

Table 5.6 Summary of suggested changes to the system, extracted from the questionnaires and interviews.

Overall the team leaders reported that the system was easy to use, with the interface acceptable, although a more colourful, appealing and user friendly interface, was suggested by some team members. The display of the results could be improved by having a better structure, and the possibility to output results in different formats, e.g. by person. The system should also provide a list of how many members liked a particular task, to make it easier to see if there is too many allocated to a task.

The team leaders thought that being able to access it from the university intranet was an improvement. Two of the respondents suggested that using Java means that the interface runs more slowly than it would if written in another language, and the interface had a "*clunky, obviously Java interface*", which proved to be slow in operation. Minor difficulties with the login and display of items to choose from were reported, some team members were not sure whether they had to make a selection for all tasks, even if they were not relevant to their project, and an automated login was suggested.

All of the team leaders in this study used the allocation of tasks function, but four of the team leaders did not use the ground rules selection, as they did not see the selection interface for these, or any reporting of them, because the interface did not specifically lead the user to the ground rules section. Of the remaining three team leaders, one reported that the ground rules seemed reasonable, the others did not actively promote choosing ground rules to their team members, and did not use the outputs of suggested ground rules to guide any discussion.

Considering the content of the system, the task areas caused some concern, as many more tasks could have been included, and one suggestion was that the team leader should have the facility to add extra tasks. Some students reported that they did not understand some of the tasks given, the task name alone was not sufficient to explain what is involved in the tasks, e.g. project management, so more detail is a feature which would be of benefit, in particular, for first year students. Another enhancement suggested was to ask team members to rate the level of their ability in a task.

In thinking about the project skills displayed by the system, team leaders came up with suggestions for additional information the system could provide, such as what is expected of a task, what roles and responsibilities are involved, the sorts of documentation required, and how problems have been handled in previous years as guidance. These will be pursued further in the next chapter.

Feedback from the team project module tutor as well as these suggestions for improving the display, the interface and the contents were taken into consideration

when revising the system for the next round of prototyping. The next section outlines the design and implementation changes for the third prototype.

5.4. Design and implementation of third prototype

Following on from the successful implementation and use of the second prototype, the amendments considered for implementation in the third prototype system are given in Table 5.7.

• Embed the system in web pages, for easier access over the Internet; • Improved interface for selecting options; • Improved instructions for using the system; • A less "clunky" interface; • Link the login to the Blackboard login; • Improved presentation of results, by person as well as by task; • Printable output of results; • Selection of skills and tasks divided into generic and project specific; • Team leader can add extra tasks; • More information about each task; • Grading of degree of ability and preference; • The system could indicate which rule was triggered to provide the allocation; • Guidance on carrying out some of the management tasks.

Table 5.7 Modifications to the second prototype, arising from the evaluation

The interface was improved in line with most of the suggestions listed, but the main change was to provide two lists of tasks: project generic tasks, those that apply to most project types (e.g. report writing, project management), and project specific tasks, which may only apply to certain types of projects, and from which the team leader could select the most appropriate (e.g. programming languages, database design, web design). The third prototype system was redesigned to have a two-stage process for interacting with it, firstly selecting generic project skills and ground rules, and secondly selecting skills specific to the particular project.

Stage 1 - The team leader would first ask all the team members to input their preferences for project generic skills, from the list presented (Figure 5.11). The output would provide guidance for the team leader to structure the team into appropriate sub teams and establish team working practices, in order to get work started on preparing a project specification. Team members would also input their preferences for ground rules at the beginning of the project (Figure 5.12), so that the team could discuss the output and agree on rules they would all adhere to, as part of good team practice. The ground rules included were the same as in the previous prototype.

Stage 2 - After the team had acquired a more detailed understanding the specification of their project, they would be in a better position to know what technical skills were required. At this stage the team leader would select from a list of skills (Table 5.8), those that are relevant to their particular project, and the team members would once again input their preferences for these selected skill areas. On the basis of the allocations output, the team leader could allocate the technical tasks to appropriately experienced and willing team members.

Database design	Programming – Visual basic
Web design	Programming – Java
Multimedia design	Programming – Javascript
Application HCI design	Programming – HTML
Data modelling	Programming – PHP
Normalisation	Programming – SQL
Process modelling	Programming – XML
Object oriented design	Programming – ASP
UML	Microsoft Access
Testing	Microsoft Project
	Macromedia Dreamweaver

Table 5.8 Project specific skills included in the third prototype

The list of tasks included was intended to cover all possible types of projects, so the team leader was able to select a smaller subset of the tasks, representing those relevant to their particular project. A brief explanation of each task was also included, as a text box to be displayed when the mouse hovered over the item.

5.4.1. Design of the third prototype for students

The system was recoded in PHP with a MySQL database, because this would avoid the slow operation of Java and be more readily embedded into web pages, which would make the system accessible to students from home or elsewhere. The colour scheme and design was based on university corporate colours already associated with the ISI web pages, as shown in Figure 5.9. The login screen was identical for team leaders and team members.

Figure 5.9 Example of the login screen, opened in a school window

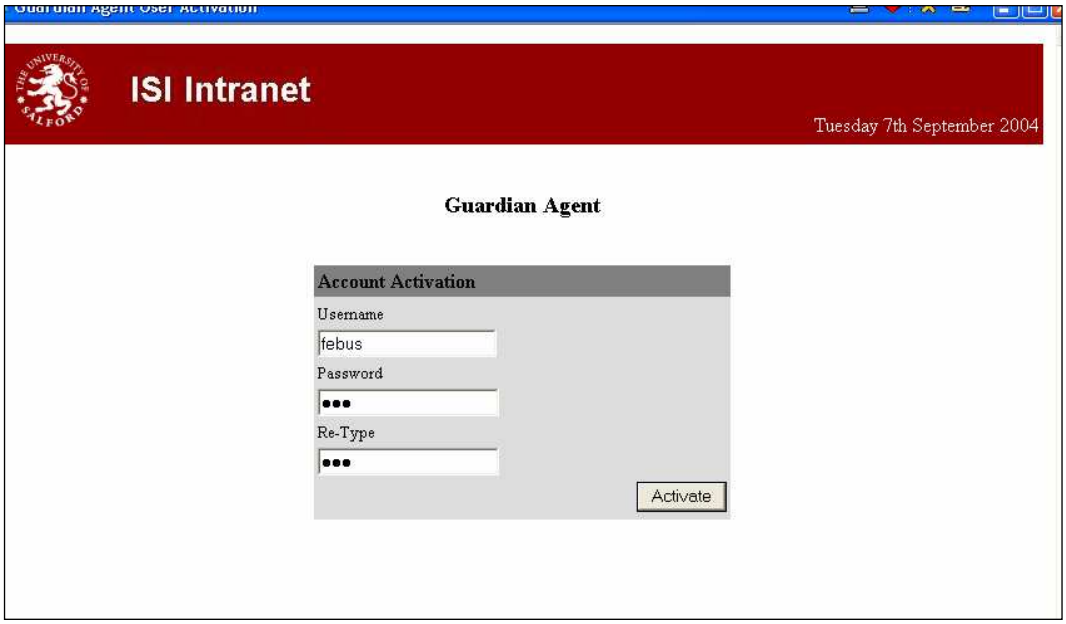


Figure 5.9 Example of the login screen, opened in a school window

The team leader was still to be responsible for enrolling the team members, and allocating them a username. The team leader's Guardian Agent home page gave access to a listing of the team members, a function to add team members, and the function to choose the project specific skills, Figure 5.10.

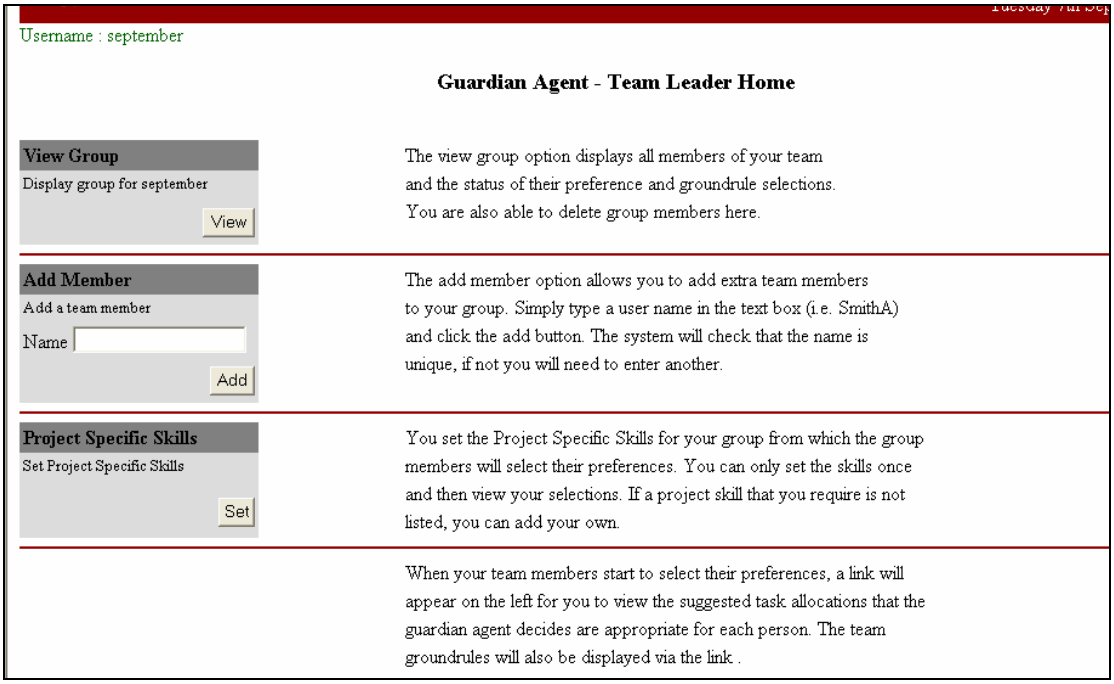


Figure 5.10 Team Leader Home Page view

Each team member was then asked to login, and choose a password, to gain access to the system. Team members could then select preferences and ability levels for each of the project generic skills listed, as shown in Figure 5.11. The design had been changed to allow students to indicate their ability at the given tasks, from Poor to Good, and their preference from Dislike to Like, on a nominal scale of 1 to 6. The choices made would be input to the database when the selection process had been completed. The task allocation rules were modified so that a grading of 5 or 6 (according to the position on the scale selected), would trigger a "like" or "good at" response, with grades of 1 or 2 representing "dislike" or "not very good". Grades in between were recorded as neutral responses.

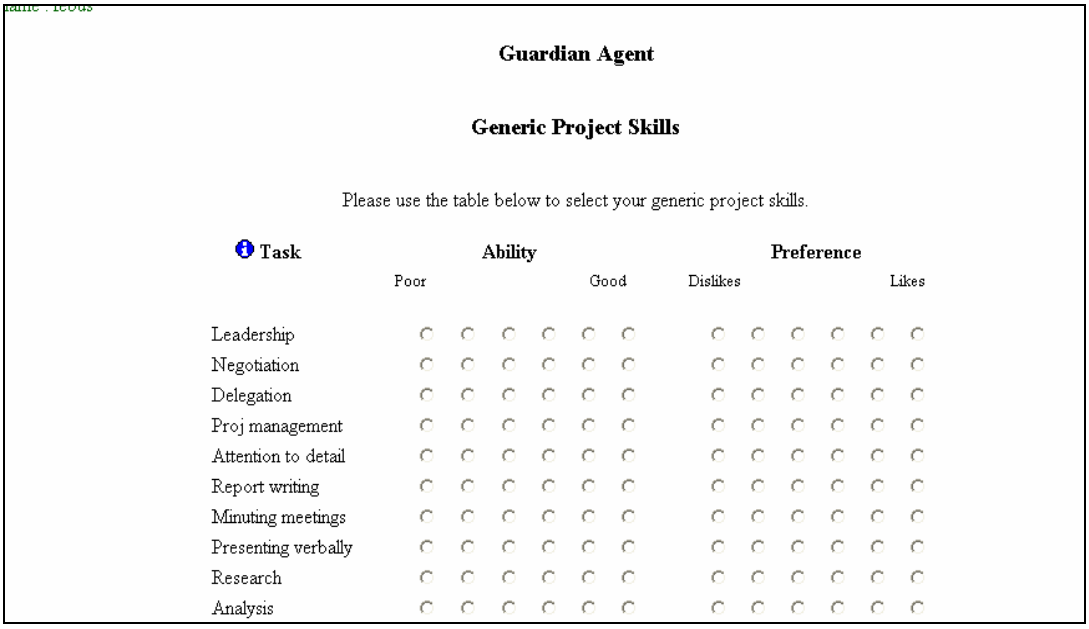


Figure 5.11 Typical view for team members to select project generic skills

Each team member was then asked to select from a list of suggested ground rules, those considered important in taking part in a team project, from a screen similar to that shown in Figure 5.12. The rule for the system to suggest a ground rule was simplified from the first and second versions of the prototype system to just one rule, because in practice it was found that the first rule was not triggered if one or more team member did not use the system. The rule for suggesting ground rules now reads:

> If more than half of the team members say they think a rule is important
> Then it is suggested for acceptance;

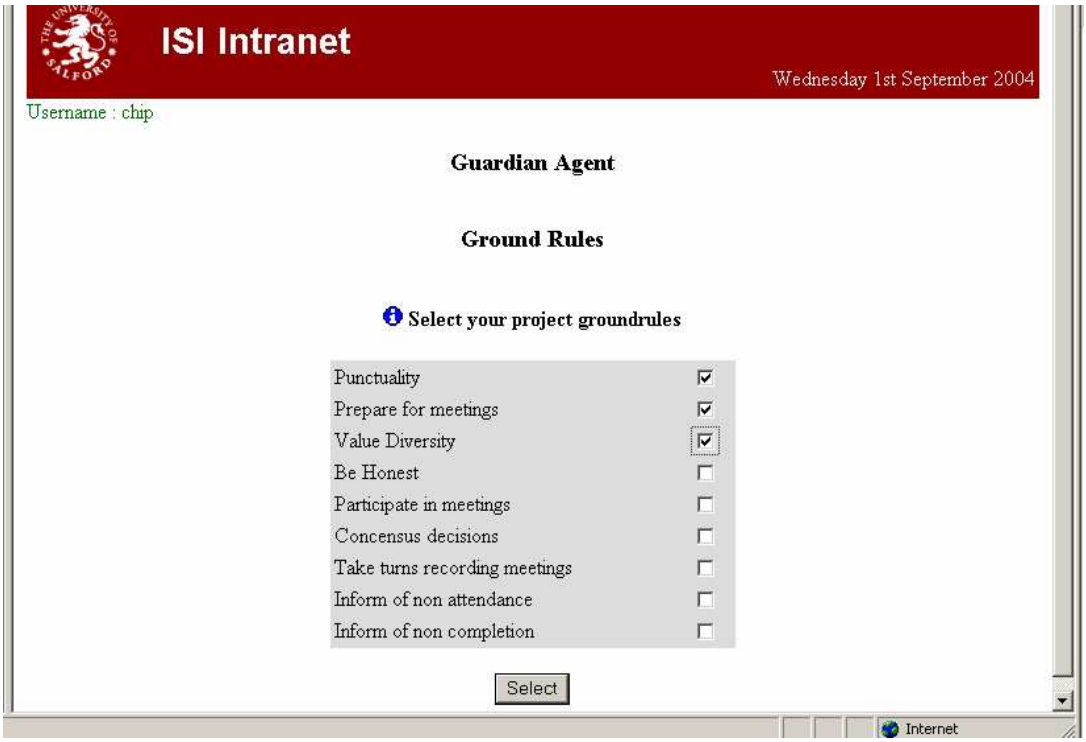


Figure 5.12 View for team members to select ground rules considered important.

When all of the team members had input their preferences for the first time, the team leader would be able to view an output screen with suggestions for initial allocations of project generic tasks and ground rules, Figure 5.13. The output screen also indicated which rule had triggered allocating an individual to a task, e.g. because they indicated liking and being good at a project skill. From the example given, Bill could be given the task of presenting verbally, but would require some training in attention to detail and Chip would be suitable for leadership and negotiation roles.

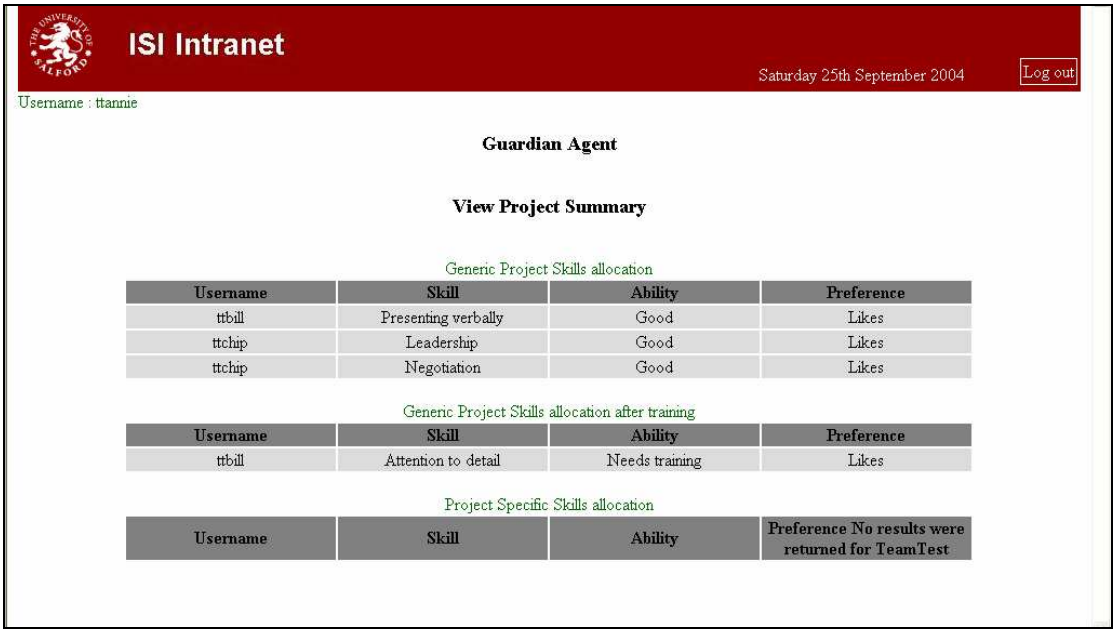


Figure 5.13 Output of project generic tasks and ground rules.

The second stage of the process took place when the team leader is in a position to be able to decide upon possible roles for team members. During the first few weeks the team as a whole would be establishing the project specification, and the team leader will then be in a better position to be able to choose which project specific skills would be required for the project. Figure 5.14 shows a typical confirmation screen for the project specific skills selected by the team leader.

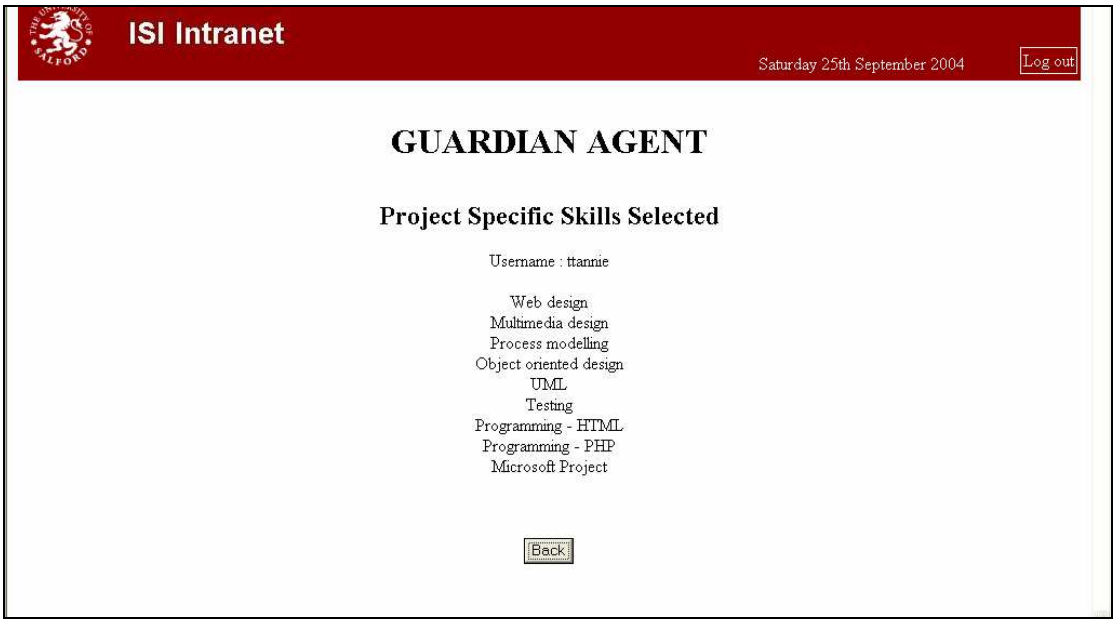


Figure 5.14 Example of the display confirming choices of project specific tasks.

All team members could then login to the system to select their ability levels and preferences for each of these skills, as before. When all team members had completed this, the team leader and team members could view the output task allocations, as in the example given in Figure 5.15. The final output listed task allocations for generic project skills, and indicated whether individuals could undertake a task if they were given some training, i.e. a high grade for liking a skill, but a low grade for ability, e.g. Bill needed training in attention to detail and two of the project specific skills, and Chip needed training in testing as well as using Microsoft project, as shown in the example in Figure 5.15 This screen dump also shows three suggested ground rules for the team.

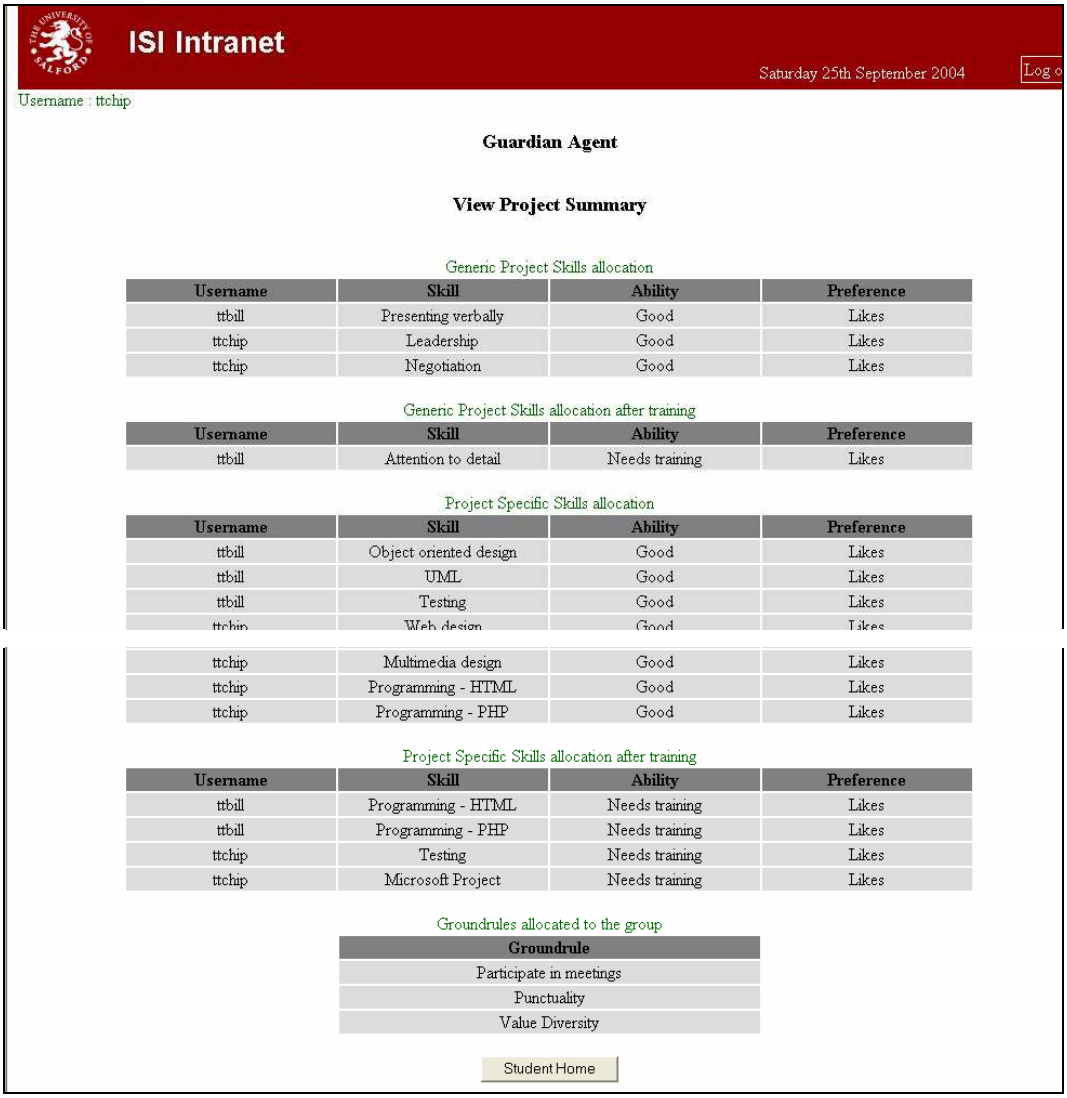


Figure 5.15 Example output screen, showing allocations of tasks and ground rules.

5.4.2. Data from the final version of the prototype trials

This version of the system was made available to all of the project teams at the beginning of the teaching semester, week 1, at the end of September 2004. The seven teams that used the system over the following three weeks were asked to complete the same questionnaire as used in the previous years, during weeks 4 and 5 of the semester. However, the wording of the questionnaire was changed to reflect the different functions of the system they had used, as follows:

Was this agent facility of use to you in your team project?
All functions?
Generic project skills?
Project specific skills?
Ground rules?

Again, the questionnaires were given to the team leaders to hand to their team members to complete, and the team leaders were asked to collect the completed questionnaires, for returning to the researcher. The results were collated and typed by the researcher into the same spreadsheet that was used in the previous two years.

All seven of the team leaders were willing to be interviewed by the researcher, and these interviews were conducted in weeks 9 and 10 of the semester, in the same manner as in the previous year. The first three interview questions were changed to ask about the different functions of the system:

1. *Did your team use it?*
   Project generic skills to structure your team? Ground rules? Project specific skills?
2. *Was it successful, in terms of your project?*
   Project generic skills to structure your team? Ground rules? Project specific skills?
3. *How did you use the outputs?*
   Project generic skills? Ground rules? Project specific skills?

In addition a focus group was arranged, but this was not possible for practical reasons until March 2005, by which time five of the teams had also used the system as a support for their projects in the second semester of the teaching year, starting at week

11. All team leaders and team members were invited to give feedback, and nine students attended the session. (The invitation, with the purpose of the session, is provided in Appendix 13). The focus group was held in a small meeting room, and participants sat around the same table. A colleague, who was briefed on the purpose of the focus group in advance, facilitated the focus group session. The introduction given at the beginning of the session was as follows:

> *"Regarding the Guardian Agent system, what I am looking for is your opinions, your thoughts on it, anything you want to say fairly freely about what you think of it, how you think it should be developed, whether it is useful of not, or whatever."*

The following points summarise the purpose of the focus group from the researcher's perspective:

- *The usefulness of the functions tried, i.e. general skills, ground rules, roles specific to each project, which the team leader chose from a list;*
- *Whether the team members liked the concept of an agent to help them;*
- *Were there any specific interface issues;*
- *Their opinions on the rules programmed into the system;*
- *Difficulties of team working they experienced;*
- *Should we continue to develop it?*

The same open-ended questions to guide the discussion were used for this focus group as used in 2002, but were only used as prompts to ensure that all of the purposes of the session were achieved (Appendix 13). The facilitator prompted all participants to add comments to ensure that even the quieter members participated to some extent. This focus group session was tape recorded, and the researcher typed the transcript up within a week. Again, in order to prevent bias from the researcher, she only commented when asked to clarify any issues. Analysis of the focus group comments was carried out by separating the comments according to themes, aligned to the questions asked. The resulting list of comments is in Appendix 7.

Owing to the small number of questionnaires that were returned after the trial of the prototype in autumn 2004 (only 12 completed questionnaires were returned from three of the teams), the same trial was repeated the following year, autumn 2005. No

changes were made to the prototype, except that the new team leaders were entered onto the system in advance. The same questionnaire was distributed to all the students in teams that used the system, and 35 completed questionnaires were returned from five of the ten teams that used the system. These were collated as before onto a spreadsheet, but the feedback from both the 2004 and 2005 trials were consolidated, as the version was identical, and these findings are discussed in Chapter 7. The same interview questions were used to gather feedback from seven of the team leaders, carrying these out in an identical manner to previous interviews. There was no focus group for the autumn 2005 trial, because of the practical difficulties of arranging one.

5.4.3. Feedback from the students

Of the 17 teams that used the system in the two years, 14 team leaders were interviewed, seven from each year. In each year, six of the team leaders interviewed said that their team used the system. One reason given for not using the system was that the team leader wanted to get started as soon as possible, another did not want the time overhead for learning the system and setting it up, and another said that the skill areas on the system did not match the type of project their team was carrying out, which was a research based project. In 2004 of these six team leaders, three said they did not use the ground rules function, whereas in 2005 all six did use the ground rules function.

When asked what changes, differences or additions to the system they would like to see, several suggestions were given, given in Table 5.9. This table combines the comments from the questionnaires, team leader interviews and focus group, and dividing them into those issues related to the interface and to the content. It can be seen that some of the comments were similar to those reported after the previous two prototypes. These have been extracted from the full list of comments from the questionnaires (Appendix 5), interviews (Appendix 6) and focus group (Appendix 7).

The main suggested improvements are for a more attractive interface, perhaps using images, but definitely still requiring to be a little more user friendly. The format of the outputs was still not acceptable, requiring a better display, and more details on how the allocations were arrived at. There was still a need for more information on the skills included, both the generic and the project specific skills.

	Suggested improvements from questionnaires	Suggested improvements from interviews	Suggested improvements from focus group
Interface issues	• Add pictures, animations, more colour, more lively • More friendly interface, HCI issues. • Less complicated • Simpler results, what they are good at and what they are not. • Some buttons weren't self explanatory, suggest consultative text for buttons. • Ability to save data to external file and print • Results displayed more clearly, because hard to read	• Relatively easy to use, once sussed out, I read instructions and explained to others. • I did not see the whole thing the first day I wanted it. • Negative answers could be shown, if the members don't want to do things.	• Display at end could be simpler, e.g. graphs, output summarised. • A bit confusing at the end. • Print out allocations, better display. • Printer friendly output
Content issues	• More details available for skills	• More information on skills, e.g. report writing. • Help needed, defining generic skills. • Ground rules, really good	• Confusion with ground rules

Table 5.9 Summary of suggested changes to the system

5.4.4. Findings from the third cycle of Prototyping

Most students and team leaders agreed that the latest version of the system was simple and easy to use.

> *"...good, straightforward and basic, and led the user through it..." Focus group, 2004*

HCI issues are important in developing any information system, as they can become a reason to not use a system, in spite of the benefits, as may have been the case in this research. The interface for users to interact with the system must be supportive, as well as usable, and this is often difficult to achieve in prototype systems, where the functionality is the prime purpose of the system, and the function depends very much on the context (Chiasson and Dexter 2001). According to the questionnaire, the level of acceptance of the interface was similar in each of the three versions of the prototype.

Displaying the results is also an important HCI issue, ensuring that the output is in a format that can be easily used by the intended audience. There were more difficulties with this aspect, as the allocations had to be displayed for the team leader and members of the team to see immediately. But they also said they would like to have a print out of the results for future reference, which was not incorporated into any of

these prototypes. The third version had an improved layout for presenting the allocations, and an ability to choose between output by person or by skill area.

Although there were instructions for using the agent available as a Word document (The team member user guide is presented in Appendix 15), brief guidance on screen would have been preferable. There was an overwhelming need for more information on how to use the system, its functions and the benefits to their team projects, and some training before using it. Some additional information on the meanings of the different skill areas and the ground rules was included in the interface, but few students remarked that they had seen these, so there is insufficient data to indicate how useful this information was.

Both the project generic and specific skill areas of the third prototype were regarded as a good selection for most projects. The ground rules were considered to be comprehensive to most respondents, for example this quote from a later interview:

> *"...by looking at the ground rules, the team had a better understanding of team working, and I based the contract on them…" Team leader, Team3, 2008*

Dividing the skills into generic and specific areas did not seem to help the students to any great extent, as it was found that some teams missed out the project specific skills section altogether. However, some found the project specific skills directly useful, one team leader would have liked to have been able to add more specific skills as progress was made on the project.

> *"Areas spot on" Team leader, Team5, 2005*
>
> *"Other odd skills e.g. photography" Focus group, 2004*

As there was no intention to continue the prototyping process, this feedback was not needed to modify the system further at this stage, but will be referred to later when discussing future developments for the system in Chapter 7.

5.5. Summary

At the beginning of this chapter the following evaluation objectives of the iterative prototyping process were identified as:

- Identify changes to the current implementation that can be incorporated into the next prototype;
- Evaluate the suitability of the pre-programmed content in each version of the system;

At each cycle of the prototype trials, users (students and tutors) were asked for their suggestions for improvements to the current implementation, through the questionnaires, interviews and focus groups. A number of these suggestions were incorporated in subsequent implementations of the system, including an improved interface and output of results, a wider range of skill areas and improved information on using the system. As a result, the pre-programmed skill areas were modified, over the development of the three prototypes, from a single short list of broad skills, to a single longer list of broad and specific skill areas, and in the final version two separate lists of skill areas, one for generic skills and one for project specific skills. According to student feedback, the final lists of skill areas represent a reasonable selection of skills, with additional provision for student team leaders to add other skills that may be required for their particular project type, although this facility was not found by all of the team leaders. The function for agreeing ground rules was included in the second and third prototypes, and the ground rules pre-programmed in the system, were regarded by the students as appropriate for most projects. Whilst the third version of the system used a single rule for suggesting ground rules for adoption, this did not make a significant difference to the suggestions output by the system.

The iterative prototyping method was successful in producing a final version of the system, incorporating modifications suggested through feedback, and establishing that the pre-programmed content was suitable for the types of projects undertaken in this case. Some of the issues identified were not incorporated into the support system design, within the three cycles described in this chapter, and reasons for this will be discussed further in Chapter 6.

The data on acceptance of this type of system for students was analysed by totalling the number of respondents who answered “yes” to those questions on the questionnaire, reported in Tables 5.1 and 5.5. By collating the comments from the

questionnaires, it was possible to collect together the suggestions for changes and improvements to the system, reported in Tables 5.2, 5.6 and 5.9. The responses to the other questions on the questionnaire were collected together under the themes of suggestions for other functions and issues of team working (Appendix 5), some of which have been used in the discussion in Chapter 7.

Much data was obtained from the team leader interviews, which was collated and displayed under themes related to the issues identified in the literature (Appendix 6). Many of these comments have been used to support the discussion on the main research questions of this thesis in Chapters 6 and 7, but some comments were not useful for the discussion, because they were unrelated or discussion of a general nature, and these were left out.

The data from the focus groups was similarly analysed, by separating comments into the same themes as used for the interviews. As suggested by Flick (2006), a focus group enables the participants to come to agreed views on the topic, so many comments recorded in a focus group session may be irrelevant, others may be a result of the discussion becoming sidetracked, so these were omitted from the summary table given in Appendix 7.

As the student teams could only use each prototype system at the beginning of their team projects, the whole testing process extended over several years. The Team Project module did not change in this time, so the different students in these years were comparable. However, the researcher did use the same questions for the different tools each year, which in hindsight should have been amended slightly to enable the interviewer or facilitator to ask more specific questions, as greater knowledge of the literature on team working was gained.

Chapters 6 and 7 that follow, provide detailed discussion using comments from the focus group sessions and the team leader interviews to answer the main research questions posed in this thesis. Many of the comments are included as quotes in these chapters, using the following abbreviations, and followed by the year of the trial:
FG = Focus group, TL = Team leader, T4 = Team 4, Q = Questionnaire

6. STUDENTS' PERCEPTION OF THE SYSTEM IN USE

In the last chapter three cycles of the research were described, showing how each prototype team project support system was altered from the previous version, using the feedback from student users of the system and from the team project module tutor. This chapter is devoted to analysing the data collected through the prototyping cycles in order to answer the following research question:

- In what ways does output from the automated system to allocate tasks and agree ground rules helps students to get started on their team project work, and impact upon relationships between students?

These findings will contribute to answering the overall research question:

- How useful is online software support in the first stages of co-located student team project working?

In this chapter the findings from all three cycles of the research will be brought together to inform the discussion to answer the research question stated above. The results are given in full in Appendix 5 (questionnaire findings), Appendix 6 (interview findings) and Appendix 7 (focus group findings). From the literature several issues were identified, and these could be used to separate out many of the comments into appropriate themes, other comments formed new themes. The themes were divided into those associated with task allocation and with ground rules, roughly correlating with themes concerned with the product of a team project and those associated with the processes of team project working (Table 6.1). In analysing the feedback from the interviews and focus groups, these identified themes were taken as headings for separating out the student comments. Not all of the themes were represented by comments, and the eventual themes used to categorise the students' comments for this part of the analysis are given in Table 6.1.

These themes were useful for picking out common ideas elucidated by team members and team leaders, when they reflected on the ways in which their teams operated. Although the literature suggests that there is a division between task-oriented and

maintenance-oriented roles, many of the statements made by students demonstrate considerable overlap between these roles, as will become clear in this chapter.

Software system functions	Issues from the literature	Themes identified from student feedback
Task allocation (product)	• Types of tasks • Skill development • Skill levels and accuracy of input • Types of projects • Planning and project management • Leadership • Managing collaborative learning	• Task allocation • Skill development • Types of projects
Ground rules (process)	• Individual roles • Norms, contracts and expectations • Relationship of individual within teams • Shared understanding • Culture • Conflict • Motivation, developing a sense of commitment • Trust • Developing an understanding of team issues	• Ground rules • Expectations • Team cohesion • Problems • Culture

Table 6.1 Themes arising from the literature search to be investigated through feedback

The team process model, with process (maintenance roles) and product (task roles) overlaid, Figure 6.1 (on the next page), shows the ground rules as an example of an aid to the process part of a team project, and the task allocation as an example of an aid to the product part of the team product. As we have seen from the literature, the team, individual and task parts of the team project are intertwined, and there is a similar overlap between the product and process parts. The relationship between the team and the individual needs relies upon the processes adopted by the team, and these are essential to the cohesion of the team, which is in turn essential to achieve the product of the team project. The team processes model (Figure 6.1), derived from the literature, provides a summary of the main issues of team working, shown in two of the boxes, and these issues form the headings for discussion of the findings in relation to the issues:

- Task allocation in relation to equitable division of labour and working to a common purpose (using the themes: task allocation, developing skills, types of project, culture);
- Ground rules in relation to coming to a shared understanding (using the themes: ground rules, expectations);

- Communicating the output from the system (using the theme: task allocation);
- Trust and culture within the teams (using the themes: team cohesion, culture, developing skills).

In this case study, the team leaders were crucial in driving the projects forward, through developing team cohesion, so the effect of the team leaders is considered within the headings indicated above.

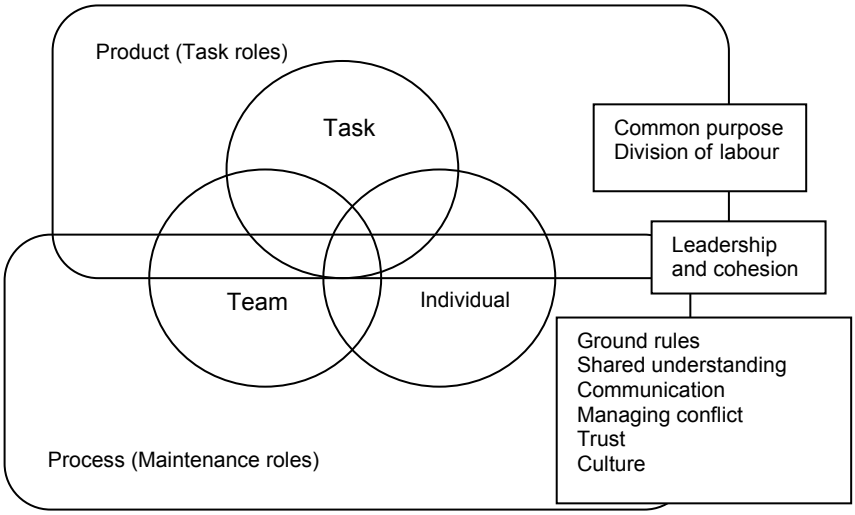


Figure 6.1 Team processes model

The skills that students may acquire through working on a team project include task based skills and "soft" team process skills, and managing the learning of task skills is a function of the organisation put in place by team project module tutors. This case study examined information systems development team projects, and even these can vary in scope, topic and skill requirements, so there is considerable variation in ways in which team projects are organised.

A team relies on its members to perform what is expected of each member, to agreed deadlines. When team members fail to perform to the expectations of other team members, trust levels start to fall, and cohesion reduces. It was proposed that the output from the prototype system would promote greater shared understanding at the getting started stage of the team projects, which would encourage cohesion, and good collaborative relationships between team members.

The next sections discuss the findings from the research that have contributed to understanding the ways in which the output of task allocations and suggested ground rules helped students to get started on their team project work, and affected the relationships between students in the teams.

6.1. Task allocation leading to division of labour

Task allocation often poses difficulties for students within a project team, particularly for the team leader, who is ultimately responsible for ensuring the tasks are performed adequately to result in a successful project. The literature suggests that a team project consists of different types of activities, performed at different times by different team members, over the course of the project life stages. Planning and project management are important in student team projects for successful completion, and team leadership is instrumental in a good plan for the project progress. In the context of student team project work, team members are attempting to learn together, collaboratively, and are learning from each other; so managing this process is crucial for developing team working skills.

The task allocation function was aimed at providing some help for teams to identify suitably experienced and able team members that could carry out tasks identified for the project. The task allocation function was intended to serve two purposes:

- provide automated selection of allocation of project tasks and suggestions of training needs, and
- create a database of abilities and preferences for each team member.

Feedback obtained from the surveys and focus groups suggested that team leaders thought the agent system provided valuable information on team members' skills and preferences, which was good for forming the structure of the team, by dividing technical from administrative sub-teams, as well as dividing the work appropriately between team members.

As Berge (1998) suggests, students do not always know other students' capabilities, and tutors may not have the time or knowledge to allocate members to teams according to their previous learning. That was a factor in this case, and the agent system did provide this functionality:

"Yes, showed clearly the technical and other types of people." TL, T10, 2003

"...helped me to know who to put into which part of the team ..." TL, T8, 2004

The team projects being investigated were unique to the situation at Salford, in that first, second and final year undergraduate students work together. This provides the context where final year students may not have worked with the first or second year students previously. Although some leaders did say that because they have often done mini projects with others in their team in the past they did have a good appreciation of what some of their team members were capable of doing, and the system gave them some confirmation of this.

"Yes a good idea with people you have not seen before." TL, T13, 2005

In these teams some of the final year students may not have worked with the first, second year or indeed other final year students previously (there are also some direct entry students). So the system provided the team leaders with valuable information on the team members:

"Useful with people I did not know before, 1st, 2nd and some final years, because some of us had been on placement. Team leader is responsible in this project, so it provides more information" TL, T3, 2008

There has been a tendency in the past for team leaders in this case to divide their team members into technical and administrative sub-teams. From the team leader's perspective, the task allocation was very useful, because it helped to identify the technical oriented team members. Many team leaders were reluctant to change the ways in which they organised their projects, because the tried and tested methods were familiar, though a need for flexibility was recognised:

"Use it to divide the team into technical admin and research sections" TL, T15, 2004

"Simple team structure works quite well, because if you are technical someone has to be admin, can move people around, flexible" FG, 2004

So the task allocation function did help the team leaders to distribute project tasks appropriately, with a degree of fairness, though they had to be aware that the output from the system could only be as good as the data input by team members. And team

members, in this research, sounded a note of caution because it was remarked that individuals' perceptions of their skill levels might be misleading:

> *"Rating/grading but may be subjective – all say they are good at word processing but what is 'good'" FG, 2002*

The third prototype split the task areas into generic ones, such as report writing and presenting verbally, and project specific tasks, such as programming in particular languages and database design. In this way team leaders would be able to allocate an initial structure to the team, and assign more specific task areas later on, when the project tasks and necessary plan of work had been more clearly defined. Most respondents in this case study regarded both the project generic and project specific skills, included in the third prototype system, as a good selection for most of the project types they had encountered. As noted by Murthy and Kerr (2003), conveying tasks are often associated with project specific skills, and this team comment supports the usefulness of the project specific skills in this way:

> *"Project specific skills were used to plan the project, work out what and when things needed delivering" TL, T17, 2004*

Automated allocations of tasks may take some of the conflict out of decisions taken by the team, as the outcomes suggested are transparent to all. However, there might still be conflict generated through the output:

> *"Assumes that there would be no rebellion against the agent – would not argue with the machine, simply would not do it. Would have to argue with the whole team if only one person out of step" FG, 2002*

An important difference between team working in higher education and in organisations is the assessment necessary to provide grades for students, and the additional conflict this often generates (Wells 2002). Burdett (2003), who studied student groups, found that one of the worst aspects of group working, as cited by the students, was unequal distribution of effort, and the resulting conflicts. Duffy (1996) found that in schools the presence of assessment prevented teams from developing a team ethos. Although some conflict in a team can be good (task conflict), interpersonal and personality conflict (relational conflict) and process conflict are not, and there may be resentment if some student team members are seen as passing

assessed work on the backs of others (Jehn and Mannix 2001). So management of task allocation is crucial, because students don't like teamwork when there are inequalities of assessment (Drury et al. 2003).

Some students recognised the problem of too many individuals being allocated to do the same task, and a suggestion was made that the system should be more explicit in indicating how many members like or are good at a skill area, to give the team more information upon which to engage in discussion and make decisions, and to highlight if a team is too homogeneous. Team diversity is related to performance, because knowledge diversity increases task conflict, which positively affects performance (Liang et al. 2007), so a team comprising students with a variety of skills and experience is useful. As part of the assessment for the team projects in this case, teams need to quickly determine the type of project they have been assigned, identify the main tasks involved and produce a plan and specification for the project. The output from the system was also said to be useful to:

> *"...build a knowledge base of the skills existing and required and matched to the specification of the project" TL T8, 2004*

In previous years, some teams had used a paper based audit of each individual's skills to provide the basis for the team structure, and team leaders who used both a paper based skills audit and the agent system reported that the agent output and their allocations did agree closely. Team leaders used the output in different ways, for example also talking to each team member, to ask what they enjoy and would like to do, or another team leader asked team members to write down what they would like to do, and why they should be allocated to that task:

> *"Agent results used to justify the choices" TL, T5, 2003*

However, the projects being undertaken in this case vary in their nature, some being technical development and some based on research. Different types of projects require different structuring, and as individuals may be involved in different types of projects each year, these projects provide a wide experience of possible structures. This team leader felt that automating the process of task allocation was not necessary for a research type of project, as the actions needing to be taken were obvious:

"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." TL, T7, 2004

Students should be encouraged to adapt their working structure according to the requirements of the particular project. One team leader had indeed considered the team structure in relation to the project:

"I did not feel a project of this nature required a complex structure" TL, T11, 2005

Team leaders said that they would have liked more information about the different tasks, and perhaps some help with suggested timing for tasks, to help them plan and complete the Gantt chart:

"How long will task take, how many people will be needed to do task" FG, 2002

The influence of the team leader on the project process is marked. The statement above is in agreement with the work by Keller (2006), who found that different styles of leadership are more appropriate for certain types of projects, i.e. a transactional style, as demonstrated in this example, is more suited to research projects, and the leader of this type of project was less likely to use the output from the agent system. A study by Sanders and Schyns (2006), carried out with teams involved in tasks requiring coordination and information exchange, considered the transformational style of leadership, and found that cohesion seemed to be linked to solidarity between members, but not vertically with the leader. But vertical solidarity seemed to be associated with members' perceptions of the leader's style as being transformational. This case study shows that the team leaders involved seemed to be aware of the need for different approaches depending upon the project type, which could be made more explicit in the agent system, to provide greater usefulness.

The extent to which a particular team structure determines the success or otherwise of a team project is only partially known, or whether a shared understanding is more important. In a recent study it was found that shared and accurate mental models of

the task were positively related to team process, which was in turn related to team performance (Banks and Millward 2007).

Cornelis at al. (2006) talked about a belongingness need in a team, so if individuals have a strong belongingness need, then fairness of the leader is important in relationship building. They also mention the importance of the leader representing the other members, a point brought out by a team leader in this case:

> *"Define what kind of relationship we should have between each other" TL, T15, 2004*

Driskell et al. (2006) considered the importance of personality traits on the success of the team, and suggested that some of the facets of personality traits may have a negative or positive impact on different teamwork dimensions, for example agreeableness, in the form of trust and cooperation, has a positive impact on communication and interpersonal relations, but dominance may impact negatively on interpersonal relations and shared awareness. Team leaders might benefit from an awareness of dominant team members, who could have an adverse effect upon the cohesion of the team, or friendly members who could be a calming influence on the team.

One limitation of the system as it stands, is that it takes no account of personalities of the individual team members, which would perhaps be of benefit in forming task sub-teams:

> *"Can't pick out personalities, may not work together in practice. We need to put 1st with 2nd and 3rd years" TL, T5, 2005*

The team leaders were acutely aware of their role in leading the team to a collective good grade for the project, supporting the proposal of De Cremer at al. (2006) that self-sacrificial leadership leads to greater self-esteem and cohesion:

> *"Team work can drag you down or push you up, so need to measure individuals' skills" FG, 2002*

The literature suggests that a team project may consist of many different activities, which may be divided into conveying and converging tasks, some requiring individual working away from the team, others requiring bringing work together (Murthy and Kerr 2003). In a study by Swaab et al. (2008), conversations between small sub-sets of the team membership were sometimes found to lead to factions in the team, which could be beneficial in brainstorming types of activities, but could be detrimental when team unity is important. Whether CMC tools or face to face discussion is used, may impact upon the quality of decisions made by the team for converging tasks:

> *"We meet together and decide the next task, face-to-face [communication] is important" TL, T7, 2004*

So a mixture of communication styles is implied for different types of tasks. Even co-located students appreciated the usefulness of online communication tools:

> *"Online team shared workspaces, linked with project management for deadlines, update from home" TL, T5, 2005*

However, one student expressed caution over spending too much time on face to face discussion, when they were under pressure to meet deadlines:

> *"Debates slow projects" TL, T20, 2003*

Education, and team projects particularly, are concerned with developing technical and people skills within the students. Skill development is a matter of building up skills by adding to previous experiences, so the input required for the agent system was an indication of their proficiency in the task areas selected. At first this was a simple indication of "good at" or "not very good at", for each task in the list, but in later versions of the agent system, team members were asked to choose from a scale between 1 and 6, to indicate how good at a task they felt they were. The extent to which the team leader was able to trust the output varied. One team leader reflected that:

> *"It made them think about the skills, choosing them" TL, T17, 2004*

Though another team leader remarked:

> *"Everyone ticked all the boxes so they did not really think about it" TL, T9, 2004*

Some individuals may inadvertently exaggerate their skill levels, or be over or under confident. Perhaps negative skill preferences would be better to indicate if individuals do not want to be allocated to a certain skill area, so that tasks they have no previous experience of would not be discounted. However, quite rightly, the team leaders involved were cautious about using the task allocations output without any further discussion with team members, and further suggested using the grading to pair off members with higher ability with members of lower ability:

> *"See all gradings for everyone. So if low mark can put with more confident person" TL, T10, 2005*

The problem of too many individuals being allocated to do the same task was recognised, and a suggestion was made that the system should be more explicit in indicating how many members like or are good at a skill area, to aid discussion. On the other hand, some respondents did realise the importance of developing different skills, rather than sticking to skills already acquired in previous projects:

> *"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." FG, 2002*

> *"Limiting yourself as a person. learn something new, try, more skills" FG, 2004*

And also to extend their skills, by learning from each other:

> *"Pair off people with contrasting skills, e.g. report writer with researcher, to collaborate" TL, T3, 2008*
>
> *"Team Leader makes decisions on the basis of what you have seen, but the system allows you to let them have a go at something." TL, T3, 2008*

One team leader also used the output to provide opportunities for team members to show what they could do, compared to what they had indicated:

> *"Test if what they say is true in work given, e.g. are they really any good at proof reading, as they say" TL, T3, 2008*
>
> *"Members may be trying to impress by ticking things they are not really any good at. A very good tool" TL, T3, 2008*

"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

Team leaders also felt able to use the system for identifying training needs, either by identifying individuals who liked something but felt they were not very good at it, or when the system returned no allocations for a skill area, indicating a shortfall in skills for the project. Training through a tutorial or by peer mentoring could then be put into place. There is a recognised need for training in using groupware effectively (Duffy 1996), and this system is no different:

"Down to purpose, and explaining the purpose – if people understand that it is there to help them" FG, 2002

Instruction in using the system is an essential addition in its implementation, if knowledge sharing is to be achieved, because students need to be aware of the affordance it provides. Helping the team to pinpoint training needs, and to support each other in learning skills was an important outcome from using the system.

In terms of project management, the agent system seemed to save time, as it offered suggestions of skill areas and preferences, which the team leader could take as a starting point for discussion, leading to allocating tasks appropriately within their team, and an informed choice of structure for the team.

So, concurring with Banks and Millward (2007), it might be that the structuring of the team does not have such an impact on team performance, but it is the sharing of knowledge that is important, and student teams may be better off ensuring that the output of the agent system is shared within the team, rather than worrying about a team structure. In contrast Livingstone and Lynch (2000) suggests that team structure is important, along with empowering students, so that their team work experience is positive. In this case study one or two of the teams each year did opt for a different structure for their team, but it was outside the scope of this research to investigate the impact of different team structures on project outcomes.

6.2. Ground rules and shared understanding

From the literature it is evident that the use of norms or ground rules will affect the maintenance roles of team projects. This section identifies feedback concerned with the ways in which the project teams of this case study recognised the need for ground rules, their use of the system's output suggestions of ground rules, and the impact this function had on their team projects.

The second function that this system provided was to suggest ground rules for working together that could be agreed for the team. Norms and ground rules are concerned with the ways in which the team members work together and react to each other, which would be a main contributor to positive relationships between members. Agreeing upon ground rules acceptable to all the team members, and adhering to them ensures that trust levels are maintained, with improved cohesion within the team. The ground rules function in this system served these purposes:

- alerting the team members of some of the issues that might affect team cohesion;
- providing a means of ascertaining individuals' perceptions of the importance of the suggested ground rules, and automating a process for helping to agree appropriate rules to adopt.

There was a general feeling that the list of ground rules presented by the system, and getting the opinion of all of the team members on their importance was useful, as a prompt to discussion, and to achieve some common agreement within the team:

> *"Ground rules. Really good, some may be upset, but acceptable to all as worded" TL, T8, 2004*
>
> *"Good to air the ground rules, no one was shy to talk about it" TL, T8, 2004*
>
> *"Everyone read them, knowledge transfer. No conflict, all agreed them" TL, T5, 2005*

In the study by Liang et al. (2007) of co-located software development teams in Taiwan, differences in values held by individuals did increase relationship conflict, and negatively affect team performance. In a highly structured team, agreeing ground rules plays an important part, but the team leader or manager of the team may need to ensure the rules are being applied.

In this research we were interested in finding out how team members, and leaders in particular, used the output from the system. Team leaders had the discretion to use the output in any way they felt suitable for their particular team, whether a formal contract was produced or the output was used informally:

"Just looking rather than formal" TL, T2, 2005

"Team contract helped performance, like in outside world. Know the rules" TL, T13, 2005

"...getting people's opinions, success factors of the project" TL, T15, 2004

The idea of a written contract, that all team members sign up to, had been used by many of the teams in this case study in previous years, and several team leaders used the output from the agent system to formulate a contract to implement for their team:

"Ground rules used to establish a Contract" TL, T15, 2004

"I did make a team contract which includes some of the ground rules from the Guardian agent" TL, T15, 2004

"Make it [the output] into a Contract" FG, 2004

"...by looking at the ground rules, the team had a better understanding of team working, and I based the contract on them…" TL, T3, 2008

An alternative view is that the ground rules should be taken as read, so there is no need for any formal contract or the like:

"Ground rules, did not use output, as all rules on list are expected anyway" TL, T3, 2008

"Common sense, don't need rules. Good to highlight to team at start" FG, 2004

"Much team work is undocumented rules" FG, 2002

Formalised contracts, based on the outputs of ground rules selected, seemed to help the teams to get started on the project. However, even a formal contract signed by all of the team members, does not necessarily ensure that the rules are adhered to. The ground rules outputs were used and interpreted in different ways:

"*Better understanding of rules. Team contract based on these" TL, T3, 2008*

"Set ground rules, tried to enforce them e.g. absences. Hard to say if it is as a result, or made them think about expectations" TL, T10, 2005

Alongside ground rules, team leaders recognised a need to agree on sanctions to be applied for non-compliance:

"The rules are a bit harsh, attendance tends to be an honourable agreement, I ask that I am informed of any non-attendance" TL, T7, 2004

"During meetings in agendas. Sanction if not done. Registers monitor [attendance] and deliverables chart monitor contribution. Everyone knows where they stand. Clear what consequences were, low mark" TL, T9, 2005

However, findings from this research did not suggest whether any sanctions agreed were effective or not, and the main difficulty still remained:

"Getting members to do the work is a problem" TL, T7, 2004

Even though students may feel that ground rules are common sense, establishing some working rules at the beginning may help to engender team cohesion. Appelbaum et al. (1998) suggest that handling conflict includes diagnosis and planning for overcoming it, including agreements on behaviour, which constitute ground rules. However, at the beginning of a team project intentions may be good, and it may be better if ground rules were to emerge over time as a need arises:

"Everyone has other methods of working – develop norms after a few weeks." TL, T14, 2005

"All ticked everything, and did not necessarily comply" TL, T10, 2005

One team leader suggested that agreeing ground rules made no difference to their project, but that if the ground rules were emphasised more at the beginning, they are more likely to contribute to improved performance:

"Ground rules, no difference to performance, but should be emphasised more" TL, T5, 2005

A study by Patterson et al, with sports teams, found some correlation between norms of social interaction and cohesion, leading to improved team performance, but no correlation between task-related norms and cohesion towards performance (Patterson

et al. 2005). This suggests a need to only use norms related to social interaction, communication etc., rather than ground rules referring to actual work tasks. The ground rules included in the latest version of the prototype system comprised task related and social interaction ones, and were considered by most respondents to be a comprehensive list of possible rules, even though in the past, the notion of agreeing ground rules had not usually been considered by the students in this case study. This intervention did change the ways in which some teams worked, for example:

> *"...a big list but they are effective" TL, T15, 2004*
>
> *"It did use it, but not how I thought I would" TL, T17, 2004*
>
> *"Good to highlight to team at start, made them think about expectations" FG, 2004*

Unfortunately, during the trial of the two later prototypes, some teams did not see the option on the screen to choose ground rules, and they overlooked it. So these teams simply used the task allocation function. Students reported being confused about what to do with this part of the system. The affordance was designed in, but not perceived by the team, and particularly the team leader, when using the other functions of the system.

In this research agreeing ground rules had the effect of making the team members think about their expectations of other members, ways of communicating and obligations towards others, as well as helping team cohesion. Although the students are studying on campus, they are working from home more often, so online communication was regarded as very important. Using the ground rules as the basis for a working contract was a preferred way of using the agent system output, but enforcing any such contract is problematical. There was a feeling that simply looking at the ground rules encouraged the team members to think about working relationships, which although not the intended purpose of the system, was a positive benefit over the experience of teams in previous years.

The next section considers the ways in which the outputs were communicated to team members, and the impact this might have on trust, culture and diversity.

6.3. Communication, trust and culture

The previous sections provided some evidence for allocation of tasks and agreeing ground rules leading to a shared understanding. In the next sections the importance of communication of these norms, and the impact of agreeing ground rules, and automated task allocation on an appreciation of the role of trust, culture and diversity are discussed, as a contributor to team cohesion.

6.3.1. Communication of outputs

In this research respondents agreed that communicating the reasons for any decision is important, and on reflection most members in this research were satisfied with the resulting task allocations, because the team leaders used the output as a basis for a face-to-face discussion with team members. The sort of team building activity inherent in discussions between the team leader and team members leads to task and social cohesion, but according to Bahli and Buyukkurt (2005), task cohesion is more important than social cohesion in group performance, so task allocation with each member knowing the reasons for the allocation is all important. The sort of activity involved in design is said to be enhanced by social processes (Detienne 2006), so converging activities are better supported by face to face discussion.

A few respondents said that including ground rules did get the team thinking about their means of communication in general, and how they work with each other, indeed some team leaders reported improved team spirit, with less conflict experienced during their project. Socialising is an important part of the "forming" stage of the project, in which communication is key.

Communication face to face, in addition to the automated allocation of tasks and agreement to ground rules, seemed to play a large part in achieving some consensus between all of the team members:

> *"Another source to look at. Socialising is important. Something else to think about and help making decisions" TL, T1, 2003*

In this research a combination of using the system output with face to face communication seemed to have been the most effective. One team leader suggested that team members would not trust the output from the system without some discussion:

"If tasks are allocated without having to meet the team members, then may not be aware of any 'man machine' argument taking place" FG, 2002

In the study by Barcus and Montibeller (2006) on virtual teams in organizations, they refer to the man-machine conflict, and noted a marked preference of decision makers to rely on their gut feeling, over the analytical approach, as exemplified through using the output from this system. So too, some of these teams disregarded the output from the system in favour of their previous experience in teams.

Another study, with virtual business teams, found that use of some tools helps to generate team trust, and that team leaders are usually the ones who determine the extent and type of communication tools used within the team (Thomas and Bostrum 2008). The team leaders in this case decided how to communicate the output to team members, whether to base a contract on the ground rules output, and how this would be applied.

Project management is important to prevent failure of the project, through failing to meet the stated objectives, and involves steering the project through a series of different activities (Lauden and Lauden 2006:555). Student teams need to apply their knowledge and skills, with the aid of technology tools to achieve a successful outcome, within certain constraints. They are working with incomplete knowledge about each other, skills that need to be developed and there is a strict time constraint on its completion. The students in this case study use Microsoft Project as an aid, usually producing a Gantt chart showing stages of progress, and to communicate which tasks are assigned to different team members. The software system of this research is designed to help gain information upon which to base a project plan so can be a precursor to using a project management tool. The teams of this case study have a designated leader and deputy leader; it is the team leader who drives the project, needing to co-ordinate the activities according to the available skills, and communicate this to members, as noted by Beranek et al. (2005). It is notable that many of the comments on project management are from the team leaders themselves; few team members were involved in project management in the initial stages of their projects.

The following comment reinforces the authority the team leader has over the team members as project manager, but shows an appreciation that an agent system could aid communication, through implementing an hierarchical team structure:

> *"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*

The system was mainly used as a starting point for discussion of allocated tasks, very few team members consulted the database of other members' skill levels and preferences after the initial allocations had been made, because team members relied on their team leader to communicate this information. The output of ground rules suggestions were often communicated through drawing up a contract, and there was limited discussion of the ground rules, but improved team spirit was reported by some teams. The next section discusses the impact of the outputs from the system on trust within the team, and the part played by the culture of these teams in using the output is given.

6.3.2. Trust and culture

A cohesive team is based upon mutual trust between the members of the team. The previous section highlighted the importance of communication for developing this trust, both between the members, but also between the team leader and members. Mistrust and miscommunication, arising from poor management of communication at a distance, may be sources of conflict in the team (Appelbaum and Shapiro 1998).

The team leader must feel he is able to trust the output from a system, and must be able to trust the team members' input to the system, as a precursor to assigning roles on the basis of the system output. A study with global teams by Paul et al. (2004), highlighted the need for trust in order to use forms of team support systems effectively. An indication of the degree of mastery of a task is an important means of giving more information to team members, enhancing a shared mental model (Edmondson et al. 2006). Barcus and Montibeller (2006) suggested that difficulties arise through lack of information sharing in virtual business teams, particularly not knowing competence levels of team members.

But what individuals say they will do, and what they do in practice may differ. In an effort to appear willing, answers given at the beginning of the project may have been given with good intentions. This may call into question the honesty of some team members, which affects other team members' perceptions of their peers' integrity:

> *"Some factors have affected relationships in our team. For example honesty, not everyone contributing fairly, so read delegated tasks, no it was not fair, some people didn't see it as being honest. Need an agreement" TL, T15, 2004*

There was a suggestion that as part of the learning process, team members could be asked to rate their colleagues' honesty in working in the team, and commitment to the contract, as a form of peer assessment.

This research is centred on a unique situation, where less experienced first and second year students learn from their more experienced peers. Although there is an obvious benefit of learning from each other, there is a disadvantage that as the culture endemic in these team projects is passed on to the following year, the students could learn good or bad practice. The need for a comfort zone was particularly noticeable in the case where a final year student was team leader more than once (deputy leader one year and leader the following year). This student was able to reflect and compare the output to ways in which they had previously worked, and concluded that relying on previous experience was better:

> *"Put all details in, but I did it the way I did last year, more accuracy" FG, 2004*

Within the culture of the ISI team project, there was a tendency for team leaders to divide the team into technical, administration and research sub-teams in the first instance. There was a feeling that this predominant breakdown into sub-teams, also tended to predetermine membership by year of study. Changes made to successive prototypes arose from the students' feedback, and the team project module tutor expressing a desire to try to break away from the team structure used in the past (Jones and McMaster 2004). First year students were often "dumped" into administration jobs, which were regarded as boring, because team leaders had not ascertained whether these team members could be trusted with other more demanding jobs. One of the team leaders had already made this observation and provided his solution to the problem:

"1st years – realised that the work they had been allocated was boring and that they are now going to rotate around" FG, 2002

The previous sub-team culture also enabled some students to try to avoid tasks they perceived as difficult:

"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

There was a tendency for students to stick to tasks they had already acquired skills in, such as using Dreamweaver or programming in a particular language, and there are certain tasks that are deemed to be easier than others:

"Restricting areas, because everyone chooses easy tasks. Nobody wants to do technical stuff, all wanted to do admin and documentation. [the system should] suggest alternatives" TL, T5, 2003

According to the literature, gender differences tend to be deeper seated in different cultures, and may cause difficulties particularly in teams of mixed gender. In this case study the team project module tutor had observed a trend regarding the roles taken on by female students in these projects, who tended to perform administrative roles, a trend also noted by Ingram and Parker (2002). But in analysing all of the data gathered in this research, gender was not mentioned in any context. There were, however, several comments confirming observations that the team project culture is propagated year on year, and team leaders will often stick to actions based on previous experience:

"Hard to get away from method used previously. Let's do what we normally do" FG, 2004

"Get set as you arrive in 1st year" FG, 2004

In these teams the leader had the job of allocating work to the individual(s) with the greatest aptitude for that task, based on the system output, but with incomplete knowledge of an individual's motivation. The team leader, taking responsibility for the project's completion, had to make crucial decisions on task allocation, not necessarily optimum in training terms:

"Task allocation affected by motivation, allocate tasks using a risk analysis approach – don't allocate key tasks to high risk people" FG, 2002

Bos (2002) talks about fragile trust which can be strengthened when ground rules are used, and team wellness can result from using ground rules as part of the team processes (Groesbeck and Van Aken 2001). It was left to the discretion of the team leader what emphasis they placed upon the ground rules, and as one team leader suggested, more emphasis on the rules from the start, might have helped all members to appreciate their significance, and helped improve cohesion and performance. The suggestion that the agent system should be cleverer, to see through dishonest answers, prompts that perhaps it should remind students of their obligations as the project progresses:

"…but people agree, but don't act on it. Always honest, make perfect answer" FG, 2004

"It did not really assess what people think about, not clever enough. People can make things up" TL, T9, 2004

"*Yes it may help trust, but they may trust or be cynical about the work" TL, T3, 2008*

"Problem that it is what each individual team member thinks they are good at, not what their aptitude is" FG, 2002

In spite of some cautionary comments, respondents in this research said that including ground rules did get the team thinking about their means of communication and how they work with each other, indeed some team leaders reported improved team spirit, with less conflict:

"This [team spirit] is an important factor, [ground rules] help to understand how they work together and adapt to situations" TL, T15, 2004

In published work by Banks and Millward (2007), based in a students' simulated environment, a shared understanding of the task was found to be related to team performance, as well as accurate procedural knowledge. This emphasises the importance of valuing the diversity of team members in the maintenance roles of a team project, and persevering to generate a team spirit even though team members are very different.

Homan et al. (2007) also found that informational diversity may have positive effects on team functioning even when teams are not homogeneous. From the individual team member's perspective, it was acknowledged by some students that it was useful for all team members to see what everyone else thought they were good at and liked, to gain an appreciation of the diversity of their team. The additional information, that all team members were able to access, should have encouraged a broader look at the project, however, this was not the case, and it was noted that:

> *"...but people get on with their own work rather than look at project as a whole." FG, 2004*

Although based on a case study of collaboration between HE and FE staff to develop online learning material, Connolly et al. (2007) found that tension inevitably arises because of the different expectations of the participants, but suggest that addressing the issues of trust, organisation, common goals, sharing and mutual respect may play a part in alleviating these tensions. In support of this, according to Wells (2002), managing cultural diversity and managing distance in virtual team working, such as when students adopt a flexible approach to managing their learning, are two challenges for the future. Similarly, setting clear roles, tasks and ground rules for team members, that are available for all the team to see, may help to fulfil the expectations of individuals as to who is responsible for what.

The extent to which a shared understanding promotes trust in a team is in debate, but tacit knowledge needs to be converted to explicit knowledge and this is achieved through sharing experience and dialogue, which is a desired student skill (Politis 2003). The sorts of traits that contribute to knowledge acquisition have been identified as communication, problem understanding, personality traits, control, organisation, negotiation and liberal communication, some of which were apparent in these student teams (Politis 2003). Evaluating each other's knowledge, to develop a shared understanding, was found by Leinonen and Jarvela (2006) to be an issue in distributed teams; it is similarly an issue for co-located teams, and this research suggests that this system has played a part in reducing the issues that prevent coming to a shared understanding.

6.4. Summary

From the discussion in this chapter, it is clear that the documented distinction between maintenance and task roles of team project working does not always apply. Although the task allocation function was separated from the agreeing ground rules function, it was difficult to partition the comments for these into the task and maintenance roles of team working. The diagram in Figure 6.1 shows a small overlap between the two areas, but in practice this research has shown that the overlapping area should be drawn much larger.

Task allocation is an important part of project management, and the student team leaders in this study used the output from the system in a variety of manners to identify team members most appropriate to undertake the various tasks. However, there were often constraints to their management, such as the culture inherent in this particular case study, which dictated a team structure from past experience, reluctance on the part of some team members to undertake new tasks, and the impact of assessment on their team practices.

The function to automate the allocation of tasks for teams was also aimed at providing a database of all members' abilities and preferences and the suggested allocations. But in this research it was found that the team leaders were the main users of the output of task allocations, even though the team members had access to the task allocation output. The team leader was the primary source of information for team members, on which team member should be allocated to which task, and how this fitted in with the project planning. Motivation of the team members is still a potential difficulty for most team leaders, and automating the process of agreeing ground rules may not have much impact on this.

The list of ground rules presented included task and social rules, which most team leaders thought were appropriate, although the literature suggests that only social interaction rules are needed. There was a feeling that simply looking at the ground rules encouraged the team members to think about working relationships, which had not always happened in the past. Some team leaders used the output to write a contract for team members, others kept the output informal, others said that the rules are common sense.

Agreeing ground rules seems to contribute to improved team spirit or cohesion, and the automated allocation of tasks helped the teams to get started. But this research found that communication of the output is important for teams, even on campus; effective teams use whatever means of communication is available on a frequent basis (Driskell et al. 2006). The teams in this case used the output as a basis for discussion:

> *"Communication is the biggest thing, with language barriers, technology available e.g. a forum to communicate" TL, T15, 2004*

It is difficult to change working practice, as was the case with these teams, but some of the teams did work differently as a result of using the system. The output from the system was used to communicate information, but did not have any proven impact upon trust within the teams. However, the need for honesty when inputting preferences was noted, as output can only be as good as the input data.

Trusting that other team members are capable of carrying out assigned tasks was thought to be important in developing positive relationships in the teams. The findings from this research shows that the functions of ground rules and task allocation both contributed to cohesion to some extent, so cannot be separated form each other, as in the task or maintenance roles model of a team. The teams in this case did embrace the concept of learning with and through each other.

The findings from research into team working using student teams may not be transferable to work teams, where many different issues play a part (Watson-Manheim et al. 2002). But team leaders would welcome a system that can help to promote team cohesion, and can help the team leader to control work quality and attendance.

The comments acquired through the interviews and focus groups suggest that there would be support for the concept of an agent that learnt what each individual had already done, and could suggest trying out new skills, or providing training through online tutorials, or by mentoring within the team. This aspect might appeal to tutors who are trying to cover a wider curriculum as part of the learning outcomes from a team project, and this will be discussed further in the next chapter. The system was

designed with a “real (intended) affordance” of providing information aimed at all team members, with the exception that the team leader was intended to set the system up for the team members to use. However, the “perceived affordance” of the system was at variance with the “intended affordance”, as students chose whether or not to look at the results. Reasons given for not using the system included time constraints, which is often cited as a reason for not doing something, if the tool is not immediately accessible to them or has a time overhead to learn it.

Personal development planning is based upon reflection of the individual to identify key learning experiences, and to learn from them for the future. Building transferable skills is an important outcome of team project work, as well as practicing the technical skills needed for the tasks. When using this system during the research, students were reflecting on how they had seen tasks done in the past, and judging how to apply the output from the system to their team projects. This appears to be a significant contribution of the system to their skills development.

This chapter has presented the analysis of data gathered in the research, to provide an answer to the research question asking about the ways in which the output from the system was used by teams to help them to get started on their team projects, and the impact the system had on relationships between team members. The next chapter presents analysis of data gathered to answer the remaining research questions.

7. SUITABILITY OF THIS SYSTEM FOR SUPPORTING STUDENT TEAMS AND ADDITIONAL FUNCTIONS

This chapter is devoted to analysis of the research data to answer the following questions:

- How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working?
- What level of suitability of the system do these students perceive for online student teams?
- Which other functions could be incorporated into this agent system that would help students with their team project work?

In this way the chapter contributes to answering the overall research question:

- How useful is online software support in the first stages of co-located student team project working?

The previous chapter presented a discussion of the findings to identify ways in which the output from the system helped the student teams to get started on their team project work. Using feedback from the same data collection tools, this chapter considers the final research questions, by establishing the suitability of this sort of system for supporting the maintenance roles of student team project working, and to identify other functions that could be incorporated into this system that would further help these students. This section also contains an assessment of the implementation issues that prevented the full usefulness of the system to be realised in this case, and perceptions of the suitability of the system for online student team working.

7.1. How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working?

In establishing the suitability of this prototype system for supporting the maintenance roles of co-located students at the getting started stage of the team projects, this section will identify feedback from the students that either corroborates or disputes the assertion that this type of system helps with the maintenance roles of their team projects. Maintenance roles are those associated with individuals' feelings and relationships between team members, including team building, and leading towards

team cohesion, but as indicated at the end of the previous chapter, the maintenance and task roles are very much intertwined. So the discussion that follows uses feedback about both the task allocation and the agreeing ground rules functions, to establish the suitability of the software system for supporting the maintenance roles of the getting started stage of their team projects.

Responses from the questionnaires provided data to evaluate the students' acceptance of the system, both in the co-located context they were engaged in, and their perceptions of its usefulness for online teams. A summary of the responses to these questions is given in Table 7.1.

Guardian Agent	**Summary of Questionnaire results 2002 to 2005**											
Year of prototype trial	Was the system useful – all functions	Was the system useful - generic skills	Was the system useful - specific skills	Was the system useful - ground rules	Was the interface easy to use	Was the interface self explanatory	Would you like to have a character for the agent	Do you think it would be useful - online	Do you think it would be useful - on Campus?	Would you like the concept of agent help: online?	Would you like the concept of agent help: on campus?	Would you personally like to use such an agent (Y/N)
Prolog 2002 (50 responses)												
Number answering Yes	26				41	36	8	40	28	35	28	26
% of total respondents	52				82	72	16	80	56	70	56	52
Java 2003 (22)												
Number answering Yes	13				18	14	5	14	10	9	8	7
% of total respondents	59				82	64	23	64	45	41	36	32
PHP 2004/2005 (47)												
Number answering Yes	20	25	21	18	35	35	9	30	23	24	15	21
% of total respondents	43	53	45	38	74	74	19	64	49	51	32	45
All Prototypes (119)		(47)	(47)	(47)								
Number answering Yes	59	25	21	18	94	85	22	84	61	68	51	54
% of total respondents	50	53	45	38	79	72	19	71	52	57	43	46

Table 7.1 Summary of questionnaire results from 3 cycles of trials

Taking the data collected from all three cycles of prototyping, the returned questionnaires (response rate just over 50%) showed that half (50%) of the respondents thought the system was useful to their team. Fewer respondents agreed that overall the third version of the prototype was useful, than for the previous two

versions (43%, compared to 52% and 59%), but 53% agreed that the generic rules programmed into the third version of the system were useful to them, although only 45% agreed that the project specific skills were useful, and 38% agreed that the ground rules function was useful. These figures were consistent with the fact that some teams did not use the ground rules function, or the project specific skills for task allocation.

Just over half (52%) thought that such an agent system was useful for co-located students (on campus), but more (71%) thought it could be useful for online students. Similarly, a higher proportion said that they would like such a system if they were working online (57%), but only 43% said they would like to have the system for co-located project work. Across the three prototypes the variations in responses remained consistent, even though the second and third prototypes seemed to elicit less favourable responses. But the small number of the questionnaires returned meant that it was difficult to elaborate on the quantitative data in any meaningful way. The perception of what is meant by an "online" student may have biased their responses to a certain extent, because it would have been difficult for these students to envisage how the system could be used when working online on team projects.

Just under a half (46%) of the students said that they might personally like such an agent to help them, but when asked if they would like to see a characterization for the agent only a small proportion (19%) said "yes", justifying the decision not to introduce an avatar. Those students that did not say they would personally like to have this system may have been influenced by the difficulties some teams had in using the system to obtain allocations, and limitations of the interface. Nevertheless, over 70% did say that the interface was easy to use and self-explanatory, so the difficulties with the interface and access, were not universal.

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. This issue raises questions of affordance of the software. Some students did not perceive its affordance, i.e. what it could do for them, so did not spend time learning the system. Using the grid suggested by Sadler and Given (2007)

for analysing affordance in terms of intended and perceived, provides us with the summary in Table 7.2 for the ground rules function, and Table 7.3 for the allocation of tasks function..

Intended and perceived	**Perceived but not intended**
• Used as a basis for discussion towards agreement • Formalised the process • Better understanding of team working processes • Improved team spirit • Acceptance of ground rules • Helped assigned responsibility • Good for online teams	• Used to draw up a contract • Used just for information • Dishonesty may skew the output • Sanctions need to be alongside rules • Register used for attendance • Communication and language barriers
Intended but not perceived	**Wanted but not provided**
• Shared understanding to give team cohesion • Ground rules function should be emphasised at beginning of project • Some teams did not see this function • Not necessary for co-located teams	• Emergent ground rules as project progresses • List mixes task and process rules • System should be cleverer to identify dishonest answers • Rating for honesty (cf Ebay)

Table 7.2 Grid analysing affordance interpretations of Ground Rules function

The use of the function for agreeing ground rules, that was both intended and perceived, has been discussed in the previous chapter, and indicates the suitability of the system for its intended application. In addition, some of the ways in which the teams used the output, had not been anticipated by the designer, such as its use for drawing up a contract. Team leaders recognised the need for sanctions, a register of attendance and the difficulties in communication, which had not been anticipated by the designer. Also the list of suggestions in the "Wanted but not provided" quadrant indicates functions the students would have liked, but which were not intended in the design of the system.

The "Intended but not perceived" quadrant is where the students did not perceive the system's intended purposes; there was limited recognition of the system contributing to a shared understanding between team members. The ground rules function was not even seen by some students, because there was limited introduction to the system at the start of the team project module, and a feeling by some students that the system was not necessary for co-located students at all.

Intended and perceived	Perceived but not intended
• Information on members' skill levels • Automated allocation of tasks to individuals • Shared mental model • Think about skill levels • Training needs • Awareness of need to develop new skills • Takes conflict out of decision making	• 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	**Wanted but not provided**
• 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	• More information on task durations • Resolving conflict in allocations • Pick out personalities

Table 7.3 Grid analysing affordance interpretations of Task allocation function (Sadler and Given 2007)

Similarly, the task allocation function did not live up to expectations for all teams, but of those teams that tried it, team leaders used the outputs in different ways, and to good effect in terms of their projects. The teams did not particularly use the output to share knowledge on abilities of individuals, and the system did not give awareness of team working processes or team structure, leading to team cohesion.

"Not a major role in helping team cohesion" TL, T3, 2008

Indeed this particular team leader chose not to share the results with the team members, using the output as a management tool rather than to help develop team cohesion, a point to be returned to later in this section. The following comments reinforce the authority the team leader has over the team members as project manager, trying to understand why the team members behave as they do, in terms of quality of work produced:

"Management tool rather than to help team cohesion" TL, T3, 2008

"Yes it helped develop shared understanding of members, why they do what they do in that way. Helps me to understand why the work they produce is good or bad, when I looked at the system output, and realised they are not that skilled in it." TL, T3, 2008

The rules included in the system for allocating tasks or suggesting training, were not criticised in any of the feedback, and the interviews with team leaders confirmed that, from the point of view of task allocation, the agent system was found to be useful,

> *"In a way, made us know who to put in section" TL,*
> *"Useful, not used completely. Gave an idea of what they [team members] could do" TL, T3, 2008*

The system was eventually set up with just one rule to flag a suggestion for a ground rule, if more than half of the team members agreed that it was an important rule. However, half may not be the best proportion, and an output that indicated the degree of consent to a rule, or a ranking of the presented ground rules, might provide a better basis on which to negotiate and make a decision. It is difficult to determine whether seeing a list of ground rules, and the output list of those rules the majority of members agreed with, actually contributed to a feeling of team cohesion.

One team leader pointed out that these team projects are not like real work, where money motivates team members and there are procedures in place for dealing with poor quality of work:

> *"Not like real work. At work money motivates threat of sack, procedures, warnings. Don't produce work of bad quality. Can pass team project on backs of others. Would need team time as well. Contribution and attendance" TL, T9, 2005*
> *"There is no formal contract, they don't work, we are not able to sack the team members" TL, T7, 2004*

Half of the team leaders interviewed agreed that the system was successful in that it

> *"…did what it was supposed to do…",* and it *"…worked with no errors…" both from FG, 2002*

But simply getting a system to work is only part of implementing a successful support system, its impact upon the tasks of the users of the system is just as important, as discussed in the previous chapter.

All team leaders interviewed said they definitely found the system to be a useful tool for a team leader, and would use it again. Even team leaders who did not use it with their team thought it would have been useful, and wished they had persevered with the agent system in the first weeks of the semester:

> *"Used earlier it may have speeded up the project, because the first tasks allocated would have been based on their preferences, and see how they got on with them." TL, T3, 2008*

Whereas the interview responses provided feedback from team leaders, the questionnaire responses represented the views of team members. The findings indicate that team members were not all as enthusiastic as the team leaders, because the role of allocating tasks to individuals tended to be invisible to team members. From the focus groups it was found that few team members actually looked at the outputs from the Guardian Agent to find out about their fellow team members' abilities and preferences. This meant that the majority of team members did not think that this system was very useful for co-located student teams, but they did think it would be useful for online student teams. The research data did not indicate how many of these students used the system elsewhere than on campus, and whether this would change their perception of its usefulness. This is considered further in the next section.

The findings from the evaluation of the Guardian Agent system are that this system, used at the beginning of a team project, did help support the students in the maintenance roles of their team project working. The team leaders, in particular, benefited from the output from the system, and used this in various ways to manage the maintenance of their teams.

7.2. What level of suitability of the system do these students perceive for online student teams?

Although not a primary objective of this research, we were interested in finding out whether this system might be suitable for students working on team projects online. As many of the students in this case study also frequently work online as well as on campus, their feedback could be considered as a good barometer of the perspectives of online students.

In this research students used the first prototype agent system on campus, but in later versions were able to use the system from home as well, and many appreciated the possible usefulness of such a system for online team working. One unanticipated advantage was noted, as one student emphasised the privacy this system afforded to individuals:

> *"Feel comfortable putting into it in private" TL, T5, 2005*

In order to support students who spend more time working from home, this online system might be an appropriate adjunct to other tools. Respondents were asked how they thought that such a system could be useful for online teams:

> *"Online where it was very difficult to decide on the skills that each member had" TL, T15, 2004*

Students acknowledge that online forms of communication are also applicable for co-located students in teams, and suggest using any of a range of online tools:

> *"We meet together to sort the next task, face-to-face is important, if online we would need some kind of structure, communication plan, e-mail, would be more useful" TL, T7, 2004*

In the co-located setting, agreeing to a formal set of ground rules may be unnecessary for the smooth running of a well motivated project team, as previous experience with team working teaches team members how they should behave. But as students work away from campus more often, this sort of informal operation may not be appropriate. Workman (2004) found that more formal structures were necessary for virtual teams, a result appreciated by respondents in the focus group:

> *"Even more difficult in virtual teams, to abide by ground rules, e.g. trust, culture develops in time.." FG, 2004*

Team cohesion, trust and conflict issues may become more pronounced online, and current research into virtual team working with student teams suggests that the structure of the team affects the information finding methods used. Swift trust is relied upon more in virtual teams to build trust, as the processes of team working tend to be hidden, preventing a deeper trust from being developed (Powell et al. 2006). But swift trust may be fragile (Jarvenpaa and Leidner 1998). The Johari window shows that

hidden areas of knowledge occur, and that more knowledge should be made available to all team members, through disclosure (Chapter 3, section 4). Different team structures and processes are suggested for virtual teams to ensure effective team working (Piccoli et al. 2004). Team management and leadership are important, together with a need for training in using online tools for supporting virtual team working (Paul et al. 2004).

> *"It needs to be communicated to all team members at the beginning to introduce the tool, and mention it in the team brief." TL, T3, 2008*

In a recent study Alexander (2006) found that students were dissatisfied with virtual team working, suggesting that additional help is needed for online students, beyond what is currently available as supporting technology for teams. Providing virtual rooms for students to meet in to engage in synchronous chat is one possible improvement (Beer et al. 2005), because there is often less communication when the teams are virtual (Bohemia 2004), and in another study email alone did not seem to be adequate for team working (Gatlin-Watts et al. 2007), all of which suggests that additional tools are needed to support online student teams. Student satisfaction with their team working was found to be lower for virtual teams doing systems development than for co-located teams (Whitman et al. 2005). Therefore, the help provided by a system, such as this Guardian Agent, might play some part in providing appropriate support for student teams, if further developed.

Feedback indicated that the agent system was not as good as communicating face-to-face; but they agreed that it would be good if face-to-face contact was not possible, particularly as it would be very time consuming to find out about individuals' preferences online, as email responses can be very slow.

These students were able to envisage differences in working practices that might arise online:

> *"Example of strong personality attempting to take democracy out of the debate – could be even more of a problem on-line –'if it comes to a staring match then someone backs down' – equivalent is turning the computer off." FG, 2002*

"...you have a leader and hierarchical structure, on-line there would be no hierarchy" FG, 2002

When asked whether they thought that the agent system would be useful for students doing team projects online, many agreed that it would, particularly as part of a package providing other tools as well.

Although Patti and Gilbert (1997) provide a convincing argument in favour of co-locating product development teams, to enable knowledge sharing, particularly in the early stages of team formation, there are difficulties in achieving this, because global workers are not easily co-located for even a short period of time, and there are benefits in using team members representing other cultures. Also, as staff members become more accustomed to communicating using online tools, there may be less need to co-locate to carry out projects, and as experience of using online communication tools grows, online tools to perform different but specific tasks will become more acceptable to teams. This agent system could become one more tool in the virtual team working armoury, as it could provide exposure to online collaboration tools as an important experience for undergraduate students, who may eventually be working in virtual teams.

Access to information sources and communication with their peers and tutors over the Internet is key to achieving this freedom, so students are learning online, whether as part of distance learning, or because they choose to use the technology to work from home some of the time (Attaran and Attaran 2002). However, team project working is difficult when students are working face to face, suggesting there may be greater difficulties when team members are separated from each other physically (McDonald 2002).

7.3. Which other functions could be incorporated into this agent system that would help students with their team project work?

During the three cycles of prototyping, feedback was elicited in order to improve on the system design, and to address some of the team working difficulties these students have experienced. In addition to the feedback used to improve the prototypes, many

other valuable suggestions for the system were collected through the survey tools. These have informed the understanding of the author of the team working experience of the students in this case study. This picture of the difficulties the students in this case study actually experienced, will contribute to further development of this agent system for better supporting students in their team working, not only at the getting started stage, but also throughout the project lifetime. The students used all of the data gathering tools to provide suggestions for additional functions they thought the guardian agent system should perform, i.e. through the open-ended questions in the questionnaire, the interviews and the focus group sessions (Appendices 5, 6 and 7). In the next section all of the suggestions for improvements and additional functions are drawn together.

7.3.1. Difficulties in team working

In order to gauge the extent to which student team projects may be hampered by difficulties in team working, students were asked to state any particular difficulties they had encountered in their team working. The responses, summarised in Table 7.4 were found to be in line with much of the literature, principally including communication, recognised for example by (Williams 2002; Politis 2003; He et al. 2007), commitment, recognised for example by (Cornelis et al. 2006; Powell et al. 2006), time keeping (Hogan and Thomas 2005), attendance and agreeing tasks (Bahli and Buyukkurt 2005), clashing personalities (Wells 2002), agreeing with the findings for school children of Gillies (2004) and Jehn and Mannox (2001), leadership styles (Bligh et al. 2006) and motivation (Schunk 2000).

The team working difficulties mentioned in the student questionnaire feedback (detailed in Appendix 5) has been divided into those associated with maintenance issues and those relating to task issues on Table 7.4. The items mentioned give an indication of issues that future developments of this agent system should try to address, that were not solved by the current version of the Guardian Agent system, but are still of concern to these students.

	2002	2003	2004/2005
Team cohesion (Maintenance oriented):	• Communication was cited frequently in various contexts • Understanding the project • Leadership issues • Time keeping of members • Dedication or motivation of members • Ensuring Responsibility taken for tasks, in addition to allocation • Clash of personalities • Differences of opinions • Time management of individual team members • Absenteeism from meetings	• Communication, Absenteeism, • Not knowing what to do exactly • Poor communication can lead to a breakdown in the project • Some students carry other students through team time as they don't pull their weight • Lack of contribution from some members, • No discipline structure • Different opinions • Work can only be completed when everyone is there	• Lack of communication within team, • More tasks being delegated to certain students • Team functioning properly • Some people only do what told, have no sense of overall project, they do their part for the team but don't take part in the team • Not everyone knows what is expected • Low attendance • People taking charge when they don't have authority. • Getting on with each other • Failure to reach a consensus • Dishonesty
Project management (Task oriented):	• Setting Deadlines and monitoring them • Problem solving • Knowing how to carry out the project • A lack of feedback on progress • Lack of training in skills • Limited strengths of some team members • Coordination of the roles	• Decision making • Some organisational issues such as dividing up tasks • Organisation, communication, assigning work • Getting started on project earlier • People struggling with technical roles while someone appropriate could fulfil this role • Not sure if answers provided were real • Lack of ability, • Lack of instructive control	• Student skills • Keeping to deadlines • Work distribution • Lack of attendance and communication • Tracking all students are doing the work they are supposed to be and delivering it. • Students are not using their own initiative in taking on work that needs to be completed.

Table 7.4 Summary of team working difficulties mentioned

In particular, communication, uneven distribution of work, attendance and getting the work completed, as well as assessment issues were mentioned, corresponding to the issues raised in reports in the ISI team projects, as reported in Cooper and Heinze (2007). In fact the list of difficulties we collated at the end of the prototyping trials is longer than the lists for earlier trials, so it might seem that the agent system had no impact upon team difficulties. But difficulties in taking responsibility for tasks, and allocating tasks were not mentioned after the first version; also tasks appeared to have been allocated to more appropriate team members by the time of the final prototype. However, as the sample sizes were small in this research, it is not possible to infer that benefits seen are a direct result of the interventions.

7.3.2. Additional functions

Overall the students felt that the system only went so far, and could have provided a lot more information and help. In the past they said that learning about team working

has been very much trial and error on the team projects, whereas this agent system has the potential to be a guide for team working, which would be of benefit because there is no teaching input to the team project module:

"No teaching, more to do with previous years' experience" FG, 2004

Many aspects of team project work, although specific to team projects in this particular case study, could be supported by the system, such as help with completing the documentation needed for preparing final reports, help with writing a client contract etc. These suggestions were for more specific instructional use that the agent system could have, as guidance to help students to perform well in the team project, and to acquire good team working skills as they do so:

"How to handle problems, what has happened in the past." TL, T20, 2003

There were suggestions linked to project management and planning, such as guidance on structuring the project correctly and tracking progress of individuals against a project plan. The possibility of help with planning in this area was recognised by some team leaders:

"Methodical and logical we won't miss out anything" TL, t13, 2004

"Made sure we planned properly" TL, T13, 2004

However, Hiltz et al. (1996) also found that the teams they studied preferred not to have a *"restrictive, "mechanistic" structure"* for coordinating interactions using computer mediated communication.

Although groupware and project management tools are available and used by most of the teams in this study, there is nothing to link the task-oriented functions to the maintenance-oriented functions, such as managing interpersonal relationships. Suggestions for additional functions that the online agent system could undertake included help with minutes of meetings, progress reports, applying deadlines and linking the agent outputs with project management software. There have been some recent systems developed to help project planning, e.g. (Collings et al. 1995), but as different packages are used for different aspects of a team project, there is an issue of compatibility of the systems.

Providing calendars onto which teams can add deadlines, which are monitored by the agent system, was a suggestion, implying a shortfall in current usage of project management tools, perhaps a lack of training or time to set up the project management tools, or poor online provision:

> *"Deadlines to tick off. Agent would keep a record of deadlines" FG, 2004*
>
> *"..keeping up with tasks, assign tasks to members, monitoring of completion, for documentation" TL, T27, 2003*

Several respondents agreed that the system should learn about the students each year, building up a record of each student's progress on acquiring skills, which could be used in subsequent years to ensure the student gains experience in as wide a variety of different skills as possible. Some suggested it would be useful to be able to edit team members' skill preferences and abilities, as they learn a new skill, and so build up skills on the database from one semester to the next and one year to the next. In addition a database of contact details and some personal information could be included. Perhaps guidance to carry out a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) or some means of identifying the strengths of individuals, would be useful:

> *"Building up skills, being able to update it. More knowledge over term." TL, T5, 2005*
>
> *"More information on skills. E.g. report writing" TL, T14, 2005*
>
> *"Feedback on carrying out documentation, what is expected, roles, responsibilities" TL, T20, 2003*

One benefit of this system could be to ensure that all students receive comparable opportunities to learn different skills, by allocating to teams working on a variety of project types, over their programmes of study. The tutor could use the system to allocate students to project teams, and assign to particular roles, based on previous experience and skills building needed:

> *"Opportunity to use the system as a discoverer of other people with appropriate knowledge" FG, 2002*
>
> *"Look at how people have done on past modules (skills assessment) and undertake some form of 'measure'" FG, 2002*

"Both team leader and module tutors could benefit. Module tutor could use it to build teams for next year, so all teams are fair." TL, T3, 2008

Hiltz et al. (1996) recognised a need for teaching online students how to use CMC effectively, the medium can provide for rich communication, but its use is different to the co-located situation, so the mechanics and the social dynamics of this communication may need to be explicitly taught. Discussion forums, file sharing and instant messaging could be additional tools provided alongside the Guardian Agent system, which would be available online to enable students to work from home:

"Online team shared workspaces, linked with project management for deadlines, update from home, and freely available." TL, T5, 2005

These suggested additional functions have the potential to enhance the usefulness of the system, in terms of teaching about teamwork and providing a link between existing project management and learning tools. As shown by their comments, the students were able to envisage a more "intelligent" system, capable of learning about the individual students, and provide more personalised help for team working. For example, in time, as the system is used, a database of information about the students would be built up, including their skills, abilities and performance. This information could be used in a more "intelligent" manner if the system were to be developed to behave more like a "software agent" system. This potential development is discussed in the next section.

7.3.3. Make it more like a software agent system

Developed from artificial intelligence, agent technology has the capability of providing more personalised and specific assistance to students working in teams. Included in the working definition of agent systems are that they learn from the users, are autonomous, reactive to the environment, able to communicate with other agents and perform tasks for which they are designed, all of which would be desirable attributes of this Guardian Agent system. The current version of the system could be extended to incorporate some of these requirements, in order for it to be regarded as closer in functionality to a software agent system, as currently defined.

Other systems such as that suggested by Gregg (2007), are more specifically for supporting training, by providing instruction, learning planning and resource finding,

on an individual basis, but with the addition of a collaboration agent to search out and encourage collaboration with other learners and tutors, rather than to support team working.

> *"Agent would act as the decision maker, skills assessment, which types of people would work well together" FG, 2002*

Hansen (2006) gives suggestions for tutors to improve the organisation of team projects, but many of these suggestions were already a part of the team projects preparation in this case study, e.g. emphasising the importance of team working, providing time for meetings, a requirement for assigned roles (leader and deputy leader) and using peer assessment. This system puts the onus on the student teams themselves, also promoting self-directed learning.

Some of the students suggested that they would have liked to be able to edit the database, to update team members' skills as they learnt new things, and use the system to allocate a different set of tasks later in the project:

> *"Build up skills from 1st year and just edit them" TL, T5, 2005*
>
> *"Can't go and update skills, add more and run it again" TL, T5, 2005*

A more dynamic system would grow and adapt as students learn more skills, from one semester to the next and one year to the next, throughout the three years of an undergraduate degree programme. In the first year of study initial information would be input, and this would change over time:

> *"Capture and change the database content" TL, T8, 2004*
>
> *"Suggest use it at the end of the 2nd semester, then module tutors can use it to combine the teams with appropriate skills. With the team project brief, the leader and deputy can be given some initial information." TL, T3, 2008*

The initial data on individuals' preferences in tasks, roles and ground rules is stored, along with allocations of tasks and agreed ground rules. This can form the basis of learning about the students, providing information for other team members, and being updated as the project progresses, with additional data on the individual's performance against the plan. The agent can monitor the individual's activity and

progress on the project tasks, sending out gentle reminders as deadlines for tasks get nearer, and this information can be broadcast to other team members to maintain trust levels.

These comments suggest an appreciation that using an online support system would have time implications:

> *"If it can help, mentor, requires a lot of input to have it dynamic*
> *GA [guardian agent] job of someone to run it rather than team leader, an extra admin job" FG, 2004*

So the agent should act autonomously, gathering new facts to store in the database, reacting to this data, and suggesting action, without involving too much work overhead from the students themselves:

> *"Idea of an agent to help is OK, but must be real help and streamlined" FG, 2004*

In terms of affordance, whether the students would actually work with the agent system is another matter, the system would have to be truly useful, or team members might circumvent the system, as one team leader suggested:

> *"Whole team dynamics - whilst appearance could be of cooperation through the agent, could in fact be operating outside of the agent with the team, then interacting with the agent post decision making" FG, 2002*

This of course is a matter of trusting the agent to work on the user's behalf. An agent as a personalised pedagogical agent is examined by Mahmood and Ferneley (2006). They identified several issues to be aware of in implementing agent systems for learning, one of which is that autonomous, proactive and agile agents means that quality assurance may be difficult to ensure, also a user profile would have to be built up for tailoring the output for individuals, and initially the student users may not know their personal preferred learning approaches, required to set the system up.

A further common feature of an agent system is to have some form of character, representing the embodiment of the system, as a friend offering advice (avatar). Throughout the prototype cycles feedback suggested that there was no need for a character as a vehicle for providing the output from the system. A study by Moreno et al. (2001) suggests that learning is no better if there is an animated agent presenting

material for computer aided learning, although when the material was presented with a voice over agent, learning was improved. Another study by Hershey et al. (2005). found that a fully animated agent did help the learning experience, but they suggest that for an agent to be useful it should be designed well, or there is a possibility that it might detract from the learning The findings of this research were that these students would not like to have a character, purporting to be a friend giving support to them. The content and quality of the advice or help is more important than visual effects:

> *"Characterisation irrelevant – if it does not do what it's supposed to" FG, 2002*

Feedback obtained from this study suggests the possibility that a more elaborate agent based system would be suitable for this implementation, with functions that include learning about the individual students, autonomous operation to advise on the progress of the project and a mentoring and tutoring role for specific skills. However, this functionality should not involve any more effort on the part of the students.

7.3.4. Improvements to the implementation and interface

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 to be recognised. Quantitative results for user acceptance of the agent system were disappointing, but team leaders pointed out that training and information at the beginning of the project may help its acceptance, so one or more sessions at the beginning of the project, explaining its functions and how to use the output would have helped:

> *"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 way in which such a system is implemented will play a part in how well it is used and accepted. For example not all team members even saw the output from the system:

> *"Yes if more people used it and it can be tailored to the needs of particular projects and not only the team leader but the members must know how to use its. Start the project with it." TL, T17, 2004*

"I did not see the whole thing the first day I wanted it" TL, T15, 2004

"By the time we figured it out" TL, T7, 2004

"Confusion with ground rules" FG, 2004

As well as user documentation, the system should be furnished with more details to help users to complete the forms, including on screen guidance, and more explanation of what might be involved in each of the roles displayed, to help users make their choices. These could be included as mouse over text boxes or splash screens:

"Most helpful thing would be a cursor over area for help" FG, 2002

"Introduction screen (splash screen with explanation)" FG, 2002

"Not sure what some mean. What is in jobs such as administration" TL, T20, 2003

"Help needed, defining generic skills" TL, T8, 2004

From the team members' as well as team leaders' perspective, the output of task allocations and suggested ground rules should be in a better format, easier to read and interpret, perhaps with a choice of display formats (this was partly implemented for the allocations display in the last prototype, but was largely unnoticed):

"Improved format of the outputs" Q, 2002

Team leaders suggested an improved interface to enable them to edit preferences over the period of the project, and the suggested allocations, so that the team leader can input the actual allocations:

"Better interface for Team Leader to edit progress over term" TL, T5, 2005

The interface should be designed with more features to help the teams, providing more information and guidance, in which case team leaders thought that the system would speed up their decision making processes:

"Give more information to base decisions on" TL, T14, 2005

"Better guidance" TL, T20, 2003

Overall the students who responded did find the system useful, it performed its functions well and the interface was adequate. Variations in satisfaction could be explained by differences in the length of time the researcher spent explaining the

agent system to individuals, and the time spent by team leaders instructing their team members:

> *"Relatively easy to use, once sussed out. Read instructions and explained to others" TL, T10, 2005*

There were some reservations about how the team members used the system, but thought to be no different to methods used previously. A major drawback would be assessing the accuracy of team member input to the system:

> *"Some were too quick 'click, click, click' – some results may not be very accurate. Point out that this quick response also occurs in manual skills assessment at start of project" FG, 2002*

There was support for developing an agent system for helping students working on team projects, whether collocated or online, but it should be fully functioning, truly helpful, easy to use and introduced at the beginning of the module:

> *"Needs to be taught in the project, part of the culture" TL, T13, 2004*
>
> *"Teams tend to be too busy to use it" TL, T17, 2004*

The interface part of all three of the prototypes was less than perfect, although working technically, the interface lacked basic instructions, guidance and suitably designed outputs. In this research most students were able to work around these limitations, with instruction from the tutors and their team leaders, and did report that the interface was fairly self-explanatory in the questionnaires. However, modifications to the system will need to include improvements to the interface along the lines suggested in this section. It is particularly important that the interface is self-explanatory when the system is to be used by students working at a distance, without the direct help from other colleagues.

7.4. Summary

This chapter has looked at the suitability of this sort of software system for helping co-located students undertaking team projects. Within the confines of this case study the software system did help most of the student teams to get started on their team projects. Feedback on whether the system was useful to team leaders varied from those in favour, who wanted to use it again in the second semester, to those who felt it added little to their understanding of members' abilities.

At the beginning of this research, it was thought that the function of task allocation would help engender greater trust, leading to improved team cohesion. This was indeed the case, but in addition, it was found that automating the task allocation helped the team members to recognise a need for developing a wider range of skills, perhaps through training or mentoring, both task oriented skills, team working skills and communication skills.

The system provided an automated means of gathering individual perceptions of the importance of different ground rules, and the system output was designed to promote discussion to agree which ground rules would be appropriate for a team to adopt. This function provided a suitable means for team leaders to base a contract upon, but it also encouraged the team members to think about working relationships and expectations, which had not always happened in the past.

In conclusion, the Guardian Agent system was found to be suitable for supporting the maintenance roles at the getting started stage of co-located students' team project working. This chapter also looked at the suitability of this sort of system for students working on team projects online, and feedback from these students suggested that the system would be of greater use to online teams.

Finally this chapter considered the feedback from students as to the other functions it might be possible for this system to provide for student team projects, and changes to the interface and implementation. These suggestions are based on feedback from the students, which indicated difficulties these students still recognised in their team working. Some of these will be discussed further in the next chapter, as possible future work on the system, including enhancements of the present version based on a database, and enhancements to provide more of an agent like architecture, which was what the original system design intended. For the purposes of this research, only a small subset of the possible functionality was incorporated, sufficient to demonstrate the potential for the support agent. This agent system has potential for co-located student teams, who may choose to work in a dispersed manner, as they adopt a flexible approach to their learning. It may also be suitable for supporting distance

learning student teams, but this research was not intended to prove that, as the research suggests that the requirements of the system may be very different.

The next chapter provides a summary of the whole thesis, bringing together the findings as reported in Chapters 6 and 7, to answer the research questions as set out in Chapter 1 of the thesis.

8. CONCLUSIONS

In this chapter the author will draw together the findings of this research. The identified findings will be summarised, in as much as the findings answer the research questions posed at the beginning, to show a contribution to the body of knowledge. An appraisal of the research process used will be given, to determine whether the methods used were appropriate for the objectives of the study, and to consider the validity of the case study approach used. Next the author will consider limitations of this work, and discuss further work that can be carried out in this area of research. Finally there will be a discussion of the learning of the researcher, showing development as a researcher over the years of the research, and how case study research emerged as the most applicable to close the study out.

8.1. Review of the research objectives

The original research questions were derived from the wealth of issues that contribute to team working. The main research question adopted represents a suitably sized chunk of work to be examined, and is:

- How useful is online software support in the first stages of co-located student team project working?

In order to answer this question, three research objectives were identified as follows:

- In what ways does output from the automated system to allocate tasks and agree ground rules help students to get started on their team project work, and impact upon relationships between students?
- How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working, and how suitable is the software perceived to be for online student teams?
- Which other functions could be incorporated into a support system that would help students with their team project work?

The cycles of prototyping also used the following research objectives, in order to modify the system in the light of feedback, and arrive at a system that goes some way to satisfying the students' requirements for such a system:

- Identify changes to the current implementation that can be incorporated into the next prototype;

- Evaluate the suitability of the pre-programmed content in each version of the system.

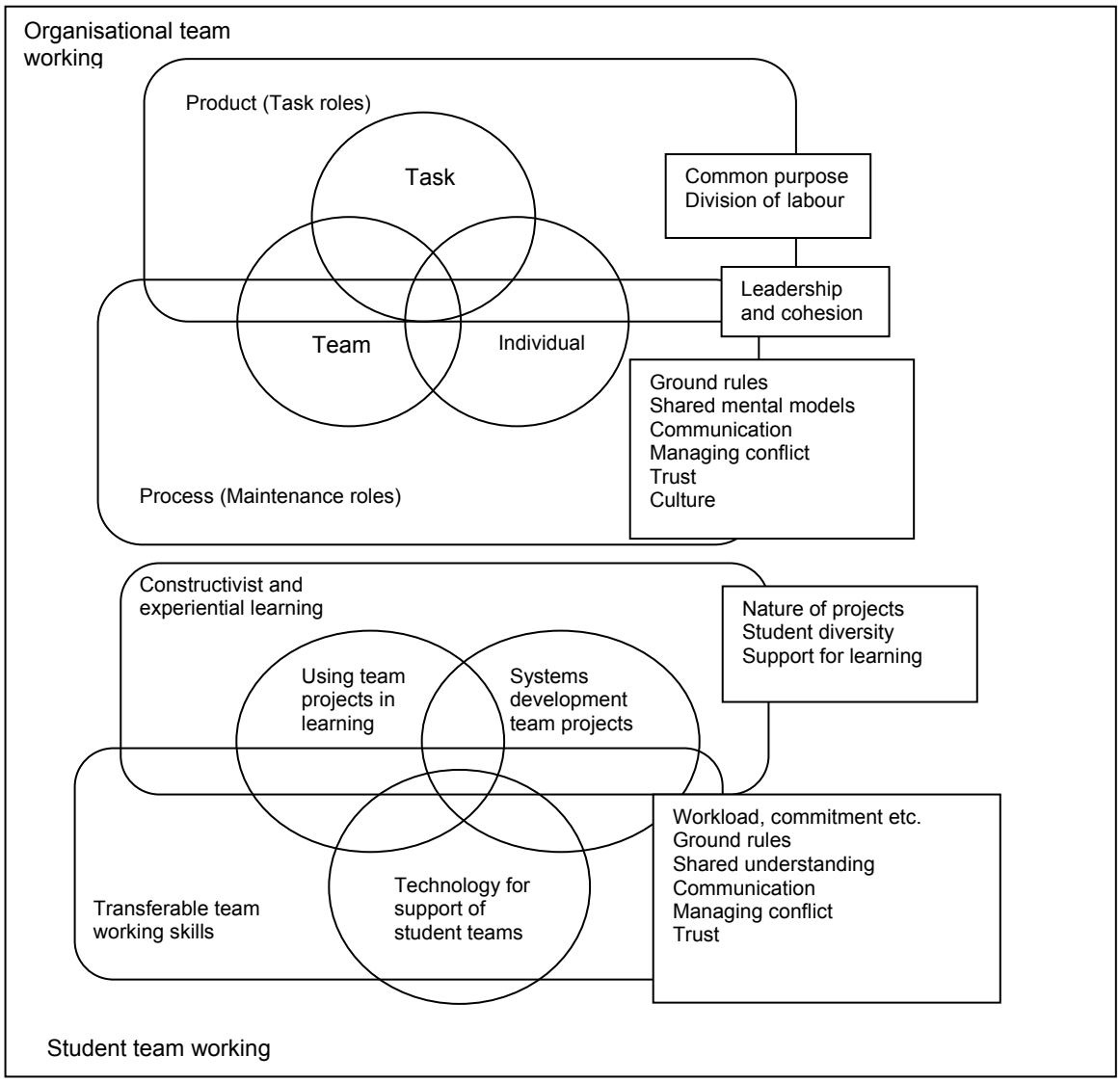


Figure 8.1 Model of team processes in organisational and educational settings

A conceptual framework for this study was developed from the literature, to position this work within the existing body of knowledge, Figure 8.1. The two main areas of the conceptual framework represent the areas of literature that contributed to the study, i.e. team working in organisations and the part played by team projects in learning in higher education. The lower part of the framework shows how the outcomes from the research will contribute to knowledge by demonstrating how such a software system may be designed and used by the students to help them get started on team projects, the part it might play in developing team working skills in students and directions future work could take.

The next section gives the contribution of this research using the research questions asked within the study as an outline for describing the results.

8.2. Contribution of this work

Carrying out research should contribute to the body of knowledge that exists on a topic, in a manner by which the reader can be sure of its validity. This section looks at the contribution to the body of knowledge, and the section that follows considers how valid the results actually are, given the learning curve that has been experienced by the researcher. The structure of this section is provided by the research objectives, considering the three sub-questions first.

8.2.1. In what ways does output from the automated system to allocate tasks and agree ground rules helps students to get started on their team project work, and impact upon relationships between students?

Interpretive research, in the form of a case study, is more directed towards finding out why as well as how things happen, and the responses from students in this case study did provide a wealth of informative data, to use for answering this research question. The literature suggests there are two main divisions of the processes of teams, namely the task and the maintenance roles, and the necessity of addressing both of these intertwined roles if a team is to be successful, e.g. (Beranek et al. 2005). The first research objective asked about the ways the outputs from the system was used by teams, to help them get started, in terms of both the maintenance and task roles of team working. As maintenance and task roles are intertwined, this question also asked what impact, if any, the outputs from the system had on relationships within the team.

The system was found to contribute some support for students in the forming stage of their team projects, which may have in turn contributed to a reduction in conflict arising in the storming stage. In particular the team leaders benefited from using the task allocation output to help with project management and planning, because it provided additional information upon which to base their decisions. It was not possible to directly attribute the task allocation function to improved team cohesion or trust, but there was an indication from students' responses that this function helped

team leaders to apportion the work appropriately, giving tasks to suitably qualified team members, so other team members could trust that the output would be completed well. The system also highlighted deficiencies in skills within the team, so that training or shadowing a more experienced team leader could be arranged.

The output was used to help team leaders to structure their teams, dividing the technical from non-technical members, useful in this particular case because team leaders did not always know about members' capabilities from previous work together. The culture of the ISI team projects was to divide the team into sub-teams, and some leaders used the output to help do this, others tried a more open and flat structure, because team leaders recognised that the structure of the team is important for success in their project. In most teams the paper based audit of skills was replaced by this automated system.

On the downside, the input to the system relied on students being honest about their abilities, whether intentionally or not. The culture of the ISI team projects had developed to the extent that students know which tasks represent the "soft options", and purposely select skill areas they believe will point them to those tasks, hence avoiding more difficult tasks. The system sometimes identified too many students to be allocated to tasks, which team leaders overcame by discussion and negotiation, reported to reduce conflict in allocation of these tasks. Using the output was used as a basis for discussion, formed a valuable means of communication at the starting phase of the projects.

The function for agreeing ground rules, incorporated into the second and third cycles of the prototype, may not have directly contributed to improved trust and team cohesion. However, this function did prompt the students to think about their norms of working, and their relationships with each other, something that had been absent previously. Team leaders either used the output to form a contract of working for team members to sign up to, or simply used the output for discussion and as a means of communicating expectations and obligations to each other. Team leaders were aware of their limited authority over team members, and suggested that the ability to impose sanctions was necessary in addition to agreed norms, possibly enforced by tutors.

The students in this study reported an improved sense of team cohesion as a result of using the different prototypes systems. This was manifested as both an improved level of trust through knowing other team members' capabilities, and a shared understanding of the processes of team working, as the team collectively agreed to abide by certain ground rules. It is not possible to say whether discussion and agreement with ground rules contributed to the tasks of the project being completed on time, because many factors may affect this, which were outside the scope of this research. The task allocations and suggested ground rules, combined with face to face discussion was the preferred means of communication of a shared understanding at the start of the projects.

Overall, students did find the task allocation function of benefit, not only from the task oriented roles point of view, but also from a maintenance oriented view, because the system output helped the team members to recognise a need for developing both hard and soft skills in order to complete the project. Similarly, the agreeing ground rules function helped the students to reflect on norms for their team, thus helping the maintenance roles of the team. The output from the system encouraged students to consider their working relationships in the team and form a common agreement, in spite of the prevailing custom and practice of the ISI teams.

Team projects are aimed at developing certain transferable skills, such as communication, listening, presentation, leadership and negotiating (Chadwick 1994). From this research there is little evidence that this system had been instrumental in helping to develop team working skills, but the system did encourage a sense of belongingness in the teams that used the output effectively. The system did also provide support for the team leaders to put in place training to develop different task related skills in individuals. The students (particularly the team leaders) still had to negotiate with members to finalise allocations, and plan the project accordingly, thus developing project management skills.

In this case study, team leaders take responsibility for leading the team to a collective good grade, hence they used the output of task allocations and suggested ground rules in different ways, depending upon their previous experience of team projects. This research shows that the ways in which they used the output did help the teams to get

started on their projects, and did get team members to think about their team working relationships.

8.2.2. How suitable is this type of software system for supporting the maintenance roles at the getting started stage of co-located students' team project working, and perceived suitability for online student teams?

The literature review identified a number of issues of team working in organisations and within student teams, which could be addressed by a software system. Software systems to address these issues in organisations include groupware, but Collings, Richards-Smith et al. (1995) highlighted difficulties with using groupware for student teams. Of the other tools to help team working, some were designed for students, e.g. WOTS (Chan et al. 2005), but most support for teams is based around use of a virtual learning environment, which does not provide specific help for team working. Many of these tools provide good help for the task oriented roles of team working, but not the maintenance oriented roles, and leave students to find out themselves the best ways to use tools, e.g. using collaborative tools. This research objective was to demonstrate how well this prototype system helped student teams with maintenance roles of team project working, when co-located, then to assess their perceptions of this system as a support for virtual student teams.

Although a number of roles were identified for such a software system, the scope of the implemented system had to be limited because of time constraints, so two distinct functions were chosen, i.e. task allocation and agreeing ground rules, both aimed at providing support for the "getting started" stage of their team projects.

Team leaders used the task allocation output to help with project management. Time is a factor of project management, so when tools can be used to save time, this should be an advantage to the students. This was the case with this support system, which automated the process of allocating tasks, and was found to speed up the process of getting started.

Non-contribution by team members is a symptom of lack of motivation, or poor team cohesion. The suggested ground rules function was found to contribute to improved team cohesion, by providing a list of ground rules for all team members to see, and indicate their agreement with, whilst at the same time encouraging individuals to think about team working obligations and expectations.

Some team leaders used the suggested ground rules output to compile a formal team contract, for all members to sign up to. However, the limited authority of the team leader limited the effectiveness of any contract, in the absence of agreed and workable sanctions.

The students in this study reported an improved sense of team cohesion as a result of using the different prototypes systems. This was manifested as both an improved level of trust through knowing other team members' capabilities, and a shared understanding of the processes of team working, as the team collectively agreed to abide by certain ground rules.

Although the system did work technically, limitations of the interface did restrict the level of success of the prototype. 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 (as shown on Tables 7.2 and 7.3). In particular, there was confusion over how to use the ground rules function, leading to it being ignored by some teams. However, an unanticipated benefit was the privacy afforded by the system for inputting their preferences.

Team leaders found the system to be useful for getting started on their projects, but not all team members shared their enthusiasm. Few team members looked at the output, for information on other team members, after any discussions to establish initial allocations of roles was completed.

For co-located students this prototype system was found to be useful, especially for team leaders. However, the student users said that they thought the system would be more useful for online student teams, than for co-located student teams. The students

in this case were taking the opportunity to use online tools to enable them to work from home. Although the students of this case were not online students, they could be taken as a barometer for the perceptions of online students, so were asked for their opinions of the suitability of this system for online students.

In designing this type of support system, the intended affordance of the system should be signposted, although the affordance perceived could still be at variance to that intended. In addition, it should be noted 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, and this research is concerned with co-located students.

Responses suggested that the system would be useful in conjunction with other communication tools, to provide more information to students. But they were aware that team structures and processes would be different for online teams, and training would probably be necessary for online students to reap the benefits.

This research has demonstrated that the design of this prototype system enabled these co-located students to use the system in different ways, to support the maintenance roles of team project working in the forming stage of their team projects. The findings also indicate some potential for its use to support online student teams.

8.2.3. Which other functions could be incorporated into a support system that would help students with their team project work?

In order to identify other functions that this support system could provide for student teams, a review of the difficulties students experience was compiled, followed by considering suggestions of other functions gathered in the feedback from the users of this prototype system. Finally, suggested enhancements that might contribute to the system becoming more like a software agent system, according to current definitions, were analysed.

Many of the difficulties these students cited during this research were the same as those recorded in the literature for student teams, including communication, attendance or commitment, equal distribution of work and assessment. This system

has improved communication between team members to some extent, but feedback indicates a need for more communication between tutors and students, in particular to provide more information about carrying out team projects. So students would like more guidance on team working, such as help with the specific documentation of this case, help with project management and provision of calendars with automated reminders.

Students suggested that the system should learn about individual students year on year, to build up a database of abilities, preferences and performance. This would provide useful information for team leaders at the start of a project, and if the system could be edited, to grow and adapt over the time of a project, it could be useful at later stages of team projects as well. An agent system should be autonomous, and operate with minimum additional work required from students, but according to this research does not need a character. Assuring the quality of the output from an agent system that is learning, is an issue to be considered in its design. Research into pedagogical agents is mainly concerned with agents as teaching assistants, providing personalised support and animated agents, which are aimed at supporting distance learners using the Internet. The learning that takes place within teams of students resembles that of a community of learners, where social interaction and constructivist learning is important. The type of structured learning associated with software agents may interfere with the desire for student centred, self-directed learning, but designing software agents as tools to support teams of learners, particularly those who are working at a distance, could be a fruitful area for future work, because it can substitute for tutor support that is difficult to provide in a timely manner.

The interface should be improved to provide on screen guidance on using the system, perhaps linked to some training at the start of the project, and outputs in a format more readily accessible to the students. In using the grid of Sadler and Given (2007) to analyse the findings from this research (Chapter 4, section 4.5), 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 (Tables 7.2 and 7.3). As suggested in the literature, some users may

either disregard the tool, or use it in a different manner, which happened in this case, notably the choosing ground rules function was overlooked by some of the teams (Section 6.2). The system was designed to provide information on team members for everyone to access, but it was found that team members relied upon their team leader to provide this information, so the intended affordance was not realised by the students in this case (Chapter 6). 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 features that designers did not intend.

Recent literature emphasises the importance of training at university to develop skills useful in later working life (transferable skills), such as social and team working skills (Dacre-Pool and Sewell 2007), and Prichard, Stratford et al.(2006) noted improved learning arising from active skills training. This online software support system could be developed to provide more training in particular skills, and could also be programmed to suggest opportunities to develop new and different skills. Although it does in its present form already prompt students to think about their technical skills, team skills and norms of team working, more explicit guidance and reflection would provide skills development better preparing students for team working in business.

8.2.4. How useful is online software support in the first stages of co-located student team project working?

In carrying out this research, an overall research question was posed. The previous sections have discussed the results of the three research objectives that comprise the overall research question; these will now be drawn together to provide an answer to this question.

Early research into team working in organisations was concerned with co-located teams, and educational research into teams for learning was concentrated mainly in the compulsory (under 16) sectors. It is only recently that research into learning in higher education has been regarded as a field in its own right, and the impact of team working is beginning to be examined, particularly concerning its pedagogical aims, though based upon team working theories from business organisations. There is considerable research into using teams for collaborative learning, but less into team working skills acquisition. Many researchers are using findings from student team

working to extrapolate to business organisations, but as the aims of team working, and evaluation criteria are different between higher education and organisational teams, this may not be valid. In particular the recent research into virtual team working carried out with students may not be valid for global teams in the workplace. Apart from developing groupware and virtual learning environments to date there has not been much research into the use of ICT to aid co-located students in their team working.

The research was composed of a cycle of evolving prototypes of a system to help students with allocating tasks to individual members and agreeing a set of ground rules to work to. These functions of the system were proposed to help students to get started on their team projects. The findings from this research show that this online software system did help support the first stages of student team projects, in spite of only being a prototype with limited functionality. It did this not only by providing a practical tool to perform specific tasks, but also by encouraging students to reflect on the output from these tools, which led to their insightful reflection on their reactions to others in their team. In this case, the main beneficiaries of the system were the team leaders, who guided team members.

Contribution to knowledge from an interpretive study should develop new concepts, apply an existing theory in a different way, contradict conventional wisdom or offer insights into human, social or organisation behaviour (Myers 1997).

This research offers a contribution in the following ways:
Chapters 3 and 4 provide a review of literature, showing how team working theories and learning theories on their own may not be appropriate for student team project working, and that the issues of student project team working in higher education are different and need to be addressed for learning to take place. A brief review of the literature on technology to support team working indicated shortfalls in their provision for student teams;
Chapter 5 describes this case study research study in practice, showing how the researcher gathered data from the research subjects to gain rich interpretive data, whilst trying out three evolving prototype systems;

Chapters 6 and 7 provides an analysis of the data findings, giving a rich description of the student experience of using the system to support two aspects of their team project work in this context.

8.3. Evaluation of the research process

Any piece of research should be evaluated to determine the extent to which it has achieved the original aims of the study, and provides a contribution to knowledge. This piece of case study research was a pragmatic study, based on evaluating the implementation of an artefact, at the same time as asking appropriate questions and analysing the answers given to further knowledge of the context. So the system can be evaluated in terms of usability, helpfulness and potential as a tool to help with getting started on a project for co-located student teams, and the findings of the case in this context can be evaluated in terms of how students used the output from the system, how useful this was, and why students behaved in these ways, and so answering the research question.

8.3.1. Evaluating the use of case study method

Case study research is a particular form of interpretive research, which answers the how and why questions, by considering a single case. The case chosen should be exemplary, in that it is unusual but the issues are of general interest, in that findings may be generalisable to other similar situations. Research results are said to be valid if they are generalisable, representative and the experiment is applicable to other settings (Lee and Baskerville 2003). The methods used for gathering data may also be scrutinised and although focus group results are said to not be generalisable, because data is grounded in the particular environment of the participants, combining them with other survey methods can produce generalisable findings (Powell et al. 1996), as in the results from this research.

This was an evaluative case study, evaluating an artefact alongside gaining knowledge about the context. In this section I will critically evaluate the ways in which case study was used in this research, by evaluating the validity with the four tests of empirical social research (Yin 1994:34):

1. Construct validity
2. Internal validity

3. External validity
4. Reliability

A brief note applying each test to my research is given in Table 8.1.

Four tests	Evaluation of the validity of my research
Construct validity	Criteria to evaluate the artefact: usability, helpfulness and potential for use. No criteria for measuring changes were defined, but qualitative expressions of benefit gathered from subjects
Internal validity	Rival explanations examined. Inferences made only where more than one respondent supported them
External validity	Applying "fuzzy generalisation" is possible from my findings
Reliability	Some errors and bias may be present in the data gathering and interpretation of data, but sufficient evidence to show that these have not influenced findings of the research

Table 8.1 Evaluation of my research against the four tests of Yin (1994)

The research design for case study consists of the questions asked, propositions put forward, the analysis units, how the data links to the propositions and criteria for interpreting the findings (Yin 1994:21). The questions asked were broad at the beginning, but as the data was analysed, it was possible to narrow down the questions to give meaningful results. At the beginning of this research there was a proposition put forward that software could be implemented that would help students to get started on their team projects. But the overall research question asked instead "how useful..?", which is not really a proposition, but a qualitative measure, more in keeping with the "how? And why?" questions that characterise case study research. This makes Yin's definition of case study less useful for an evaluative case study.

Although the method adopted was a case study investigation, the prototyping cycles borrowed much from the action research method advocated by Atweh et al. (1998) for education studies and Baskerville and Wood-Harper (1998) for information systems, because the researcher, although not involved directly with the participants, did learn from feedback from the participants as the research progressed through the prototyping cycles. The design of the system was modified at each cycle in accordance with some of the student (and tutor) feedback, learning about the processes of student team project work each time, and hence, improving the environment for the students.

The experience and findings of this research offered rich insights into student team project working, using the implementation of a software system as a tool to elicit these insights as students use the system. The insights gained relate to student teams who used the software system, as no attempt was made to gather data from student teams who did not use the system. Not only was the software system evaluated for the functionality it offered, but in using open-ended questions at interviews and focus groups, further understanding of difficulties these students experienced was gained, and their reflective suggestions for enhancing the functionality of the software system were provided. In addition students' perceptions of potential usefulness for online students was obtained. In this way the case study method proved to be an excellent means of gaining a wide picture of student team project work, at the same time as evaluating the implementation of a software artefact. The next section gives some of the limitations of the research.

8.3.2. Limitations of this research

Software systems development often follows a prototyping methodology, so that a cycle of refining the product in the light of feedback is possible. IT development with a software engineering approach can produce a software artefact, that matches the known user requirements, but it is the ways in which users tailor the output from such a system that makes the whole into a functioning information system.

The methodological choices made should match the research objectives (Silverman 2000), so an interpretive approach was taken, using qualitative data collection tools, because the author was interested in the meanings and reasons behind observed action, as well as the usability of the system. Although a positivist approach was at first considered as suitable for testing whether the proposed artefact worked, relying on quantitative data only would only have provided findings confirming whether the system developed was useful, and would not have provided the rich picture of the effect of and reasons for the students' interactions with the system on their team processes. In taking a longitudinal study approach it should have been possible to compare the responses over the cycles to identify any specific trends in the issues, but there was not enough data collected at each cycle of a comparable nature, to be able to compare effects.

Prototyping is useful for evaluating a system with unclear requirements, so simulating the interface can be a good way to try out an idea, as in the study of a pedagogical agent by Morch et al (2006). Although in this research the interface was found to be acceptable to most students, its design did not have the rigour expected of systems development alone, because I was concentrating on the ways in which students used the artefact. But their dissatisfaction with the interface may have influenced their responses. It was not until the latter stages of the prototyping that a more acceptable interface was implemented, and this effect would have been minimised.

The tools used for this research included questionnaires, interviews and focus groups. Some questions asked gave quantitative results, which served to give an indication of overall opinions on the use of the system, but it was the qualitative responses given in the open-ended questions of the questionnaires, the interviews and focus groups that was responsible for stimulating the identification of rich understanding of the ways in which the students actually work together in doing project work. As a result it was not possible to give statistical measures of acceptance, or opinions, but triangulation of the findings gave verification of some of the issues raised, because they were identified from different sources. One limitation of the research was that team leaders were interviewed, but not the team members. Team members had the opportunity to provide reflective feedback through focus groups or open-ended questions, but the discussion in chapters 6 and 7 contains mainly comments from team leaders. This could suggest that the findings are biased to be a reflection of the team leaders' perspective only, but in reality it was found that not all of the team members used the system sufficient to provide feedback, above that which had been obtained from team leaders.

In order to gain a more interpretive outcome from the study, careful evaluation of the feedback from users was made, by sorting comments by themes. The choice of themes was partly guided by the literature, but also by the feedback itself. The resulting findings from this research are not exhaustive enough to provide valid theory, but they have indeed discovered more about students' attitudes and processes when they carry out team project work, in the particular context of the systems development projects at the University of Salford.

When the researcher is a lecturer, their involvement, in the context of higher education, would inevitably involve some tutor- student power relationship issues, so this research was designed as case study research, rather than action research, to limit the participation of the researcher to a consultative role. Ethical approval for the research was gained part way through the investigation, which justified data collection methods already used, but the activities of a tutor involved in assessing student work would always pose ethical difficulties, such as in this work.

The findings from this research are subject to other limitations, including a small sample size of respondents, reliance upon the responses of the students to identify new issues and elaborate on those already found, and more time would have enabled me to probe for further details on these issues, and provide more insights.

8.4. Recommendations for future work

This section presents some directions for this research, including improvements to the system, to enable the current prototype to continue to be used for the ISI team projects (now incorporated into the Salford Business School).

Chapter 7 suggests a number of developments for the system, including interface issues that need to be addressed, to make the system more usable for students. A number of additional functions could be included in the system, to provide guidance on team project work aimed at developing team working skills in the students. This research only considered the start phase of team projects, additional functions for the performing and finishing phases could be designed. We could enlarge the database so that the system adds preferences, abilities and performance for all students over the three years of their undergraduate studies, and provide functionality to enable the tutors to select teams on the basis of the previous work of students, and a need to learn different skills.

Going one stage further the system could be developed as a software agent system, to operate autonomously, learning about students, and the pedagogical needs of team projects. This would involve investigation into acceptance of agent system for students and tutors, and quality assurance issues.

In carrying out the above modifications, this research into student team working would provide further insight into the effect of the system on team cohesion, trust and performance. Additional functions that cover the whole team project lifecycle would provide a platform for investigating team working issues holistically. A carefully planned programme of evaluation and surveying would provide data to gain insight, in an area that has not been studied much.

Another strategy is to map the teaching of transferable skills gained in co-located team working with those of the skills needed for organisational team working, both co-located and online. Then, a study into how team working transferable skills are presented for undergraduates to gain from the experience. Virtual team working is becoming an essential transferable skill, and using online support tools for their team projects would help students to master online working. The actual tool would not be something they would eventually use in the workplace, but an awareness of the usefulness of online tools, and experience of using tools to support project work, as an adjunct to co-located working would be of benefit. At each cycle of the action research participants were asked for their views on using the tool for virtual team project work, and consistently the view expressed was that it would be useful for students working on team projects online. There is a feeling, e.g. (May et al. 2000), and supported by some of the students in this research, that it is not possible to carry out team project work without ever meeting face to face, and this proposition is worth exploring.

Whilst the results show that the system is useful for the particular students in this study, the system could also be applicable for other students carrying out team projects in systems design, and possibly team projects in other disciplines. Tutors can set up the system with any chosen skill areas, to enable their students to use and benefit from the system, and as students from a wider range of discipline areas become more computer literate, the affordance of such a system for them is likely to be more applicable. The system was set up for use with students undertaking team projects in the School of the Built Environment, by editing the lists of skills included in the system, and this proved to be a simple task, with a small number of students successfully using the system. This demonstrates that the system can be used in other modules, and so could be generalisable to other disciplines.

8.5. Learning of the researcher

Over the period of this research, a series of prototype systems were developed for the students of this case study to use in their team projects, in order to find out how the systems helped them to get started on their team projects. In this section my learning as a researcher will be outlined, as a reflective critique using strengths and weaknesses. My learning was partly about carrying out research and partly about developing an information system.

8.5.1. Learning about research

There has been a gradual change in my research approach from one of a positivist experimental idealist, to one of a practical interpretivist, realising that research is not simply finding out if something works, but also finding out the reasons why it did or did not work. I have been exposed to examples of possible interpretive research methods available, which forced me to identify the suitability of each approach to this particular situation. As a result, the early stages of the research, which was over six years ago, may not have had the rigour expected of doctoral research, and the methods established early on may not have been the most appropriate, but in analysing the findings and interpreting these within a conceptual framework there has been an immense amount of learning about research methods.

The decision to use a case study approach for the research was not made at the beginning, so the research was designed as a systems development and testing process, and case study validity constructs were not planned for from the start.

A more in depth survey of the literature on team working in organisations and students in higher education in the early stages, might have provided more appropriate questions to ask students about their team working processes. From the literature, other researchers may have identified different functions to include in the support system.

As the cycles of prototyping research progressed, time became a critical factor, both as a constraint on time for implementing the various systems in time for the beginning of the teaching term, and limited time for carrying out interviews and focus groups, which tend to be very labour intensive, both in administering and in analysing them. It

would have added greatly to the validity of the results, had I been able to conduct more interviews and focus groups, and had the opportunity to explore some of the respondents concerns in more depth, by immediately following up the interviews with specific questions. Should time have permitted, it would have been better to have analysed the surveys straight away, so that there is a possibility to ask follow up questions in interviews to clarify or elaborate on the findings, to help in explaining the results. The prototypes could only be evaluated at the beginning of a new academic year, as the students were using the system to support real team projects. So the research was protracted, and there could have been variations in students and their attitudes to team projects that were not consistent throughout the study, and the experience of the researcher would have affected the manner in which the research was conducted.

In an effort to maintain some consistency of method from one cycle to the next, the same questionnaire and interview questions were asked throughout, because my intention was to find out how well the latest version of the system had performed, compared to a previous one. But adding questions that probed for responses to the specific issues identified at each stage of the prototyping, might have provided more reflective opinions from the students on the processes of their team working.

Laurillard (1993:50) said that it is difficult to find out exactly what is going on inside students' heads, and asking about processes after the event is not satisfactory. It is the same in this study; interviews, focus groups and questionnaires were administered or used sometimes a few weeks after the event, leading to responses that may have been reflective, but more likely lacking in details, as respondents had forgotten the details.

Through objectivity Guba suggests we can use a lever to *"find nature's secrets, without altering them in any way"* (Shaw 1999:45). It was postulated by positivists that everything could be observed, but observation was found not to be theory neutral, and there is a complex relationship between theory and observation (Shaw 1999:46). And so it appeared in this case, I made observations through interviewing, but they were subject to a certain amount of interviewer bias, and the interviews, supplementing the questionnaires, showed more complex issues than had originally been envisaged, beyond those highlighted in the literature.

8.5.2. Learning about systems development

When designing information systems it is often difficult to acquire the user requirements before designing begins, which is one of the advantages of using the prototyping method for design. Very often a new system automates an existing process, but if there were difficulties with the existing system introducing a new system will not alleviate these, it is the users' interaction with any system that makes it into something useful for them. In prototyping the users are encouraged to give feedback on initial designs, and by trying out early designs of the system are able to envisage the capabilities of such a system and give suggestions for additional functionality based on their exposure to the early design (Nickolls 1993).

The choice of prototyping for the student team project support system was to incrementally build up a system that users would find useful, and also to find out from users, more about their use of the system in relation to achieving the aims of their project work. The iterative cycles of prototyping were essential for introducing modifications to the design, and allowing the system to evolve, in ways that are driven by the user feedback.

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 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.

Distance learning was a growing phenomenon at the beginning of this research, so I though that the system would be used to help distributed learners to accomplish team project work. Even though blended provision has become more common, with online tools supporting a variety of learning activities, some of which are undertaken at a

distance, there is still little evidence of widespread use of team projects for online learners, who do not meet up face to face. Hence the change of emphasis for this research, from a tool for online students, to the latest version of the system providing an online tool to support students who are co-located.

8.6. Summary

For a long time students in higher education have been involved in team project work, for gaining experience applying the theories and skills they have learned at the same time as learning about team working. When students are co-located difficulties arise that prevent students from fully benefiting from the team working experience. Many of these difficulties are common to organisational team working as well, but some are unique to team project working within the context of this research. ICT is becoming a major player in all aspects of learning and working life, providing support for aspects of team working; students are also spending more time working from home, using the online provision of learning resources, but these have not always been effective in helping student team projects. Team working is no longer strictly co-located, but is virtual as well, and in the workplace often global. Students should have the opportunity to develop virtual team working skills as well as co-located team working skills. This research was based on co-located student team project work, and has further identified some of the issues that arise in this context as students work in teams, and attempted to find out whether two particular functions of a support system can help the students to get started on their team project work, mitigating some of the difficulties that may arise. The research also investigated whether these automated functions would be of benefit to students working in virtual teams, and whether the system should incorporate other functions to help students at other stages of their team projects as well.

This research has shown that students experience many difficulties when engaged in team working on campus. The initial investigation did not determine the degree of difficulty these issues may have caused, but sought to identify the difficulties, for example maintaining adequate communication between team members has been found to present difficulties throughout this study. Student motivation and coping with absent team members has been mentioned throughout, along with a lack of skills and difficulties identifying team members best skilled for particular tasks. The issues

of coordinating roles, assigning responsibility for tasks and time management seemed to be mentioned by respondents at the beginning of the study, but were less often cited after the last cycle of using the prototype.

The original objective of this study was to develop a prototype software system that would help students to get started on their team project working. In order to achieve this objective a review of research methods was given in Chapter 2, providing justification for the methods chosen. Chapters 3 and 4 provided a review of the literature, examining team working theories, learning theories, student team projects and skills acquisition, identifying some of the key issues of team working, which would need to be addressed in a team project support system. Chapter 5 gave an account of the preliminary design for a team project support system, and the three cycles of prototyping within the case study selected, showing the successive changes resulting from student user feedback. After these prototyping cycles Chapters 6 and 7 discuss all of the findings relating to the student experience of team projects, assesses their perceptions of the usefulness of the two functions included in the prototype and considers additional functions the team project support system should provide.

REFERENCES

Adair, J. (1986), *Effective teambuilding: how to make a winning team*, London, Pan Books.

Agre, P. (1997), *Computation and human experience*, Cambridge, Cambridge University Press.

Aiken, M., Lui Sheng, O. and Vogel, D. (1991), "Integrating expert systems with group decision support systems", *ACM Transactions on Information Systems,* 9(1): 75-96.

Akdere, M. (2003), "Action research paradigm in the field of training and development", *Journal of European Industrial Training,* 27(8): 413-422.

Alavi, M. (1994), "Computer-mediated collaborative learning: an empirical evaluation", *MIS Quarterly,* 18(2): 159-174.

Alavi, M. and Leidner, D. (2001), "Research commentary: technology-mediated learning - a call for greater depth and breadth of research", *Information Systems Research,* 12(1): 1 - 10.

Albrechtsen, H., Andersen, H., Bødker, S. and Pejtersen, A. (2001), *Affordances in Activity Theory and Cognitive Systems Engineering,* Risø National Laboratory, Roskilde.

Aldea, A., Banares-Alcantara, R., Jiminez, L., Moreno, A., Martinez, J. and Riano, D. (2004), "The scope of application of multi-agent systems in the process industry: three case studies", *Expert Systems with Applications,* 26: 39-47.

Alexander, P. M. (2006), "Virtual teamwork in very large undergraduate classes", *Compters and Education,* 47: 127-147.

Alexander, S. and Boud, D. (2001), "Learners still learn from experience when online", In-*Teaching and learning online: pedagogies for new technologies*, J. Stephenson. London, Kogan Page, pp-3-15.

Allison, C., McKechan, D., Ruddle, A. and Michaelson, R. (2001), *A group based system for group based learning*, EuroCSCL 2001, Maastricht, Netherlands, March 2001,

Alm, I. (2003), "Designing interactive interfaces: theoretical consideration of the complexity of standards and guidelines, and the difference between evolving and formalised systems", *Interacting with Computers,* 15(1): 109-119.

Appelbaum, S. and Shapiro, B. (1998), "The management of multicultural group conflict", *Team Performance Management,* 4(5): 211-234.

Aranda, E., Aranda, L. and Conlon, K. (1998), *Teams: structure, process, culture and politics*, London, Prentice Hall.

Atherton, J. S. (2005), *Learning and Teaching: Bloom's taxonomy*, UK, http://www.learningandteaching.info/learning/bloomtax.htm, Accessed-October 2007.

Attaran, M. and Attaran, S. (2002), "Collaborative computing technology: the hot new managing tool", *Team Performance Management,* 8(1/2): 13-20.

Atweh, B., Kemmis, S. and Weeks, P. (1998), *Action Research in Practice*, London, Routledge.

Avison, D., Baskerville, R. and Myers, M. (2001), "Controlling Action Research Projects", *Information Technology and People,* 14(1): 28-45.

Ayers, E. (2004), "The academic culture and the IT culture: their effect on teaching and scholarship", *Educause Review,* Vol 39, No 6, Accessed-11/04.

Aylett, R. (2001), *Intelligent virtual agents*, IVA2001, London, Springer Verlag,

Baggetun, R., Dolonen, J. and Dragsnes, S. (2001), *Designing pedagogical agents for collaborative telelearning scenarios*, 24th Information Systems Research Seminar in Scandinavia (IRIS'24), Ulvik, Norway, Department of Information Science, University of Bergen,

Bahli, B. and Buyukkurt, M. D. (2005), "Group Performance in Information Systems Project Groups: An Empirical Study", *Journal of Information Technology Education,* 4: 97-113.

Bales, R. (1970), *Personality and interpersonal behaviour*, New York, Holt, Rinehart and Winston.

Banks, A. P. and Millward, L. J. (2007), "Differentiating knowledge in teams: the effect of shared declarative and procedural knowledge on team performance", *Group Dynamics,* 11(2): 95-106.

Barcus, A. and Montibeller, G. (2006), "Supporting the allocation of software development work in distributed teams with multi-criteria decision analysis", *The International Journal of Management Science,* 39: 464-475.

Barnett, R. (1992), *Improving higher education*, Buckingham, Open University.

Baskerville, R. (1999), "Investigating Information Systems with Action Research", *Communications of the AIS,* 2(19).

Baskerville, R. and Wood-Harper, A. T. (1996), "A critical perspective on action research as a method for information systems research", *Journal of Information Technology,* 11(3): 235-246.

Baskerville, R. and Wood-Harper, A. T. (1998), "Diversity in information systems action research methods", *European Journal of Information Systems,* 7: 90-107.

Bassey, M. (1999), *Case study research in educational settings*, Maidenhead, Open University Press.

Beer, M., Hill, R. and Sixsmith, A. (2003), *Building an agent based community care demonstrator on a worldwide agent platform*, Autonomous Agents and Multi Agent Systems (AAMAS), Melbourne, Australia, July 2003,

Beer, M., Slack, F. and Armitt, G. (2005), "Collaboration and teamwork: immersion and presence in an online learning environment", *Information Systems Frontiers,* 7(1): 27-37.

Belbin, R. M. (2000), *Beyond the Team*, Oxford, Butterworth-Heinemann.

Bellotti, V. and Blandford, A. e. (1996), "Interpersonal access control in computer mediated communications: a systematic analysis of the design space", *Human-Computer Interaction,* Vol 11: 357-432.

Benbasat, I., Goldstein, D. and Mead, M. (1987), "The Case Research Strategy in Studies of Information Systems", *MIS Quarterly,* 11(3): 369-386.

Bennett, C., Foreman-Peck, L. and Higgins, C. (1996), *Researching into teaching methods in colleges and universities*, London, Kogan Page.

Beranek, G., Zuser, W. and Grechenig, T. (2005), *Functional Group Roles in Software Engineering Teams*, Human and Social Factors of Software Engineering (HSSE), St Louis, Missouri, USA, May 16th 2005, ACM,

Berge, Z. (1998), "Differences in teamwork between post-secondary classrooms and the workplace", *Education and Training,* 40(5): 194-201.

Bharadwaj, A. (1996), *Integrating positivist and interpretive approaches to information systems research: a Lakatosian model*, http://www.bauer.uh.edu/parks/fis/Bharadwaj.htm, Accessed-June 2004.

Bion, W. (1961), *Experiences in groups*, London, Tavistock.

Bligh, M., Pearce, C. and Kohles, J. (2006), "The importance of self and shared leadership in team based knowledge work", *Journal of Managerial Psychology,* 21(4): 296-318.

Bock, G.-W., Kankanhalli, A. and Sharma, S. (2006), "Are norms enough? The role of collaborative norms in promoting organisational knowledge seeking", *European Journal of Information Systems,* 15: 357-367.

Bohemia, E. (2004), *Working collaboratively in todays global environment: a global product development course?* International engineering and product design education conference, Delft, The Netherlands, 2nd to 3rd September 2004,

Bonoma, T. (1985), "Case research in marketing: opportunities, problems and a process", *Journal of Marketing Research,* 22(2): 199-208.

Bos, N., Olsen, J., Gergle, D., Olsen, G. and Wright, Z. (2002), *Effects of Four Computer-Mediated Communications Channels on Trust Development*, CHI, Minneapolis, USA, 20th - 25th April 2002,

Boud, D. and Feletti, G. (1997), *The challenge of problem-based learning*, London, Kogan Page.

Boy, G. (1997), "Software agents for cooperative learning", In-*Software agents*, J. Bradshaw. London, MIT Press.

Bradshaw, J. (1997), *Software agents*, London, MIT Press.

Brereton, P., Lees, S., Gumbley, M., Boldyreff, C., Drummond, S., Layzell, P., Macaulay, L. and Young, R. (1998), "Distributed Group Working in Software Engineering Education", *Information and Software Technology,* 40(4): 221-227.

Brockbank, A. and McGill, I. (1998), *Facilitating reflective learning in higher education*, Buckingham, Open University.

Brown, A. and Dowling, P. (1998), *Doing research/reading research*, London, Falmer Press.

Brown, R. (2000), *Group processes*, Oxford, Blackwell Publishers Ltd.

Burdett, J. (2003), "Making Groups Work: University Students' Perceptions", *International Education Journal,* 4(3): 177-191.

Burdman, J. (1999), *Collaborative web development: startegies and best practices for web teams*, Reading, Mas, Addison Wesley.

Canterbury (2003), *Key Skills*, Canterbury Christ Church University, Study-Support Unit, http://keyskills.cant.ac.uk/wto/index.htm, Accessed-August 2007.

Carr, W. and Kemmis, S. (1986), *Becoming critical: education knowledge and action research*, London, Falmer Press.

Chadwick, A. (1994), *Group work: an introductory guide for students*, University of Aberdeen, University Aberdeen.

Chan, S. C. F., Leung, C. W. K., Yeung, C. Y., Chow, T. C. Y., Tsui, E. W. C. and Ng, V. T. Y. (2005), "Supporting real-time collaborative learning with web-based groupware", *Innovations in Education and Teaching International,* 42(4): 349-362.

Chapman, C., Ramondt, L. and Smiley, G. (2005), "Strong community, deep learning: exploring the link", *Innovations in Education and Teaching International,* 42(3): 217-230.

Checkland, P. (1991), "From framework through experience to learning: the essential nature of action research", In-*Information systems research: contemporary approaches and emergent traditions*, H. Nissen, H. Klein and R. Hischeim. Amsterdam, Elsevier.

Checkland, P. and Holwell, S. (1998), *Information, Systems and Information Systems: making sense of the field*, Chichester, Wiley.

Chiasson, M. and Dexter, A. (2001), "System development conflict during the use of an information systems prototyping method of action research: implications for practice and research", *Information Technology and People,* 14(1): 91-108.

Chickering, A. and Ehrmann, S. C. (1996), "Implementing the Seven Principles: Technology as Lever", *American Association for Higher Education Bulletin (AAHE)*: 3-6.

Ciborra, C. (1996), *Groupware and teamwork*, Chichester, Wiley.

Clarke, R. (2000), *Appropriate Research Methods for Electronic Commerce*, Xamax Consultancy Pty Ltd., http://www.anu.edu.au/people/Roger.Clarke/EC/ResMeth.html, Accessed-June 2000.

Cohen, L., Manion, L. and Morrison, K. (2000), *Research methods in education*, London, Routledge Falmer.

Collings, P., Richards-Smith, A. and Walker, D. (1995), *Groupware Support for Student Project Teams: Issues in Implementation*, ASCILITE'95, Melbourne, Australia, December 1995,

Connolly, M., Jones, C. and Jones, N. (2007), "Managing collaboration across further and higher education: a case in practice", *Journal of Further and Higher Education,* 31(2): 159-169.

Conole, G. and Dyke, M. (2004), "What are the affordances of information and communication technologies?" *Association for Learning Ttechnology Journal (ALT-J),* 12(2): 113-124.

Cooper, G. and Heinze, A. (2007), "Centralisation of Assessment: meeting the challenges of Multi-year Team Projects in Information Systems Education", *JISE,* 18 (3): 345 - 356.

Corbitt, G. and Martz, B. (2003), "Groupware case studies: trust, commitment and the free expression of ideas", *Team Performance Management,* 9(1/2): 16-22.

Corkill, D. (2003), *Collaborating software: blackboard and multi-agent systems and the future*, International Lisp Conference, New York, USA, October 2003,

Cornelis, I., Van Hail, A. and De Cremer, D. (2006), "Effects of procedural fairness and leader support on interpersonal relationships among group members", *Group Dynamics: Theory, Research and Practice,* 10(4): 309-328.

Cornford, T. and Smithson, S. (1996), *Project research in information systems: a student's guide*, London, Macmillan Press.

Crossan, F. (2003), "Research philosophy: towards an understanding", *Nurse researcher,* 11(1): 46-55.

Dacre Pool, L. and Sewell, P. (2007), "The key to employability: developing a practical model of graduate employability", *Education and Training,* 49(4): 277-289.

Dalsgaard, C. (2006), "Social software: E-learning beyond learning management systems", *European Journal of Open, Distance and E-Learning*, http://www.eurodl.org/materials/contrib/2006/Christian_Dalsgaard.htm, Accessed-June 2007.

De Cremer, D., van Knippenberg, D., van Dyke, M. and Bos, A. (2006), "Self-sacrificial leadership and follower self-esteem: when collective identification matters", *Group Dynamics: Theory, Research and Practice,* 10(3): 233-245.

DeChurch, L., Hamilton, K. and Haas, C. (2007), "Effects of conflict management strategies on perceptions of intragroup conflict", *Group Dynamics: Theory, Research and Practice,* 11(1): 66-78.

Detienne, F. (2006), "Collaborative design: Managing task interdependencies and multiple perspectives", *Interacting with Computers,* 18(1): 1-20.

Dewey, J. (1944), *Democracy and Education*, http://www.ilt.columbia.edu/publications/dewey.html, Accessed-December 2008.

Dillenbourg, P. (1999), *Collaborative learning: cognitive and computational approaches*, Oxford, Elsevier.

Dillenbourg, P. (2000), *Virtual learning environments*, EUN Conference 2000,

Dixon, T. and Woolhouse, M. (1996), "The relationship between teachers' and learners' individual teaching/learning styles", *Journal of Further and Higher Education,* 20(3): 15 - 22.

Djamasbi, S. and Strong, D. (2008), "The effect of positive mood on intention to use computerized decision aids", *Information and Management,* 45(1): 43-51.

Doolin, B. and Lowe, A. (2001), *To reveal is to critique: actor-network theory and performativity in critical information systems research*, Defining critical research in information systems conference, Salford, UK, July 2001,

Drew, S. and Bingham, R. (1997), *The student skills guide*, Sheffield, Gower.

Driskell, J., Goodwin, G., Salas, E. and O'Shea, P. (2006), "What makes a good team player? Personality and team effectiveness", *Group Dynamics: Theory, Research and Practice,* 10(4): 249-271.

Drummond, S., Boldyreff, C. and Ramage, M. (2001), "Evaluating Groupware Support for Software Engineering Students", *Journal of Computer Science Education,* 11(1): 33-54.

Drury, H., Kay, J. and Losberg, W. (2003), *Student satisfaction with groupwork in undergraduate computer science: do things get better?* Proceedings of 5th Australasian Computing Education Conference (ACE2003), Adelaide, Australia, T. Greening and R. Lister, Australian Computer society,

Duffy, J. (1996), "Collaborative computing, groupware and knowledge", *Information Management and Computer Security,* 4(2): 39-41.

Dunne, E. and Rawlins, M. (2000), "Bridging the gap between industry and higher education: training academics to promote student teamwork", *Innovations in Education and Teaching International,* 37(4): 361-371.

Dyke, M., Conole, G., Ravenscroft, A. and de Freitas, S. (2007), "Learning theory and its application to e-learning", In-*Contemporary perspectives in e-learning research*, G. Conole and M. Oliver. Oxford, Routledge Falmer.

Edmondson, A., Dillon, J. and Roloff, K. (2006), "Three perspectives on team learning: Outcome improvement, Task mastery, and Group process", In-*The Academy of Management Annals, Volume 1*, A. Brief and J. Walsh, Psychology Press.

Education, Q. A. A. f. H. (2000), *Academic standards - Librarianship and Information Management*, Quality Assurance Agency for Higher Education, http://www.qaa.ac.uk/academicinfrastructure/benchmark/honours/default.asp.

Education, Q. A. A. f. H. (2007), *Computing*, Quality Assurance Agency for Higher Education, http://www.qaa.ac.uk/academicinfrastructure/benchmark/honours/default.asp.

Education, Q. A. A. f. H. (2007), *General Business and Management*, Quality Assurance Agency for Higher Education, http://www.qaa.ac.uk/academicinfrastructure/benchmark/honours/default.asp.

Edwards, G. (2005), *Connecting PDP to employer needs and the world of work*, HEA, http://www.heacademy.ac.uk/resources/detail/id71_connecting_pdp_edwards, Accessed-September 2007.

Edwards, M. and Clear, F. (2001), "Supporting the Collaborative Learning of Practical Skills with Computer-Mediated Communications Technology", *Educational Technology and Society,* 4(1): 80-92.

Eijl, P., Pilot, A. and Voogd, P. (2005), "Effects of Collaborative and Individual Learning in a Blended Learning Environment", *Education and Information Technologies,* 10(1-2): 51-65.

Eisenhart, M. and Towne, L. (2003), "Contestation and change in National policy on "Scientifically based" eductation research", *Educational Researcher,* 32(7): 31-38.

Entwistle, N. (1977), "Strategies of learning and studying: recent research findings", *British Journal of Educational Studies,* XXV(3): 225 - 237.

Ezzamel, M. and Willmott, H. (2001), "Accounting for teamwork: a critical study of group-based systems of organizational control", *Administrative Science Quarterly,* 43: 358-396.

Farr, M. and Psotka, J. (1992), *Intelligent instruction by computer: theory and practice*, New York, Taylor Francis.

Felder, R. and Brent, R. (1994), *Cooperative Learning in Technical Courses: Procedures, Pitfalls, and Payoffs,* North Carolina State University, http://www.ncsu.edu/felder-public/Papers/Coopreport.html, Accessed-July 2006.

Fellers, J. (1996), "Teaching Teamwork: Exploring the use of Cooperative Learning Teams in Information Systems Education", *The DATABASE for Advances in Information Systems,* 27(2): 44-60.

Ferber, J. (1999), *Multi-agent systems*, Harlow, Addison Wesley.

Ferneley, E. H. and Berney, B. (1999), *CASMIR: A Community of Software Agents Collaborating in Order to Retrieve to Multimedia Data*, 3rd International ACM Conference on Autonomous Agents, Seattle, USA, May 1999,

Fielding, N. and Schreier, M. (2001), *Introduction: On the compatibility between qualitative and quantitative research methods*, http://qualitative-research.net/fqs-eng.htm, Accessed-January 2003.

Fink, A. (2003), *The Survey Handbook*, London, Sage.

Fitzgerald, B. and Howcroft, D. (1998), "Towards dissolution of the IS research debate: from polarization to polarity", *Journal of Information Technology,* 13(4): 313-326.

Flick, U. (2006), *An introduction to qualitative research*, London, Sage Publications.

Flood, R. and Jackson, M. (1991), *Creative problem solving: Total systems intervention*, New York, John Wiley.

Ford, M. and Morice, J. (2003), *Using micro management techniques to overcome problems in group assignments*, Informing Science and IT Education (InSITE), Pori, Finland, June 24-27 2003,

Fowell, S. and Levy, P. (1995), "Computer-mediated communication in the information curriculum", *Education for Information,* 13(3): 193-210.

Franklin, S. and Graesser, A. (1996), *Is it an agent, or just a program? A taxonomy for autonomous agents*, Third Annual Workshop on Agent Theories, Architectures and Languages, August 1996, Springer Verlag,

Fuks, H. (2000), "Groupware technologies for education in AulaNet", *Computer Applications in Engineering Education,* 8(3-4): 170-177.

Galliers, R. (1992), *Information systems research*, Oxford, Blackwell.

Garratt, B. (1994), *The Learning Organization*, London, Harper Collins.

Gatlin-Watts, R., Carson, M., Horton, J., Maxwell, L. and Maltby, N. (2007), "A guide to virtual teaming", *Team Performance Management,* 13(1/2): 47-52.

George, J. and Jessop, L. (1997), "Groups over time: what are we really studying?" *International Journal Human-Computer Studies,* 47(3): 497-511.

Gibbs, G. (1995), *Learning in Teams*, Oxford Centre for staff development.

Gil, F., Rico, R., Alcover, C. and Barrasa, A. (2005), "Change-oriented leadership, satisfaction and performance in work groups", *Journal of Managerial Psychology,* 20(3/4): 313-328.

Gillies, R. M. (2004), "The effects of cooperative learning on junior high school students during small group learning", *Learning and Instruction,* 14(2): 197-213.

Golembiewski, R. T. and McConkie, M. (1975), "The centrality of interpersonal trust in group processes", In-*Theories of Group Processes*, C. L. Cooper, Wiley.

Gomm, R. and Woods, P. (1993), *Educational research in action*, London, Open University.

Gregg, D. (2007), "E-learning agents", *The Learning Organisation,* 14(4): 300-312.

Griffiths, S. and Partington, P. (1992), *Enabling active learning in small groups,* Committee of Vice-Chancellors and Principals (CVCP) Universities' Staff Development and Training Unit, Sheffield University.

Groesbeck, R. and Van Aken, E. (2001), "Enabling team wellness: monitoring and maintaining teams after start-up", *Team Performance Management,* 7(1/2): 11-20.

Hammersley, M. (1993), *Educational research: current issues*, London, Open University.

Hansen, R. (2006), "Benefits and problems with student teams: suggestions for improving team projects", *Journal of Education for Business,* 82(1): 11-19.

Hartley, P. (1997), *Group communication*, London, Routledge.

Hatzilygeroudis, I. and Prentzas, J. (2004), "Using a hybrid rule-based approach in developing an intelligent tutoring system with knowledge acquisition and updat capabilities", *Expert Systems with Applications,* 26(4): 477-492.

Haythornthwaite, C., Kazmer, M. and Robins, J. (2000), "Community development among distance learners: temporal and technological dimensions", *Journal of Computer-Mediated Communication,* 6(1).

He, J., Butler, B. and King, W. (2007), "Team cognition: development and evolution in software project teams", *Journal of Management Information Systems,* 24(2): 261-292.

Heffernan, T. and Poole, D. (2005), "In search of "the vibe": Creating effective international educational partnerships", *Higher Education,* 50(2): 223-245.

Henninger (2002), *Phibot*, http://phibot.org/new/_SID_=2002062812110289369/Search, Accessed-June 2002.

Henttonen, K. and Blomqvist, K. (2005), "Managing distance in a global virtual team: the evolution of trust through technology-mediated relational communication", *Strategic Change,* 14(2): 107-119.

Hershet Dirkin, K., Mishra, P. and Altermatt, E. (2005), "All or nothing: Levels of sociability of a pedagogical agent and its impact on student perceptions and learning", *Journal of Educational Multimedia and Hypermedia,* 14(2): 113-127.

Hietala, P. and Niemirepo, T. (1996), *Studying learner-computer interactions in agent-based social learning environments*, Proceedings of the European Conference on Artificial Intelligence in Education, Lisbon, Portugal, P. Brna, A. Paiva and J. Self, September 1996,

Hill, J. R. and Raven, A. (2000), *Online Learning Communities: If You Build Them, Will They Stay?* ITForum, http://itech1.coe.uga.edu/itforum/paper46/paper46.htm, Accessed-August 2002.

Hiltz, S., Dufner, D., Fjermestad, J., Kim, Y., Ocker, R., Rana, A. and Turoff, M. (1996), "Distributed Group Support Systems: Theory Development and Experimentation", In-*Coordination Theory and Collaboration Technology*, B. Olsen, J. Smith and T. Malone. Hillsdale, NJ, Erlbaum Associates.

Hmelo-Silver, C. E. (2003), "Analyzing collaborative knowledge construction: multiple methods for integrated understanding", *Computers & Education,* 41(4): 397-420.

Hodkinson, P. and Macleod, F. (2007), *Contrasting concepts of learning and contrasting research methodologies*, Educational Research and TLRP, Cardiff, Wales, November 2007,

Hogan, J. and Thomas, R. (2005), *Developing the software engineering team*, Australasian Computing Education Conference, Newcastle, Australia, A. Young and D. Tolhurst, July 2005, Australian computer society,

Hogg, M. A. (1992), *the social psychology of group cohesiveness: from attraction to social identity*, London, Harvester Wheatsheaf.

Homan, A. C., van Knippenberg, D., Van Kleef, G. A. and De Dreu, C. K. W. (2007), "Interacting dimensions of diversity: cross-categorization and the functioning of diverse work groups", *Group Dynamics,* 11(2): 79-94.

Hordyk, V. (2007), *A convergence of perspectives: enhancing students' employability*, Education in a Changing Environment, Salford, UK, E. O'Docherty, September 2007, Informing Science,

Huang, H. and Ocker, R. (2006), *Preliminary insights into the in-group/out-group effect in partially distributed teams: an anlysis of particpant reflections*, Special Interest Group on Computer Personnel Research Annual Conference (SIGMIS-CPR'06), Claremont, California,USA, April 2006, ACM,

Hurst, D. and Thomas, J. (2004), "Developing team skills and accomplishing team projects online", In-*Theory and practice of online learning*, T. Anderson and F. Elloumi. Athabasca, Athabasca University, Canada, pp-195-239.

Hwang, G.-J. (2003), "A conceptual map model for developing intelligent tutoring systems", *Computers & Education,* 40(3): 217-235.

Hyland, T. and Johnson, S. (1998), "Of cabbages and key skills: exploding the mythology of core transferable skills in post-school education", *Journal of Further and Higher Education,* 22(2): 163-172.

Ingram, J. and Parker, A. (2002), "The influence of gender on collaborative projects in an engineering classroom", *IEEE Transactions on Professional Communication,* 45(1): 7-20.

Issroff, K. and Scanlon, E. (2002), "Using technology in Higher education: an Activity theory perspective", *Journal of Computer Assisted Learning,* 18(1): 77-83.

Jaques, D. (1984), *Learning in Groups*, London, Kogan Page.

Jarvenpaa, S. and Leidner, D. (1998), "Communication and trust in global virtual teams", *Journal of Computer Mediated Communication,* 3(4).

Jehn, K. and Mannix, E. (2001), "The Dynamc Nature of Conflict: A Longitudinal Study of Intragroup Conflict and Group Performance", *Academy of Management Journal,* 44: 238-251.

John, P. and Sutherland, R. (2005), "Affordance, opportunity and the pedagogical implications of ICT", *Educational Review,* 57(4): 405-413.

Johnson, D. and Johnson, F. (1997), *Joining together: group theory and group skills*, Needham heights, Allyn & Bacon.

Johnson, D. and Johnson, F. (2006), *Joining together: group theory and group skills*, Needham heights, Pearson.

Johnson, D. W., Johnson, R. T. and Smith, K. A. (1991), *Cooperative Learning:Increasing College Faculty Instructional Productivity,* School of Education and Human Development, George Washington University, http://www.ntlf.com/html/lib/bib/cooplearn.htm, Accessed-July 2005.

Johnson, S. D., Suriya, C., Won Yoon, S., Berrett, J. V. and La Fleur, J. (2002), "Team development and group processes of virtual learning teams", *Computers and Education,* 39(4): 379-393.

Johnson, W. and Shaw, E. (1997), *Using agents to overcome deficiencies in web-based courseware*, World Conference of the Artificial Intelligence in Education (AIED) Society, Kobe, Japan, August 1997,

Jones, A. and Issroff, K. (2005), "Learning technologies: affective and social issues in computer-supported collaborative learning", *Compters and Education,* 44(4): 395-408.

Jones, C. (2004), *Quantitative and qualitative research: Conflicting paradigms or perfect partners?* Networked Learning 2004, Lancaster, S. Banks, P. Goodyear, V. Hodgsonet al, April 2004,

Jones, M. and McMaster, T. (2004), "Addressing Commercial Realism and Academic Issues in Group-Based IS Undergraduate Project Work", *Journal of Information Systems Education,* 15(4): 375-381.

Jones, S. and Marsh, S. (1997), "Human-Computer-Human Interaction: Trust in CSCW", *ACM SIGCHI Bulletin,* 29(3): 36-40.

Joy, M. (2005), "Group projects and the computer science curriculum", *Innovations in Education and Teaching International,* 42(1): 15-25.

Kaplan, B. and Duchon, D. (1988), "Combining qualitative and quantitative methods in information systems research: a case study", *MIS Quarterly,* 12(4): 571-586.

Keller, R. (2006), "Transformational leadership, initiating structure, and substitutes for leadership: a longitudinal study of research and development project team performance", *Journal of Applied Psychology,* 91(1): 202-210.

Khoshafian, S. and Buckiewicz, M. (1995), *Introduction to groupware, workflow and workgroup computing*, Toronto, John Wiley.

Kimble, C., Hildreth, P. and Wright, P. (2001), "Communities of Parctice: Going Virtual", In-*Knowledge Management and Business Model Innovation*. London, Idea Group, pp-220-234.

Kitzinger, J. (1994), "The methodology of focus groups: the importance of interaction between research participants", *Sociology of Health,* 16(1): 103-121.

Klein, H. and Myers, M. (1999), "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly,* 23(1): 67-94.

Knapik, M. and Johnson, J. (1998), *Developing intelligent agents for distributed systems*, New York, Mc Graw Hill.

Knowles, M. (1990), *The adult learner a neglected species*, Houston, Gulf Publishing.

Kolb, D. (1984), *Experiential learning*, London, Prentice Hall.

Lakkala, M., Lallimo, J. and Hakkarainen, K. (2005), "Teachers' pedagogical designs for technology-supported collective inquiry: A national case study", *Computers and Education,* 45(3): 337-356.

Landsberger, J. (2004), *Solving problems with the scientific method*, Study Guides and Strategies, Accessed-18/5/2004.

Last, M., Hause, M., Daniels, M. and Woodruffe, M. (2002), *Learning from students: Continuous improvement in International Collaboration*, Innovation and Technology in Computer Science Education (ITiCSE), AarthusDenmark, June 2003, ACM,

Lauden, K. and Lauden, J. (2006), *Management Information Systems: Managing the Digital Firm*, New Jersey, Pearson.

Laurillard, D. (1993), *Rethinking university teaching*, London, Routledge.

Lave, J. and Wenger, E. (1991), *Situated learning: legitimate peripheral participation*, Cambridge, Cambridge University Press.

Lee, A. and Baskerville, R. (2003), "Generalising generalisability in information systems research", *Informations Systems Research,* 14(3): 221-243.

Leinonen, P. and Jarvela, S. (2006), "Facilitating interpersonal evaluation of knowledge in a context of distributed team collaboration", *British Journal of Educational Technology,* 37(6): 897-916.

Lesser, V. (1999), "Cooperative multiagent systems: a personal view of the state of the art", *IEEE Transactions on knowledge and data engineering,* 11(1): 133-142.

Lester, J., FitzGerald, P. and Stone, B. (1998), *The pedagogical design studio: exploiting artifact-based task models for constructivist learning*, 2nd International Conference on Intelligent User Interfaces, Orlando, USA,

Li, S.-C. S. (2007), "Computer-meduated communication and group decision making", *Small Group Research,* 38(5): 593-614.

Liang, T.-P., Lui, C.-C., Lin, T.-M. and Lin, B. (2007), "Effect of team diversity on software project performance", *Industrial Management and Data Systems,* 107(5): 636-653.

Lieberman, H. (1997), *Autonomous Interface Agents*, Proceedings of the ACM Conference on Computers and Human Interface, CHI-97, Atlanta, Georgia., March 1997,

Lipnack, J. and Stamps, J. (2000), *Virtual teams: people working across boundaries with technology*, New York, John Wiley.

Livingstone, D. and Lynch, K. (2000), "Group project work and student-centred active learning: two different experiences", *Studies in Higher Education,* 25(3): 325-345.

Logic Programming Associates (2000), *LPA*, http://www.lpa.co.uk/.

Lou, Y. (2004), "Learning to solve complex problems through between-group collaboration in project-based online courses", *Distance Education,* 25(1): 49-66.

Lucas, C. and Kline, T. (2008), "Understanding the influence of organizational culture and group dynamics on organizational change and learning", *The Learning Organisation,* 15(3): 277-287.

Luft, J. (1970), *Group processes; an introduction to group dynamics.*, Palo Alto, CA, National Press Books.

Mahmood, A. K. and Ferneley, E. (2006), "The use of animated agents in e-learning environments: an exploratory, interpretive case study", *Association for learning Technology Journal (ALT-J),* 14(2): 153-168.

Marshall, C. and Rossman, G. (1990), *Designing qualitative research*, London, Sage Publishing.

Mathieu, J., Heffer, T., Goodwin, G., Salas, E. and Cannon-Bower, J. (2000), "The influence of shared mental models on team process and performance", *Journal of Applied Psychology,* 85(2): 273-283.

May, A., Carter, C. and Joyner, S. (2000), "Virtual team working in the European Automotive Industry: user requirements and a case study approach", *Human Factors and Ergonomics in Manufacturing,* 10(3): 273-289.

Maznevski, M. and DiStefano, J. (2000), "Global leaders are team players: developing global leaders through membership on global teams", *Human Resource Management,* 39(2&3): 195-208.

McAlister, D. (2006), "The project management plan: improving team process and performance", *Marketing Education Review,* 16(1): 97-103.

McConnell, D. (2000), *Implementing computer supported cooperative learning*, London, Kogan Page.

McDermott, L., Brawley, N. and Waite, W. (1998), *World Class Teams: Working Across Borders*, New York, John Wiley.

McDermott, R. (2001), *Learning across teams: the role of communities of practice in team organizations*, Community Intelligence labs, www.co-i-l.com/coil/knowledge-garden/cop/learning.shtml, Accessed-August 2007.

McDonald, J. (2002), "Is "as good as face to face" as good as it gets?" *Journal of Asynchronous Learning Networks,* 6(2): 10 - 23.

McGraw, P. and Tidwell, A. (2001), "Teaching group process skills to MBA students: a short workshop", *Education and Training,* 43(3): 162-170.

McGrenere, J. and Ho, W. (2000), *Affordances: clarifying and evolving a concept*, Graphics Interface 2000, Montreal, Canada, May 2000,

McLeish, J., Matheson, W. and Park, J. (1973), *The psychology of the learning group*, London, Hutchison.

McMurray, D. (2003), "Promoting communities of practice online", *Australasian Journal of Business and Social Enquiry,* 1(3): 131-137.

Meier, A., Spada, H. and Rummel, N. (2007), "A rating scheme for assessing the quality of computer-suported collaboration processes", *Computer-Supported Collaborative Learning,* 2(1): 63-86.

Mennin, S. (2007), "Small-group problem based learning as a complex adaptive system", *Teaching and Teacher Education,* 23(3): 303-313.

Mergendollar, J. (2006), "The effectiveness of problem based instruction: a comparative study of instructional methods and student characteriatics", *The Interdisciplinary Journal of Problem-based Learning,* 1(2): 49-69.

Miles, M. B. and Huberman, A. M. (1994), *Qualitative data analysis: an expanded sourcebook*, London, Sage.

Mingers, J. (1997), "Desirability of multi-paradigm intervention and research", In- *Multi-Methodology*, J. Mingers and A. Gill. Chichester, Wiley, pp-1-17.

Montangero, J. and Maurice-Naville, D. (1997), *Piaget or The Advance of Knowledge*, London, Lawrence Erlmbaum Associates.

Montgomerie, S. (2003), "Student learning styles and their implications for teaching", *CRLT,* April 2003, http://chat.carleton.ca/~tblouin/Learn%20More-%20Research/integrating%20the%20different%20approaches.htm, Accessed- July 2005.

Morch, A., Dolonen, J. and Naevdal, J. (2006), "An evolutionary approach to prototyping pedagogical agents: from simulation to integrated system", *Journal of Network and Computer Applications,* 29(2-3): 177-199.

Moreno, R., Mayer, R., Spires, H. and Lester, J. (2001), "The case for social agency in computer-based teaching: Do students learn more deeply when they interact with animated pedagogical agents?" *Cognition and Instruction,* 19(2): 177-213.

Morgan, D. L. and Kreuger, R. A. (1993), "When to use focus groups and why ", In- *Successful Focus Groups*, D. L. Morgan. London, Sage Publishing.

Mumford, E. (2001), "Advice for an action researcher", *Information Technology and People,* 14(1): 12-27.

Murthy, U. and Kerr, D. (2003), "Decision making performance of interacting groups: an experimental investigation of the effects of task type and communication mode", *Information and Management,* 40(5): 351-360.

Myers, M. (1997), "Qualitative research in information systems", *MIS Quarterly,* 21(2): 241-242.

Neave, G. (2002), "Managing research or research management?" *Higher Education Policy,* 15(3): 217-234.

Negoita, M. and Pritchard, D. (2004), "Using a virtual student model for testing intelligent tutoring systems", *Interactive Technology and Smart Education,* 1(3): 195-203.

Newell, S., David, G. and Chanel, D. (2007), *Exploring trust among globally distributed work teams*, 40th Annual Hawaii International Conference on Systems Sciences, Hawaii, IEEE,

Nickolls, F. (1993), "Prototyping: Systems Development in Record Time", *The Journal of Systems Management,* 44(9): 26-30.

Nightingale, P. and O'Neil, M. (1997), *Achieving quality learning in higher education*, Philadelphia, Kogan Page.

Nijholt, A. (2001), *Agent assistance: from problem solving to music teaching*, First International Workshop on Agents and Internet Learning, Montreal, Canada, May 2001, International Conference on Autonomous Agents and Multi Agent Systems,

Nissen, H., Klein, H. and Hirscheim, R. (1991), *Information systems research: contemporary approaches and emergent traditions*, Amsterdam, Elsevier.

O'Hara, C. (2004), *Learning to share*, FCW.com, http://www.fcw.com/fcw/articles/2004/0524/feat-share-05-24-04.asp, Accessed-May 2004.

O'Leary, D. (1998), "Developing multiple-agent systems is more than top-down vs bottom-up", *IEEE Intelligent Systems,* 13(2): 2 - 4.

O'Sullivan, T., Rice, J. and Saunders, C. (1996), *Successful group work*, London, Kogan Page.

Oates, B. J. (2006), *Researching Information Systems and Computing*, London, Sage Publications.

Olson, G., McGuffin, L., Kuwana, E. and Olson, J. (1993), "Designing software for a group's needs: a functional analysis of synchronous groupware", *User Interface Software,* 1: 129-147.

Opie, A. (2000), *Thinking teams/ thinking clients: knowledge-based teamwork*, New York, Columbia University Press.

Oppenheim, A. (1992), *Questionnaire design, interviewing and attitude measurement*, London, Continuum.

Oravec, J. A. (1996), *Virtual individuals, virtual groups*, Cambridge, Cambridge University Press.

Orlikowski, W., Wanda, J. and Baroudi, J. (1991), "Studying information technology in organizations: research approaches and assumptions", *Information Systems Research,* 2(1): 1-28.

Palvia, P. and Pinjani, P. (2007), "A profile of information systems research published in Information and Management", *Information and Management,* 44(1): 1-11.

Pant, G. and Menczer, F. (2002), "MySpiders: Evolve your own intelligent Web crawlers", *Autonomous Agents and Multi-Agent Systems,* 5(2): 221-229.

Papanikolaou, K., Grigoriadou, M., Magoulas, G. and Kornilakis, H. (2002), "Towards new forms of knowledge communication: the adaptive dimension of a web-based learning environment", *Computers and Education,* 39: 333-360.

Parchoma, G. and Dykes, M. (2008), *Bridging networked learning between the knowledge economy and higher education: a philosophical approach*, Networked Learning, Halkidiki, Greece, May 5th to 6th 2008,

Pask, G. (1976), "Styles and strategies of learning", *British Journal of Educational Psychology,* 46: 128 - 148.

Patterson, M., Carron, A. and Loughead, T. (2005), "The influence of team norms on the cohesion-self-reported performance relationship: a multi-level analysis", *Psychology of Sport and Exercise,* 6(4): 479-493.

Patti, A. L. and Gilbert, J. P. (1997), "Collocating new product development teams: why, when, where, and how?" *Business Horizons,* 40(6): 59-64.

Paul, S., Seetharaman, P., Amarah, I. and Mykytyn, P. (2004), "Impact of heterogeneity and collaborative conflict management style on the performance of synchronous global virtual teams", *Information and Management,* 41(3): 303-321.

Pauleen, D. and Yoong, P. (2001), "Facilitating virtual team relationships via Internet and conventional communication channels", *Internet research: Electronic Networking Applications and Policy,* 11(3): 190-202.

Paulus, T. (2005), "Collaborative and cooperative approaches to online group work", *Distance education,* 26(1): 111-125.

Peslak, A. (2005), "Emotions and team projects and processes", *Team Performance Management,* 13(78): 250-262.

Piccoli, G., Powell, A. and Ives, B. (2004), "Virtual teams: team control structure, work processes, and team effectiveness", *Information Technology and People,* 17(4): 359-379.

Piezon, S. and Ferree, W. (2008), "Perceptions of social loafing in online learning groups: A study of public university and US Naval War college students." *International Review of Research in Open and Distance Learning,* 9(2): 1-17.

Poindexter, S. (2003), "Assessing active alternatives for teaching programming", *Journal of Information Technology Education,* 2.

Politis, J. (2003), "The connection between trust and knowledge management: what are its implications for team performance", *Journal of Knowledge Management,* 7(5): 55-66.

Postmes, T., Spears, R. and Cihangir, S. (2001), "Quality of decision making and group norms", *Journal of Personality and Social Psychology,* 80(6): 918-930.

Powell, A., Galvin, J. and Piccoli, G. (2006), "Antecedents to team member commitment from near and far: a comparison between collocated and virtual teams", *Information Technology and People,* 19(4): 299-322.

Powell, A., Piccoli, G. and Ives, B. (2004), "Virtual teams: a review of current literature and directions for future research", *The DATABASE for Advances in Information Systems,* 35(1): 6-36.

Powell, R. A., Single, H. M. and Lloyd, K. R. (1996), "Focus groups in mental health research: enhancing the validity of user and provider questionnaires ", *International Journal of Social Psychology,* 42(3): 193-206.

Prichard, J., Stratford, R. and Bizo, L. (2006), "Team-skills training enhances collaborative learning", *Learning and Instruction,* 16(6): 256-265.

Quinn, C. (1997), *Engaging learning*, http://itech1.coe.uga.edu/itforum/paper18/paper18.html.

Rae, J., Taylor, G. and Roberts, C. (2006), "Collaborative learning: A connected community for learning and knowledge management", *Interactive Technology and Smart Education,* 3(3): 225-236.

Robson, C. (1993), *Real world research*, Oxford, Blackwell.

Rosenberg, M. (2001), *E-learning: strategies for delivering knowledge in the digital age*, New York, McGraw Hill.

Rubens, W., Emans, B., Leinonen, T., Skarmeta, A. G. and Simons, R.-J. (2005), "Design of web-based collaborative learning environments. Translating the

pedagogical learning principles to human computer interface", *Computers and Education,* 45(3): 276-294.

Ruel, G. and Bastiaans, N. (2003), "Free-riding and team performance in project education", *The International Journal of Management Education,* 3(1): 26-37.

Sadler, E. and Given, L. (2007), "Affordance theory: a framework for graduate students' information behaviour", *Journal of Documentation,* 63(1): 115-141.

Salmon, G. (2000), *E-moderating*, London, Kogan Page.

Salo, A. and Kakola, T. (2005), "Groupware support for requirements management in new product development", *Journal of Organizational Computing and Electronic Commerce,* 15(4): 253-284.

Sanders, K. and Schyns, B. (2006), "Leadership and solidarity behaviour: concensus in perception of employees within teams", *Personnel Review,* 35(5): 538-556.

Saunders, M., Lewis, P. and Thornhill, A. (2003), *Research Methods for Business Students*, Harlow, Pearson Education.

Schneider, D., Synteta, P. and Frete, C. (2002), *Community, Content and Collaboration Management System in Education: a new chance for socio-constructivist scenarios*, Information and Communication technologies in Education, Rhodes, Greece, 26th to 29th September 2002,

Schofield, J. (2000), "Increasing the generalisability of qualitative research", In-*Case study method*, R. Gomm, M. Hammersley and P. Foster. London, Sage.

Schrire, S. (2006), "Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis", *Computers and Education,* 46(1): 49-70.

Schunk, D. (2000), *Learning theories: an educational perspective*, New Jersey, Prentice-Hall.

Seidman (1998), *Interviewing as qualitative research: a guide for researchers in eductaion and the social sciences*, New York, Teachers College Press.

Sewell, G. (1998), "The discipline of teams: the control of team-based industrial work through electronic and peer surveillance", *Administrative Science Quarterly,* 43: 397-428.

Sfard, A. (1998), "On two metaphors for learning and the dangers of choosing just one", *Educational Researcher,* 27(2): 4-13.

Sharan, S. (1990), *Collaborative learning: theory and research*, New York, Praeger Publishers.

Shaw, I. (1999), *Qualitative evaluation*, London, Sage.

Shuffler, M. and Goodwin, G. (2007), "Developing shared mental models in computer-supported collaborative learning", In-*Computer-supported collaborative learning: Best practices and principles for instructors*, K. Orvis and L. Lassiter. New York, IGI Global, pp-278-299.

Silverman, D. (2000), *Doing qualitative research: a practical handbook*, London, Sage Publications.

Smith, M. (2001), *Peter Senge and the learning organization*, Infed, http://www.infed.org/thinkers/senge.htm, Accessed-21/08/2007.

Soh, L.-K. (2004), *On cooperative learning teams for multiagent team formation*, i-Minds Publication, http://www.i-minds.com/publications/soh2004.pdf, Accessed-August 2007.

Soller, A. and Busetta, P. (2003), *An intelligent agent architecture for faciltating knowledge sharing communication*, Proceedings of the Workshop on Humans and Multi-Agent Systems at the 2nd International Joint Conference on Autonomous Agents and Multi-Agent Systems (AAMAS-03), Melbourne, Australia, September 2003,

Stahl, G. (2002), *Groupware goes to school*, Berlin, Springer.

Stake, R. (2000), "The case study method in social enquiry", In-*Case study method*, R. Gomm, M. Hammersley and P. Foster. London, Sage, pp-19-26.

Stewart, J. R., E & bederson, B & Druin, A (1998), *When two hands are better than one: enhancing collaboration using single display groupware*, Conference on Human Factors in Computing Systems CHI'98, Los Angeles, USA,

Strijbos, J., Martens, R. and Jochems, W. (2004), "Designing for interaction: six steps to designing computer-supported group-based learning", *Computers and Education,* 42(4): 403-424.

Stringer, E. (1996), *Action research: a handbook for practitioners*, London, Sage.

Suthers, D. (2006), "Technology affordances for intersubjective meaning making: A research agenda for CSCL", *Computer-Supported Collaborative Learning,* 1(3).

Swaab, R., Phillips, W., Diermeier, D. and Husted medvec, V. (2008), "The pros and cons of dyadic side conversations in small groups: the impact of group norms and task type", *Small Group Research,* 39(3): 372-390.

Syer, J. and Connolly, C. (1996), *How teamwork works: the dynamics of effective team development*, London, McGraw-Hill.

Taylor-Powell, E. (1999), "Evaluating Collaboratives: Challenges and Practice", *The Evaluation Exchange,* 5(2/3).

Thaiupathump, C., Bourne, J. and Campbell, J. (1999), "Intelligent agents for online learning", *Journal of Asynchronous Learning Networks,* 3(2).

Thomas, D. and Bostrum, R. (2008), "Building trust and cooperation through technology adaptation in virtual teams: empirical field evidence", *Information Systems Management,* 25(1): 45-56.

Tiberius, R. (1990), *Small Group Teaching: A Trouble-shooting Guide*, Toronto, OISE Press.

Tiwari and Holtham, C. (1998), *Learning Groupware through using groupware - computer supported collaborative learning with face to face students*, ACM Technical Symposium on Computer Science Education (SIGCSE), September 1998,

Toohey, S. (1999), *Designing courses for higher education*, Buckingham, Open University.

Trigg, R. (2001), *Philosophy matters*, Blackwell.

Tubbs, S. (1995), *A systems approach to small group interaction*, New York, Mc Graw Hill.

Tuckman, B. W. (1965), "Developmental sequence in small groups", *Psychological Bulletin,* 63(6): 384-399.

Valcke, M. and Martens, R. (2006), "The problem arena of researching computer supported collaborative learning: Introduction to the special section", *Computers & Education: Methodological Issues in Researching CSCL,* 46(1): 1-5.

Vassileva, J. and Deters, R. (2001), *Lessons from deploying I-Help*, First International Workshop on Agents and Internet Learning, Montreal, May 2001, International Conference on Autonomous Agents and Multi Agent Systems,

Visser, J. (2001), *Learning communities: wholeness and partness, autonomy and dependence in the learning ecology*, International Symposium on Learning Communities, Barcelona, Spain, October 2001,

Vygotsky, L. (1978), "Mind in Society: The development of higher psychological processes", In-*Mind in Society: The development of higher psychological processes*, M. Cole, V. John-Steiner, S. Scribner and E. Souberman. Cambridge, MA, Harvard University Press.

Watson-Manheim, M. B., Chudoba, K. M. and Crowston, K. (2002), "Discontinuities and continuities: a new way to understand virtual work", *Information Technology & People,* 15(3): 191 - 209.

Wells, C. (2002), "Teaching Teamwork in Information Systems", In-*Challenges of Information Technology Education in the 21st Century*, E. Cohen. Hershey, Palo Alto, Idea Group, pp-1-24.

Whatley, J., Beer, M. and Staniford, G. (2001), *Guardian Agent Support for Students Working Online*, First International Workshop on Agents and Internet Learning, AIL2001, Montreal, May 2001,

Whatley, J., Staniford, G., Beer, M. and Scown, P. (1999), "Intelligent agents to support students working in groups online", *Journal of Interactive Learning Research,* 10(3/4): 361-373.

Whitman, L., Malzahn, D., Chaparro, B. and Russell, M. (2005), "A Comparison of Group Processes, Performance, and Satisfaction in Face-to-Face Versus Computer-Mediated Engineering Student Design Teams", *Journal of Engineering Education,* 94(3): 327-334.

Wilcoxson, L. (2006), ""It's not fair!" assessing the dynamics and resourcing of teamwork", *Journal of Management Education,* 30(6): 798-808.

Williams, J. (2002), *Team development for high-tech project managers*, Norwood, Artech House Inc.

Williams, M. (2003), *Making Sense of Social Research*, London, Sage.

Winograd, T. and Flores, F. (1993), *Understanding Computers and Cognition*, New York, Addison Wesley.

Woods, P., Hammersley, M. and Gomm, R. (1998), *Educational research methods*, Milton Keynes, Open University.

Wooldridge, M. and Jennings, N. (1995), *Towards a theory of cooperative problem solving*, Intelligent agents: ECAI-94 Workshop on agent theories., Springer-Verlag: London.,

Workman, M. (2004), "Goals, relationships, information and processes in global virtual team performance", *International Journal of Management and Decision Making,* 5(4): 348-372.

Yin, R. (1994), *Case study research: Design and methods*, London, Sage Publishing.

Yorke, M. and Knight, P. (2003), *The undergraduate curriculum and employability*, Learning and Teaching Support Network (LTSN) Generic Centre, Accessed-April 2003.

Zaccaro, S., Rittman, A. and Marks, M. (2002), "Team leadership", *The Leadership Quarterly,* 12: 451-483.

Zack, M. (1999), "Managing codified knowledge", *Sloan Management Review,* 40(4): 45-58.

Zheng, J., Veinott, E., Bos, N., Olson, J. and Olson, G. (2002), *Trust withut touch: jumpstarting long-distance trust with initial social activities*, CHI 2002, Minnesota, USA, April 2002,

Zuber-Skerritt, O. (1992), *Action Research in Higher Education*, London, Kogan-Page.

APPENDICES

Appendix 1 - Ethical Approval Certificate

Research Committee

Research Governance and Ethics Sub-Committee (RGEC)

MEMORANDUM

To **Janice Whatley**

cc: Dr Elaine Ferneley and Professor Yacine Rezgui

From M Pilotti, Contracts Officer

Date **16 March 2007**

Subject: **Approval of your Project by RGEC**

Project Title: **Guardian Agent system for Team Working**

RGEC Project code: **RGEC06/59**

Based on the information provided in your retrospective ethics application, I can confirm that the committee have no objections on ethical grounds to your project on recommendation that the following comments are taken on board as part of your learning.

The Chair has said that "It is very regrettable that the applicant was unaware of the requirement and procedures for ethical approval earlier. The main concern is the reference in the 'Informed Consent' sheet to students who did not wish to participate being asked to inform the researchers of the reasons why they do not wish to participate. I think this could be construed as onerous and undue pressure. Nevertheless, the applicant seems to have addressed most of the main ethical concerns adequately".

If there are any changes to the project and/or its methodology, please inform the committee as soon as possible.

Regards

Max Pilotti
Contracts Officer
MP/ET

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Appendix 2 – Informed Consent Form

Guardian Agent Project Research – University of Salford

The Guardian Agent system you are going to use in your Team Project is undertaken as part of our research into team working, and developing a system to support students in their team projects.

The main functions of the Guardian Agent system is to help the Team Leader to allocate roles and tasks to team members, and help with agreeing ground rules for the team members to work with.

Before agreeing to join this study, you need to understand the purpose of the study and what you will be asked to do. This process is known as informed consent.

This research is an integral part of the Guardian Agent development. Participants will be asked to read this informed consent form and to give permission to use their data for research.

1. Title of Research :

Can we design a software agent system that will be able to support students undertaking group projects online?

2. Main Researchers

Janice Whatley, University of Salford, J.E.Whatley@salford.ac.uk

Elaine Ferneley, Salford University, E.Ferneley@salford.ac.uk

3. Purpose of the Study

All team members, who choose to use the Guardian Agent system, are subjects of the research. This study is to investigate the potential for systems to support some of the processes of team working. Initially the Guardian Agent system helps with allocating project tasks to the individual team members, and help with agreeing ground rules for the team to work together.

4. Research Strategy

Questionnaire, focus groups and interview data will be collected and analysed using quantitative and qualitative techniques whilst maintaining the confidentiality of the subject.

5. Your Involvement in the Study

You are asked to follow any instructions your Team Leader gives regarding your use of the Guardian Agent system. It is stressed that the Guardian Agent system only gives recommendations for task allocation and ground rules, all team members should be involved in the final decisions on task allocation and ground rules. As you use the Guardian Agent system, please make a note of the usability of the system, so that you may give the researchers some appropriate feedback.

By volunteering to participate in this study, you will be expected to do the following things:

- Follow instructions given by your Team Leader
- Interact with the Guardian Agent system honestly
- Complete a questionnaire at the end of the activity

A focus group meeting will be organised at the end of the activity. All participants will be notified of the meeting date, but participation of this meeting is optional.

Your team will not be penalised in their Team Project mark, if you do not wish to participate. However, the researchers would like to be informed of your reasons for not participating.

6. Anticipated Benefit to You

Using the Guardian Agent system should speed up the initial processes of allocating tasks to team members, enabling the team to start on the project activities sooner. You will have the opportunity to consider ground rules for working together, helping your team to develop team cohesion.

7. Ethical Approval

Individuals who agree to participate are asked to type their name on the signature line of the consent section and send it to the main researcher, Janice Whatley, via her email address J.E.Whatley@salford.ac.uk or pass it to their Team Leader, before starting to use the Guardian Agent system. Questions or concerns can be emailed anonymously to the researchers using their email address on the front page of this informed consent form.

A link to preliminary research results (or reference to any publications) will be posted on the Team Project area.

8. Confidentiality / Anonymity:

Researchers who undertake this collaboration will hold data securely and confidentially and will strive to maintain the anonymity of subjects. There may be exceptions if individuals volunteer to participate in face-to-face interview or focus group meetings with the researchers. Data will be securely reserved and will not be transferred to any third party.

Please type your name on either section 9 for consent or section 10 for revocation of consent.

9. Consent:

Based on the above information, if you wish to participate in this study, please indicate by typing your name and date over the dotted line below and send back informed consent form electronically to the researcher, Janice Whatley, via her email address.

……. …….

(Signature of Respondent) (Date)

10. Revocation of Consent:

If you wish to withdraw your consent to participate in the above research, please indicate by typing your name over the dotted line below and send back informed consent form electronically to the researcher, Janice Whatley, via her email address.

……. …….

(Signature of Respondent) (Date)

11. **Researchers' verification:**

We certify that we have carefully explained the purpose and nature of this research on the participation information and consent form. By providing our email addresses and other contact details, we have provided the opportunity for the respondent to discuss the research project with us in detail.

Elaine Ferneley 19th September, 2004

Janice Whatley 19th September, 2004

(Signature of Researcher)

Appendix 3 – Questionnaire and information given

A request from Janice Whatley for some help in testing the Guardian Agent software tool

This is part of an agent system, which is designed to help support students undertaking group projects as part of their studies online. Group projects form an important part of the learning process for students in many fields of study. The particular problems of working on projects in groups have been explored, and the system designed to support some of the maintenance roles of group working.

A simplified summary of group project stages and some identified factors is given below:

Project stage	Factors identified as problematical
Planning	Introductions Setting ground rules Produce a project plan Allocate tasks
Doing the project	Check the time schedule Ensure all members contribute Identify lack of skills Discuss each others' contributions
Completing	Collating the individual parts Preparing a report Appraising the group's performance

The initial work on developing the software agent to support students was targeted at the Planning functions. This prototype enables students to input their preferences and will output suggested task allocations for the group project.

The complete system will support all the stages of the group project and will be applicable to different discipline areas in higher education, and it will be customisable by the tutor for particular projects. The concept of an agent to support an individual student throughout their studies gave rise to the name we chose.

What I would like you to do

I should be grateful if you would use the software as directed by your team tutor. You will need to input your name, then input your likes, dislikes, what you are good at and what you are not very good at when prompted.

When all of the members of your team have done the same, the agent will generate lists of who should be allocated to do which tasks, and whether anyone could do a task with some tutoring.

At the end of the exercise I would like each of you to complete a short questionnaire.

Appendix 3a – Questionnaire, Version 1 (used 2002 and 2003)

I should be grateful if you would answer these questions to help me with my research. Please hand in your responses at the end of the session.

1. Was this agent facility of use to you in your team project?

2. Did you find the interface easy to use?

3. Did you find the interface self explanatory?

4. What differences would you prefer to have on the interface?
   Additions?

   Changes?

5. An agent is an intelligent support device, often given a character (e.g. in Office).
   Would you like to see a character or embodiment for this agent?

6. If so what sort and why?

7. Do you think an agent, something like this one, would be useful to students working on group projects:
   Online? On campus?

8. Do you think students would like the concept of an agent to work with them?
   Online? On campus?

9. Would you personally like this sort of agent?

10. What other functionality would you like to see for the Guardian Agent?

11. What difficulties have you observed when groups of students work together on projects?

Appendix 3b – Questionnaire, Version 2 (used 2004 and 2005)

I should be grateful if you would answer these questions to help me with my research. Please hand in your responses at the end of the session.

1. Was this agent facility of use to you in your team project?
   All functions?

   Generic project skills?

   Project specific skills?

   Ground rules?

2. Did you find the interface easy to use?

3. Did you find the interface self explanatory?

4. What differences would you prefer to have on the interface?
   Additions?

   Changes?

5. An agent is an intelligent support device, often given a character (e.g. in Office). Would you like to see a character or embodiment for this agent?

6. If so what sort and why?

7. Do you think an agent, something like this one, would be useful to students working on group projects:
   Online? On campus?

8. Do you think students would like the concept of an agent to work with them?
   Online? On campus?

9. Would you personally like this sort of agent?

10. What other functionality would you like to see for the Guardian Agent?

11. What difficulties have you observed when groups of students work together on projects?

Appendix 4 - Analysis of qualitative data

Through all the cycles of prototyping, the questionnaire asked about functionality of the system and interface, but also asked for opinions on other functionality the system could provide and difficulties in team working which students have experienced or observed (Appendix 5).

The focus group used for the first prototype testing was structured around similar questions about usefulness and usability of the system and about difficulties in carrying out team project work. But in addition the researcher was seeking feedback in the form of a comparison between the rules used by the system to allocate tasks, and ways in which students might otherwise have achieved task allocation, with suggestions for other rules that could be incorporated.

When reading through the responses from the focus group it became apparent that the reasons for their opinions were just as important as finding out about their levels of acceptance of this system, e.g. *"Task allocation affected by motivation, allocate tasks using a risk analysis approach – don't allocate key tasks to high risk people"*. Following the suggested method of Oates (2006), analysis of the qualitative data began with reading through the data, separating out textual comments with no apparent relevance, and general descriptive comments from the comments that seemed to be most relevant.

The relevant comments were compared with issues that had been identified from the literature review, e.g. *"Opportunity to use the system as a discoverer of other people with appropriate knowledge",* showed a recognition of the need to find out about other team members' skills and preferences. Using themes identified from the literature, such as culture, team structure and project management, most of the relevant comments could be grouped for comparison with issues from the literature. Many other comments were concerned with the functionality or implementation of the system, and these were grouped accordingly, such as usability of the displayed output and the need for instruction or training. The remaining comments were grouped and given theme names, such as the extra features to make the agent dynamic (see Appendix 7).

The second cycle of prototyping used an interview with team leaders as well as the questionnaires. Again functionality and interface was asked, but also how the output was used, and what they regarded as good and bad about the system in terms of functionality, interface and implementation. Open questions enabled team leaders to provide suggesting of other functions, provide feedback about the pre-programmed content, and inform the researcher whether the system did help them as team leader. Finally they were asked whether they use it again.

The responses were again matched with issues identified in the literature, and comments concerned with the implementation of the system, and arranged into the same themes as for the focus group analysis (see Appendix 6).

Appendix 5 - Questionnaire comments

	2002	2003	2004/5
Differences, additions or changes suggested	• Larger text and windows • Tick boxes for choices • Easier to follow layout • Instructions and explanation • More colour and more appealing • Ability to edit input later • Error capture for wrong name • Use guide • Quicker in operation • Clearer interface • Operation over Internet • More GUI buttons • Check boxes • Management skills • Technical roles • Management issues • More options	• More colourful, more appealing • More user friendly, Animations • More tasks available, add own tasks • More project oriented or specific with added features to help • Remove vague questions, Allow more scope, more specific details • More colours, more options • Little note to explain each section • Easier to understand • More user friendly, better use of HCI principles • Results displayed more clearly because currently • are hard to read • Printout is non stop writing, too much to take in, looks funny once printed out • Save print out of results • Some buttons weren't self explanatory, consultative text for buttons • Ability to save data to external file and print	• Pictures, more colour • More friendly interface • Less complicated, more user friendly interface • Simpler results, what they are good at and what they are not • Yes because when a task needs to be performed can check this from one location and can delegate accordingly • Animations? Make more lively • I would prefer the same interface to use • Recommend individuals to certain teams • More details available to show skills • Save print out of results • Some buttons weren't self explanatory, consultive text for buttons • Ability to save data to external file and print • Results displayed more clearly because currently are hard to read • Simpler results, what they are good at and what they are not • More consideration of HCI issues
Suggestions for other functions	• Grading, to indicate extent of ability • Improved format of the outputs • Classification, auto delegation • Identify strengths of individuals • Provide a backup or second opinion • More questions to find out about individuals • Account for diff personalities • User guidance • Allocation to sub teams • More characteristics • More friendly interface • More choice of tasks and skills • Available to all • Choose leader	• Explanation on how to make use of the product • How to structure projects correctly • Help with planning • A makeover • In scenarios where team need to communicate more • More project specific, helping students with what documentation is required from each team • A facility to let you put up messages • Student profiles, including contact and possibly timetables	• Contracts • Communication between students • Personal interests section • To recommend individuals into groups • Organisation to track who has done what and when • Save print out • Contact and a student profile of the user
Issues of team working cited Team cohesion (Maintenance oriented)	• Communication was cited frequently in various contexts • Understanding the project • Leadership issues • Time keeping of members • Dedication or motivation of	• Task of communication Absenteeism • Not knowing what to do exactly • Poor communication can lead to a breakdown in the project	• Lack of ability, lack of instructive control • Lack of communication between peers • Communication within team, More tasks being delegated to certain

	2002	2003	2004/5
	members • Ensuring Responsibility taken for tasks, in addition to allocation • Clash of personalities • Differences of opinions • Time management of individual team members • Absenteeism from meetings • Limited strengths of some team members • Coordination of the roles	• Some students carry other students through team time as they don't pull their weight • Lack of contribution from some members, no discipline structure • Different opinions • Work can only be completed when everyone is there	students • Having the system easier and not making it like a chore • Team functioning properly • Some people only do what told, have no sense of overall project, they do their part for the team but don't take part in the team • Not everyone knows what is expected • There will be different ground rules for each project which could be complicated • Low rates of communication as well as low attendance • People taking charge when they don't have authority. • Getting on with each other • Failure to reach a consensus • Dishonesty
Issues of team working cited Project management (Task oriented)	• Setting Deadlines and monitoring them • Problem solving • Knowing how to carry out the project • A lack of feedback on progress • Lack of training in skills	• Decision making • Some organisational issues When it comes to dividing up tasks • Organisation, communication, assigning work • Getting started on project earlier • People struggling with technical roles while someone appropriate could fulfil this role • Not sure if answers provided were real • Lack of ability, lack of instructive control	• Student skills • Keeping to deadlines • Work distribution • Lack of attendance and communication • Don't know where the agent is after using it • Tracking all students are doing the work they are supposed to be and delivering it. • Students are not using their own initiative in taking on work that needs to be completed.

Appendix 6 - Data from Interviews with Team leaders

Analysis of data by Main issues (Team number in brackets):

Issue	2003	2004	2005
Task allocation	Yes, showed clearly the technical and other types of people. Used as a basis, but added own methods, written lists of skills and why they should be in a certain team. Most were happy with the decision. (10)	It made them think about the skills, choosing them Project specific skills were used to plant the project, work out what and when things needed delivering (17)	Saw each person's allocation (2)
	Meeting and spoke to members, asked for experts in certain areas, and what enjoy and like to do. Agent results used to justify the choices. (5)	To develop a sub teams and training requirements (8)	Conflict both, resolve by all doing research and technical (2)
	If it told you how many liked X, because too many. Rather than read out and count, e.g. if you have 5 people who like X (9)	Negative answers could be shown, if the members don't want to do things. (8)	Yes a good idea with people you have not seen before. Guidance not specific, maybe false (13)
		The system helped me to know who to put into which part of the team, to do different tasks (8)	Not sure of their skills, do you need training. (13)
		Use it to divide the team into technical admin and research sections. (15)	Over exaggerated skill levels (10)
			Even if don't take on board, gives idea of what people are capable of. Over and under confident (5)
Developing skills	Restricting areas, because everyone chooses easy tasks. Nobody wants to do technical stuff, all wanted to do admin and documentation. Suggest alternatives (5)	Some doing things they hadn't done before (17)	Looking for general idea, yes skills and competencies (10)
		Database of skills, for instance I want to learn x, and now changed database. A lack of skills (8)	
Types of projects		In my project it was cut and dry what needed to be done, useful if programming software, but as a research project, there is really no need for automation. (7)	I did not feel a project of this nature required a complex structure (11)
		Built a knowledge base of the skills existing and required and matched to the specification of the project (8)	
Ground rules		The rules are a bit harsh, attendance tends to be an honourable agreement, I ask me to be informed of any non-attendance (7)	During meetings in agendas. Sanction if not done. Registers monitor and deliverables chart, monitor contribution. Everyone knows where they stand. Clear what consequences were, low mark (9)

Issue	2003	2004	2005
		Getting people's opinions, success factors of the project (15)	Just looking rather than formal (2)
		A big list but they are effective A pre-printed contract for the team members to sign (15)	Yes, ground rules is one of more useful bits (11)
		Ground rules used to establish a Contract (15)	Team contract helped performance, like in outside world. Know the rules (13)
		For example not being honest about something (15)	All ticked everything, and did not necessarily comply (10)
		I did make a team contract which includes some of the ground rules from the Guardian agent (15)	Set ground rules, tried to enforce them e.g. absences. Hard to say if it is as a result, or made them think about expectations (10)
		Good to air at the ground rules, no one it was a shy to talk about it (8)	Everyone read them, knowledge transfer. No conflict all agreed them (5)
		Ground rules. Really good, some may be upset, and acceptable to all as worded (8)	Ground rules, no difference to performance, but emphasise more. No contract (5)
		Getting members to do the work is a problem (7)	
Expectation		It did but not how I thought it would (17)	
Team cohesion/ problems	How to handle problems, what has happened in the past. (20)	use for peer marking, using a register (7)	Yes to allocate tasks, no conflict (13)
	Debates slow projects. (20)		Background and behaviour and attitude, positive (13)
	Already know people (27)	Define what kind of relationship we should have between each other (15)	See all gradings for everyone. So if low mark can put with more confident person (10)
	Better guidance (20)	This is an important factor, help to understand how they work together and adapt to situations (15)	Conflict in personality or year group. Areas spot on. Sub teams, so layer of authority and give out orders better idea of what's going on (5)
Culture		Needs to be caught in the project part of the culture (13)	Everyone has other methods of working – develop norms after a few weeks. (14)
		Teams tend to be too busy to use it (17)	Not like real work At work money motivates threat of sack, procedures, warnings. Don't produce work of bad quality Can pass team project on backs of others Would need team time as well Contribution and attendance (9)
		There is no formal contract, they don't work, we are not able to sack at the team members (7)	Changed way of working (2)

Issue	2003	2004	2005
		Some factors have affected relationships in our team. For example honesty, not everyone contributing fairly, so read delegated tasks, no it was not fair, some people didn't see it as being honest. Need an agreement (15)	Place where take note of problems – note pad, diary What's going on, who's doing well Useful even on campus (2)
		Preconceived ideas (15)	Can't pick out personalities, may not work together in practice. Put 1st with 2nd and 3rd years (5)
		Communication is the biggest thing, with language barriers, technology available eg a forum (15)	
		Everyone ticked all the boxes so they did not really think about it (9)	
		It did not really assess what people think about not clever enough. People can make things up (9)	
More information Training Instruction	Feedback on carrying out documentation, what is expected, roles, responsibilities. (20)	Methodical and logical we won't miss out anything (13)	Generalizes what people can do (14)
	Reports, examples, what is in jobs such as administration (20)	Can't see the big picture Have to use it at the start (13)	More information on skills. E.g. report writing (14)
	Yes to help instructing teams and give out reports (push). (20)	Good in a way, focus and requirements team understood project, what they wanted to do with (17)	Gave more information to base decisions on. Don't know needs, likes or anything. Would have taken longer (14)
	Add more detail. Display as 1 person and all allocations (1)	Made sure we planned properly (17)	Every year new people, should try to explain how useful to all their studies esp 1st years (11)
	Few missing or vague. Not sure what some mean. (9)	Yes if more people used it and it can be tailored to the needs of particular projects and not only the team leader but the members must know how to use it. Start the project with it. (17)	Relatively easy to use, once sussed out. Read instructions and explained to others. (10)
		By the time we figured it out (7)	Feel comfortable putting into in private (5)
		I did not see the whole thing the first day I wanted it (15)	
		Used it to put members into various parts of the team (10)	
		More awareness, needed guidance and a lecture to introduce it (10)	
		All positions in most areas, happy to go along with, discussed them (8)	
		Help needed, defining generic skills (8)	
Output	Another source to look at.		

Issue	2003	2004	2005
format	Socialising is important. Something else to think about and help making decisions (1)		
More dynamic agent	Yes, 2nd semester, as we have different tasks in second semester (10)	Past experiences (2)	Other learning modules and team building up skills (10)
	Already planning Feb already organised, so won't benefit. (5)	Capture and change the database content (8)	Comparison between semesters, learning (10)
	Readjust the team for next semester (21)		Can't go and update skills, add more and run it again. May need extra specific skills, e.g. Apache (5)
	No, already learned about members, can't really change the team that much (9)		Building up skills, being able to update it. More knowledge over term. Better interface for TL to edit progress over term (5)
	Keeping up with tasks, assign tasks to members, monitoring of completion, for documentation (27)		Flag up training. Online team shared workspaces, linked with project management for deadlines, update from home, freely available. (5)
			Can we build up skills from 1st year and just edit them. (5)
F2F vs online		We meet together and decide on the next task, face-to-face is important, if online we would need some kind of structure, communication plan, e-mail, would be more useful (7)	
		Agent not as good as speaking to each other (15)	
		Online where it was very difficult to decide on the skills that each member had (15)	
		It was a problem waiting for e-mail responses (15)	
		Good if there is no face-to-face contact possible (10)	

Additional interview data, October 2008.

Team Leader from Team 3

Theme	Feedback
Task allocation	Delay before using it. If I had used it earlier it would have been a great help, i.e. 3 weeks ago. Requirements not clear at start. Used at start would be very good, see how individuals cope with tasks, e.g. project management, helps to give them tasks to develop other skills. Used earlier it may have speeded up the project, because the first tasks allocated would have been based on their preferences, and see how they got on with them. Whether they really could do what they said they could do. In the first weeks I had a lot working on research, and I would not have done that, so I should have used it earlier. Adding extra skills is good by looking at the ground rules, the team had a better understanding of team working, and I based the contract on them Yes, why some work, feedback, why no work, because of lack of skills. Producing reports, can see the reason. Delegation, yes assign tasks, and delegated to others, then the GA tells me why this

	happened.
Developing skills	Pair of people with contrasting skills, e.g. report writer with researcher, to collaborate. Test if what they say is true in work given, e.g. are they really any good at proof reading, as they say. Members may be trying to impress by ticking things they are not really any good at. A very good tool.
Types of projects	Management tool rather than to help team cohesion.
Ground rules	
Expectation	Yes it helped develop shared understanding of members, why they do what they do. Helps me to understand why the work they produce is good or bad, when I looked at the system output, and they are not that skilled. Yes it may help trust, but they may trust or be cynical about the work. Team Leader makes decisions on the basis of what you have seen, but the system allows you to let them have a go at something. Give everyone a taste of everything. Weaknesses as well, overcome them with some training. Or they may stick to what they are good at.
Team cohesion/problems	Yes, it would have speeded up getting started. Useful with people I did not know before, 1st, 2nd and some final years, because some of us had been on placement. Team leader is responsible in this project, so it provides more information. No major team working problems, some small issues, e.g. leadership. It would be good to identify team members who have leadership ability, and may want to undermine the leader. Good for beginning the project, for beginning next semester will give an idea of who to appoint as the new deputy leader. People who say they are good at leadership were given a chance to lead a sub group to see how they got on. Not a major role in helping team cohesion.
Culture	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.
Output format	Wanted to do a chart in Excel showing how many team members assigned to each task, so could do with a more graphical output. Show names against tasks, some form of statistical output Output in year groups? Graphical format Which skills are strong or weak in team, output in some order, according to number in which grades. Show relationships
More information Training Instruction	Yes, 4 team members used it, but not until a few weeks into project. Should have used it earlier. GR, did not use output, as all rules on list are expected anyway. Project skills not done yet. Good to highlight training needs. It needs to be communicated to all team members at the beginning to introduce the tool, and mention it in the team brief.
More dynamic agent	Eventually link it so that a tutorial is automatically linked to. Suggest use it at the end of the 2nd semester, then module tutors can use it to combine the teams with appropriate skills. With the team project brief, the leader and deputy can be given some initial information. Use it to plan tutorials, for preparation at the beginning, and reflection at the end. Both team leader and module tutors could benefit. Module tutor could use it to build teams for next year, so all teams are fair. Testing on small tasks, good for choosing the next deputy.

Appendix 7 - Data from Focus Groups

Analysis of data by Main issues:

Issue	Focus Group 2004	Focus Group 2002
Task allocation	Common sense, if like and good. Cover what we would consider, normally. Keeping every team member happy.	Issue of avoidance – if 6 people all pick same task .. delegate to person with more skills or aptitude
		Task allocation affected by motivation, allocate tasks using a risk analysis approach – don't allocate key tasks to high risk people
		Agent would act as the decision maker, skills assessment, which types of people would work well together
		If tasks are allocated without having to meet the team members then may not be aware of any 'man machine' argument taking place
		If questions were more abstract and there were more of them it would be beneficial to have more subdivisions that lead you to a conclusion
		Rating/grading but may be subjective – all say they are good at word processing but what is 'good'
		Different levels of advice – beginner, intermediate, advanced – within context
		2 problems – too many people allocated to the same task area – what do you do in this situation
		Design manual sheets to take the approach of what do you want to learn about
Skills development	Needs to develop to other skills	Problem that it is what each individual team member thinks they are good at, not what their aptitude is
	Limiting yourself as a person. learn something new, try, more skills	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.
	Other odd skills, e.g. photography	Perhaps focus on what a person's aptitude is and 'measure' that in some way
Types of projects	Different to pure research.	
Project management		Saved time – had 6 options to chose from – did not have to think
		Make it more focussed so that can allocate specific tasks rather than generic tasks, how long will task take, how many people will be needed to do task
Ground rules	Confusion with ground rules	Much team work is undocumented rules
	But people agree but don't act on it. Always honest, make perfect answer	

Issue	Focus Group 2004	Focus Group 2002
	Even more difficult in virtual teams, to abide by ground rules, e.g. trust, culture develops	
	Common sense, don't need rules. Good to highlight to team at start Make it into a Contract	
The individual as part of team	But people get on with their own work rather than look at project as a whole.	Team work can drag you down or push you up so need to measure individuals' skills
		Need to take personality into account
Knowing team members	Mini projects, so know what people are like	
Help to get individuals participating	More functions, like calendar. Structure team time, register or something useful to use each time. Record logged on members. More interactive, acts as a marketing tool, other features, centralised tool	
Negotiation		Example of strong personality attempting to take democracy out of the debate – could be even more of a problem on-line –'if it comes to a staring match then someone backs down' – equivalent is turning the computer off.
Team conflict		Assumes that there would be no rebellion against the agent – would not argue with the machine, simply would not do it. Would have to argue with the whole team if only one person out of step
		Team dynamics were different
Culture	Hard to get away from method used previously. Lets do what we normally do	What is the culture of the ISI, hints and tips on how to do a team project
	Get set as you arrive in 1st year	
	No teaching more to do with previous years experience. Simple team structure works quite well, 'cos if you are technical someone has to be admin, can move people around, flexible	
	Online projects are going to fail	
	Put all details in but I did it the way I did last year, more accuracy	
Team structure	Diff structures each year	You have a leader and hierarchical structure, on-line there would be no hierarchy
	No teaching more to do with previos years experience. Simple team structure works quite well, cos if you are technical someone has to be admin, can move people around, flexible	Cynical approach – 2nd years know where the 'soft' options are, if they are asked questions that will allocate them to a certain team they will identify those questions that will allocate them to a specific team
		Nothing to distinguish between theoretical work and practical work
		1st years – realised that the work they had been allocated was boring and that they are now going to rotate around

Issue	Focus Group 2004	Focus Group 2002
Need for instruction/training	Confusion with ground rules	Introduction screen (splash screen with explanation
	No teaching more to do with previous years experience. Simple team structure works quite well, cos if you are technical someone has to be admin, can move people around, flexible	Down to purpose and explaining the purpose – if people understand that it is there to help them
	Good straightforward and basic, and led the user through it	Needed more instructions
		Some were too quick 'click, click, click' – some results may not be very accurate. Point that this quick response also occurs in manual skills assessment at start of project
		Most helpful thing is cursor over area for help
Project assessment	Punctual, can be marked on. Official, for assessment	Team work can drag you down or push you up so need to measure individuals' skills
Extra features to make agent dynamic	Diff structures each year	Skills assessment process to ensure some sort of learning development
	If it can help, mentor, requires a lot of input to have it dynamic GA job of someone to run it rather than team leader, an extra admin job	Look at how people have done on past modules (skills assessment) and undertake some form of 'measure'
	Idea of an agent to help is OK, but must be real help and streamlined	Opportunity to use the system as a discoverer of other people with appropriate knowledge
	Easy to wriggle out of something Hasn't done something in past they should have a go at it this year. Good idea if database kept from year to year.	Whole team dynamics - whilst appearance could be of cooperation through the agent could in fact be operating outside of the agent with the team then interacting with the agent post decision making
	Making sure people turn up, shoot in foot Everyone participating and do allocated task. Deadlines to tick off. Agent would keep a record of deadlines.	Characterisation irrelevant – it does not do what it's supposed to
Usability of the display/output	Display at end could be simpler, graphs, readability, concepts summarised. A bit confusing at the end	List one line of black text – unless you read it carefully you're not aware it's changed
	Calendar. More incentive to use it. Gantt chart. Print out allocations, better display. Printer friendly	Output could be copied to something else or be capable of printing (screen dump into word ?)

Appendix 8 - Summary of findings from ISI report documents

Report title	Author, Date	Purpose	Main points	Suggestions
"Information for a review of Team projects at the ISI"	Helen Richardson (Equality Tutor), July 2005	Report on meeting with Student Union Advisor, arising from a disproportionate number of issues from students re team projects, reported to Student Union Advisor.	• Peer assessment causes some bullying. • Sub-cultures prevent some meeting venues outside campus. • Gender bias example of experience disregarded. • Lack of confidence at raising issues. • Misinformation and bullying. • Issue of layabout student and assessment.	• More preparation for students and staff. • Influences of sub-cultures need addressing. • Consider smaller projects, e.g. 2nd years only. • Team selection could consider outside circumstances.
Team Projects Review Report - 2006	Grahame Cooper and Aleksej Heinze 2006	The purpose of this document is to communicate the suggestions and changes to the staff and students concerned in order to further improve the processes and the outcomes of team projects in the future.	• Overall there is a sense that Team Projects are a good idea in theory, but that the practical implementations in the current environment are problematic. The main areas of concern are the assessment process and the level of tutor involvement. • Administration – documentation related to peer assessment • Assessment – product and process important, consistency of marking • Equality and diversity – balance skill, gender and culture, Tutors are	• • Administration - Blackboard VLE will be used to facilitate better communication. Team Leaders briefing meetings could also be considered where team leaders can attend a session to receive guidance on any particular administrative issue related to team projects • Assessment - improving the assessment descriptors. staff should have discretion regarding both the approach to tutoring and the manner of assessing individual and team performance. review each others' projects • Equality and diversity - Students will be informed about the

Report title	Author, Date	Purpose	Main points	Suggestions
			encouraged to be vigilant and intervene where necessary.	potential risks and how to deal with these, it is anticipated that this experience would help students to learn conflict management skills. experiment with self-selection
			• Infrastructure - Maxwell building provides a “safer” place for students with respect to bullying and any other form of negative behaviour	• Infrastructure - less equipment is allocated to students on team projects.
			• Passengers - It is expected that students have different attitudes to project work, some are very keen on getting the work done and getting a good mark. Other students have the strategy of doing the minimum work to achieve a pass mark and others fall somewhere in between	• Passengers - mechanics of the peer reviewing process and the importance of honesty of information
			• Student motivation - assessment or the mark that students get is becoming the prime motivator to engage with a module. If a student knows that they can get away with doing nothing and still get a good mark, they are unlikely to be motivated to perform well.	• Student motivation - client selection process, major companies with real projects will be preferred to internal clients offering theoretical investigations. recognise and reward outstanding team projects and performance of individuals in teams using prizes:
			• Level of staff involvement in tutoring - The “working” tutoring pattern seems to be where team tutoring is given priority within the first weeks of the project starting to negotiating the project scope and then again at the time	• Level of staff involvement in tutoring - encouraged to be over-involved with the team rather than be “hands off”. providing appropriate staff development opportunities

Report title	Author, Date	Purpose	Main points	Suggestions
			of the mid semester review and assessment hand in. expertise and experience of tutors • Team Project Culture: – Tech - Admin – Management - Problems arise when members are allocated to a sub-team on criteria other than the merit of their skills. Students are also not able to learn technical skills if they are in the admin sub-team. challenged to provide a justification for their approach • Types of projects - students do tend to like a project where they can see their suggestions being implemented in real life, so that they can see that they made a difference • Team compositions - random teams based on team members' skills and competencies are a good way for students to share and learn from each other	 • Team Project Culture: – Tech - Admin – Management - "expert sessions" could be organised to focus on these issues and provide a community support mechanism • Types of projects - the "ideal" project type. If a project is too small, there is no reason why the team can't finish the project by the end of the first semester and get a different project for the second semester • Team compositions - where possible a balance will be achieved

Appendix 9 - Table of distinguishing features of the three prototype systems

Year of trial	2002	2003	2004 and 2005
Features of each version	Coded in Prolog	Coded in Java + MySQL	Coded in PHP + MySQL
Leader adds members	No	Yes	Yes
Generic project skills Or single list of skills	• Dataflow • Entity relations • Flow chart • Report • Structure chart • Programming	• Documentation, • Word Processing, • HCI Pages/Forms Design, • Access, • Entity Relations Diagram, • Normalisation, • Project Admin, • Graphical Design, • Presentation, • Leadership, • Programming, • Prototyping	• Leadership • Negotiation • Delegation • Project management • Attention to detail • Report writing • Taking minutes of meetings • Presenting verbally • Research • Analysis
Team leader selects	No	Yes	Yes
Project specific skills	N/A	N/A	• Database design • Web design • Multimedia design • Application HCI design • Data modelling • Normalisation • Process modelling • Object oriented design • UML • Testing • Programming – Visual basic • Programming – Java • Programming – Javascript • Programming – HTML • Programming – PHP • Programming – SQL • Programming – XML • Programming – ASP • Microsoft Access • Microsoft Project • Macromedia Dreamweaver
Selecting preference	Highlight and select from list: Good - Bad Like - Dislike	Highlight and move across to relevant box Good at - Not good at Like - Dislike	Select radio buttons: Ability Poor – Good scale 1 to 6 Preference Dislike – Like scale 1 to 6

Rules: Two rules used for allocating tasks One rule for suggesting tutoring	Allocation of task - 1. If team memberA likes X and is able at X - Then team memberA should do X. 2. If team memberB is good at X and has not expressed a dislike of X - Then team memberB could do X Allocation of tutoring - If team memberC likes X, but is unable at X - Then team memberC could be offered training in X		
Ground rules	N/A	• Punctuality, • Prepare for meetings, • Value diversity, • Be honest, • Participate in meetings, • Concensus decisions, • Take turns recording meetings, • Inform of non-attendance, • Inform of non-completion	• Complete agreed work on time • Inform of non-completion • Read and respond to messages within agreed time • Inform others of progress • Respect consensus decisions • Value diversity • Be honest • Play an active part in the team • Trust each other • Respect each other • Attend meetings that have been arranged • Prepare for meetings • Be punctual for meetings • Send apologies if unable to attend
Team leader selects	No	Yes	Yes
Selection	N/A	Highlight and move across to relevant box	Check box for each item
Rules applied		If all team members say they think a rule is important - Then it is suggested for acceptance If more than half of the team members think a rule is important - Then it is recommended to be considered	If more than half of the team members think a rule is important - Then it is recommended for acceptance.
Feedback on rule used	No	No	Yes

Appendix 10 - Guardian Agent shell program

```
/*
Agent Name = Guardian

Long Term Goal =   Let the users query and modify the
                   how_old_is database maintained by Angel,
                    (usually from remote locations).

Short Term Goals = Respond to the following user commands
                   Connect      (to Angel)
                   Disconnect

                   ask_one   (query the database)
                   ask_all

                   add_one   (modify the database)
                   delete_one
                   delete_all
                   reset     (reset the database)


Plans =  Following plans set out how Guardian should respond to
         the various agent events:
            sally_handle/2
            sally_comms/2

USAGE:
1. Start the agent by executing sally/0 from the command line:
?- sally.
A dialog listing the details of the agent Sally will be shown.
2. To connect to the agent who maintains
the how_old_is database (normally Simon), enter the name of the host
and the port number in the dialog and click on 'Connect'.
As a result, Sally will connect to Simon and send a 'hello'
message identifying itself.  Simon will reply with its own
details.
3. You can now click on the database query and modification
buttons to send messages to Simon.  You can query the database
by entering the name and age arguments in the Sally's dialog.
For example, if you want to know all the people who were 35
years old, just type 35 in the name field and click on 'ask-all'.
To add a person to the database, enter the name (e.g. 'tommy')
and the age (e.g. 5 ) and click on 'add-one'. If you click on
'ask-all' without specifying any age or name, Simon will reply
with all the people in the database.
Clicking on 'Reset' will reset the database on Simon's end, all
the changes you have made to the database will be discarded.
4. To disconnect from Simon, click on 'Disconnect'.
See the file, readme.txt for more information about the conversation
policy.
*/
% load all the necessary files
:- ensure_loaded( library('\agent\agload') ), agent_load_files.
:- ensure_loaded( library('\agent\agutil') ). %for trace mode
:- ensure_loaded( library('\tcp\txtwin') ). %dialog utils
:- ensure_loaded( 'guard_dlg'). %sally's dialog

% create, initialize and start Sally.
% To start Sally in trace mode, use agUtil_trace/1
% instead of agent_start.

guardian:-
  agent_reset,
  Params =  [name(sally)],
  EventHandlers = [ (incoming_msg, sally_handle),
                    (received_reply, sally_handle),
                    (send_msg, sally_handle),
                    (send_reply, sally_handle),
                    (error, sally_handle),
                    (connected, sally_comms),
                    (cannot_connect, sally_comms)
                  ],
   agent_create( Params, Me ),
```

```
  agent_initialize,
  agent_declare( handlers, EventHandlers ),

  init_window,
  sally_introduce,
  agUtil_trace(0.2).
  %agent_start.

 sally_introduce:-
  agent_id_det( ID,
                name(N),
                protocol(Proto),
                host(H),
                port(P),
                target(Target),
                url(U),
                full_name(F),
                data(File)
              ),
  (  nl, tab(5), write( 'ID             ': ID ),
     nl, tab(5), write( 'Name           ': N ),
     nl, tab(5), write( 'Protocol       ': Proto ),
     nl, tab(5), write( 'Host           ': H ),
     nl, tab(5), write( 'Port           ': P ),
     nl, tab(5), write( 'Target         ': Target ),
     nl, tab(5), write( 'URL            ': U ),
     nl, tab(5), write( 'Full Name      ': F ),
     nl, tab(5), write( 'Data File      ': File ),
     nl
  ) ~> Msg,
  writeW( sally, Msg ).
%-----------------------------------------------------
% sally's event handlers
%-----------------------------------------------------
% incoming message
sally_handle( incoming_msg, (MesNo,Channel) ):-
  one agent_incoming( MesNo, Channel, Msg, _),
  agUtil_msg2term( Msg, Term, Err ),
  (  Err \= 0
  -> agent_post_event( urgent, error, ((Err, Msg),Channel) )
  ;  sally_handle_term( Term, Channel )
  ),
  retractall( agent_incoming(MesNo,_,_,_) ).

% received reply
sally_handle( received_reply, (Reply,Ref,Channel) ):-
  wtext( (sally,4), F ),
  ( write(`~M~JRECEIVED Message Reference`:Ref ),
    write( ` From` : F ),
    write( `~M~JMessage`: Reply ),
    nl
  ) ~> Msg,
  writeW( sally, Msg ).

% send messages and replies
sally_handle( send_msg, (hello,Channel) ):-
  !,
  Ref is int(rand(10000) ),
  one agent_id( MyID, MyN, MyURL, MyF ),
  Message = hello( agent_id( MyID,
                             name(MyN),
                             url(MyURL),
                             full_name(MyF)
                           ),
                   Ref
                 ),
  sally_send( Channel, Message, Ref ).

sally_handle( send_msg, (request,Request,Channel) ):-
  !,
  Ref is int(rand(10000) ),
  sally_send( Channel, request(Request,Ref), Ref ).

sally_handle( send_reply, (Reply,Ref,Channel) ):-
  sally_send( Channel, reply(Reply,Ref), Ref ).
```

```
sally_handle( error, ((Err,Term),Channel) ):-
  sally_send( Channel, error(Err,Term,nil), nil ).

%-------------------------------------------------------------
% communication events

sally_comms( connected, (Host,Port,Channel) ):-
  ( nl,
    write(`I AM CONNECTED to `-Host:Port),
    write( ` Channel`:Channel )
  ) ~> Msg,
  writeW( sally, Msg ),
  connected_win.

sally_comms( cannot_connect, (Host,Port,9906) ):-
  !,
  ( nl,
    write( `CANNOT CONNECT TO`- Host:Port ),
    write( `~M~JIncompatible protocol or the agent is too busy` )
  ) ~> Msg,
  writeW( sally, Msg ).

sally_comms( cannot_connect, (Host,Port,-1) ):-
  !,
  ( nl,
    write( `CANNOT CONNECT TO`- Host:Port ),
    write( `~M~JConnection request timed out` )
  ) ~> Msg,
  writeW( sally, Msg ).

sally_comms( cannot_connect, (Host,Port,Err) ):-
  ( nl,
    write( `CANNOT CONNECT TO`- Host:Port ),
    write( `~M~JBecause of Socket Error`:Err )
  ) ~> Msg,
  writeW( sally, Msg ).

%-------------------------------------------------------------
% handle the prolog terms received

sally_handle_term( reply(Term,Ref), Channel):-
  (  Term = hello(_)
  -> sally_handle_term( Term, Ref, Channel )
  ;  agent_post_event( received_reply, (Term,Ref,Channel) )
  ),
  !.

sally_handle_term( error(Err,Term,Ref), Channel):-
  agent_post_event( received_reply,
                    (error(Err,Term,Ref),Ref,Channel)
                  ),
  !.

sally_handle_term( hello(AgentID), Ref, Channel ):-
  AgentID = agent_id(ID, name(N), url(URL), full_name(F) ),
  nonvar(N),
  nonvar(URL),
  nonvar(F),
  retract( agent_connected(Type,Channel,_) ),
  assert( agent_connected( Type,Channel, AgentID) ),
  !,
  write( F ) ~> Fstr,
  wtext( (sally,4), Fstr ).

% something sally doesn't understand
sally_handle_term( Term, Channel ):-
  agent_post_event( error,
                    ( ('Sorry, I do not understand', Term ),
                      Channel
                    )
                    ).
%-------------------------------------------------------------
% helper predicates
%-------------------------------------------------------------
```

```
sally_connect( Host, Port ):-
  writeW( sally, `~M~JCONNECTING..`),
  busy(1),
  (  agent_connect( Host, Port, Channel )
  -> agent_post_event( send_msg, (hello,Channel) )
  ;  true
  ),
  busy(0).

sally_send( Channel, ToSend, Ref ):-
  agent_send( Channel, ToSend ),
  one agent_connected( _, Channel, agent_id(_, _,_, full_name(F) ) ),
  ( write(`~M~JSENT Message Reference`:Ref),
    write( ` To`:F ),
    write( `~M~JMessage`: ToSend )
  ) ~> Msg,
  writeW( sally, Msg ),
  !.

sally_send( Channel, ToSend, Ref ).

sally_disconnect:-
    get_channel( C ),
    integer(C),
    agent_disconnect( C ),
    disconnected_win,
    wtext( (sally,4), `` ),
    ( write( `~M~JCONNECTION CLOSED on Channel`: C )
    ) ~> Msg,
    writeW( sally, Msg ).

request( Goal ):-
  one catch( E, request_aux(Goal) ),
  (  E \= 0
  -> write(`~M~JCANNOT SEND REQUEST Because of Error`:E ) ~> Msg,
     writeW( sally, Msg )
  ;  true
  ).

request_aux( reset ):-
  get_name_age(Name,Age),
  (  get_channel( C ), integer(C)
  -> R = reset(Result),
     agent_post_event( send_msg, (request,R,C) )
  ;  writeW( sally, `~M~JNOT CONNECTED` )
  ),
  !.
request_aux( Goal ):-
  get_name_age(Name,Age),
  (  get_channel( C ),
     integer(C)
  -> R = Goal(Name,Age,Result),
     agent_post_event( send_msg, (request,R,C) )
  ;  writeW( sally, `~M~JNOT CONNECTED` )
  ).

get_name_age( Name, Age ):-
  wtext( (sally,5), N ),
  wtext( (sally,6), A ),
  (  N = ``
  -> true
  ;  stratm( N, Name )
  ),
  (  A = ``
  -> true
  ;  number_string(Age, A)
  ).
get_name_age( Name, Age ).

get_channel(Channel):-
  wtext( (sally,4), FullName ),
   stratm( FullName,F ),   one agent_connected( _, Channel, agent_id(_, _,_, full_name(F) ) ).
```

Appendix 11 – Team Leaders' descriptions of existing practice

Questions to establish requirements for the proposed team working tool

Questions for Team Leaders:

- What type of project would you say it was?
- What tasks do you feel are needed to complete this project?
- How did you find out about your team members' likes/dislikes and abilities?
- Did you feel this method worked well?
- How did you allocate tasks to individuals?
- How did you decide how many would need to be involved with each activity?
- How did you apportion times to the different tasks?
- How did you motivate people?
- How did you deal with work done by individuals, which was incomplete or sub-standard?

Of the 22 team leaders who were emailed, responses from 10 team leaders were received, and their answers are summarised as:

Team Leaders' Questionnaire Findings

1. Project types mainly web design and database design, 1 multimedia, 1 networking solution, 1 application implementation.
2. Most cited skill was documentation, also modelling, project management, then HCI, prototyping, access skills. Programming, word processing, graphical design, analysis of networks, evaluating others all cited by 1 person.
3. Three main methods, talking either formally or informally, writing skills down or template or questionnaire. Some used a combination of these.
4. All said the chosen method worked, but some qualified it with "over estimated their skills", and interviewing was most useful.
5. In allocating tasks, most used their skills assessment, some also used a stated preference, and in one case each experience, competence and enjoy were also taken into consideration.

Appendix 12 - Student User Guide

LPA Prolog Agent

Operating Instructions

Instructions for running the Guardian Agent

Ensure that the LPA environment is running, by double clicking the LPA logo on the desktop

At the prompt type *guardian.* (including a full stop) then press Enter

You are asked to give your name. Type in the name you have been given.

Give your preferences as prompted, by highlighting all the tasks you feel apply for each of the four questions – those you like, those you are good at, those you dislike and those you are not very good at.

As the response windows appear just click on the OK button to continue.

The first time you use the Guardian Agent you will be asked for your preferences.

If not everyone else in your team has posted their preferences, the program will terminate.

Try to use the Guardian Agent again. If you have already posted the agent should tell you so. The agent will also indicate whether everyone else has posted as well.

When everyone else has posted, the next time you log on, the agent will respond with its suggestions of allocations of tasks to the members of the group.

This is only an early development version, so please ignore the trace windows that show the message passing in operation.

Appendix 13 - Focus group invitation and questions

Software Agent Trial

Tuesday 5th November 1.20 p.m.
Unipart Lecture theatre

You are invited to a Focus Group session where I hope that through an open discussion you will be able to give me some more extensive feedback on the suitability of software agents for some learning tasks. This will help me in my research and in further development of the tool.

I am particularly interested in:

- Comparing the rules the agent used with the ways in which you have allocated tasks
- What your team members thought of the usefulness of the function you tried.
- Would your team members like the concept of an agent working to help them, either online or face to face
- Were there any particular issues with the interface, any suggestions
- What other difficulties in teamworking might be helped by an agent function

Focus Group Questions

- What your team members thought of the usefulness of the function you tried.
- Would your team members like the concept of an agent working to help them, either online or face to face
- Were there any particular issues with the interface, any suggestions
- Comparing the rules the agent used with the ways in which you have allocated tasks

The rules I have programmed in are:

1. If someone likes X and is good at X, then allocate X to that person
2. If someone likes X, but says they are not very good at X, then allocate X with some tutoring
3. If someone is good at X, and has neither said they like or dislike X then allocate X to that person

What rules did you use?

- What other rules could you suggest?
- What other difficulties in teamworking might be helped by an agent function?

NB. Although focus groups should be free of any structure, a series of questions were used as prompts to keep the discussion going forward, and to add explanation of the researcher's interest as required.

Appendix 14 - Team Leader Interview Questions

Team Leader interviews - Introductory text used by the researcher

Thank you for using the Guardian Agent system with your team. This is part of the Guardian Agent research into a system designed to help support students undertaking team projects. The system was designed to support some of the maintenance roles of team working, as part of getting started on the project. I should be grateful if you would help me by answering some questions on how your team used the system.

Interview Questions to Team Leaders

1. Did your team use it?
Project generic skills to structure your team? Ground rules? Project specific skills?

2. Was it successful, in terms of your project?
Project generic skills to structure your team? Ground rules? Project specific skills?

3. How did you use the outputs?
Project generic skills? Ground rules? Project specific skills?

4. What did you think was good about the agent?
functionality? interface? implementation?

5. What did you think was bad about the agent?
functionality? interface? implementation?

6. What other functions do you think it could have to help your team project?

7. What did you think of the project generic skills pre programmed in the agent?

8. What did you think of the ground rules pre programmed in the agent?

9. What did you think of the project specific skills pre programmed in the agent?

10. Have you any other suggestions for this agent?

11. Do you think overall the agent system did help you as Team Leader?

12. Would you like to have the agent system available for Team Projects?

N.B. When the interview was used in Autumn 2003, the first three questions referred only to the system in general; the additional questions in italics were not used until the team leader interviews in Autumn 2004 and 2005.

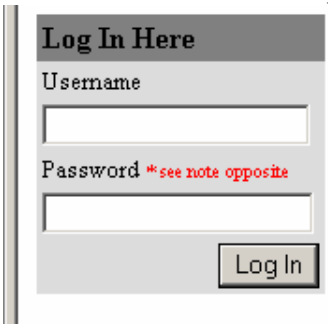
Appendix 15 - Team Member User Guide

Guardian Agent System
Team Member User Guide

This Agent software has been designed to allow a team of students to individually view tasks that need to be carried out to complete a project and specify their own preferences with regard to these tasks. The software then makes suggestions as to how to allocate the tasks amongst the team members. The software also allows team members to consider ground rules, which might be appropriate to their project.

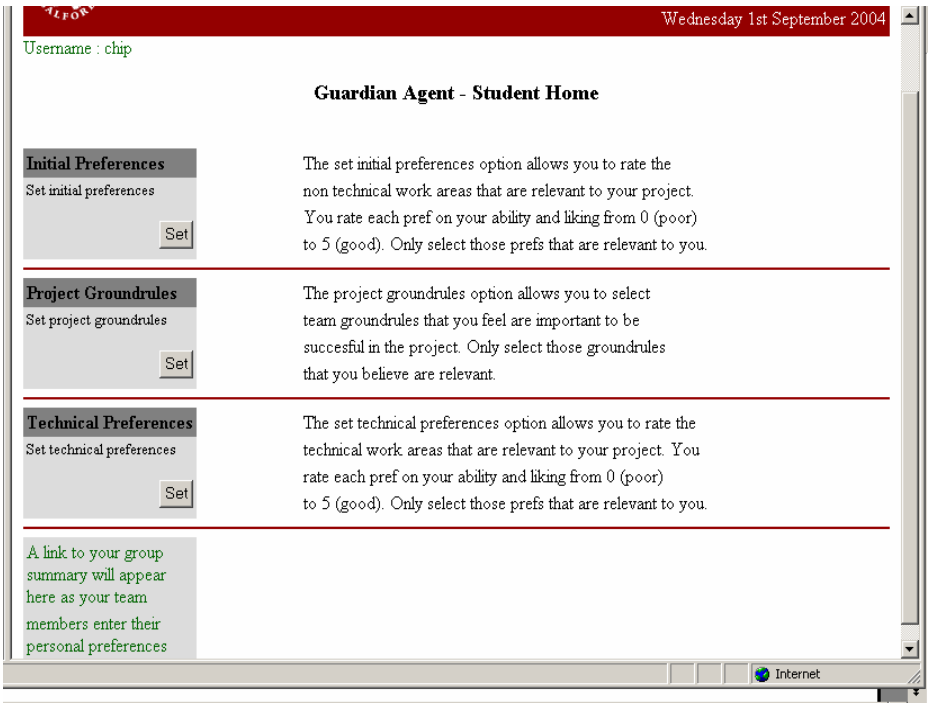
Login

When the software is run, a dialog requests the student's login name and password:



Enter the user name that you have been given, then click **Log In.** The next dialog will ask you to input your password. Please make sure that you remember this password, you will use this password to log in next time.

Following a successful login, the Student Home page is displayed.



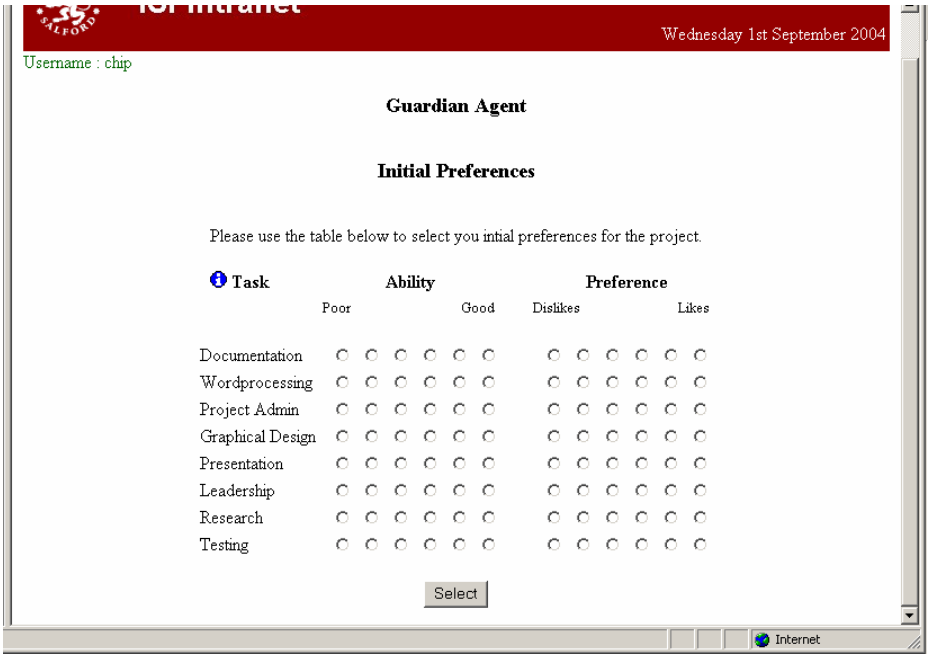
This display shows the 3 main functions of the agent system:

1. Choosing the generic skills you can offer to the project,
2. Choosing the ground rules you feel the team should work to,
3. Choosing the project specific skills you can offer.

Clicking on the Set button will take you to the appropriate part of the system.

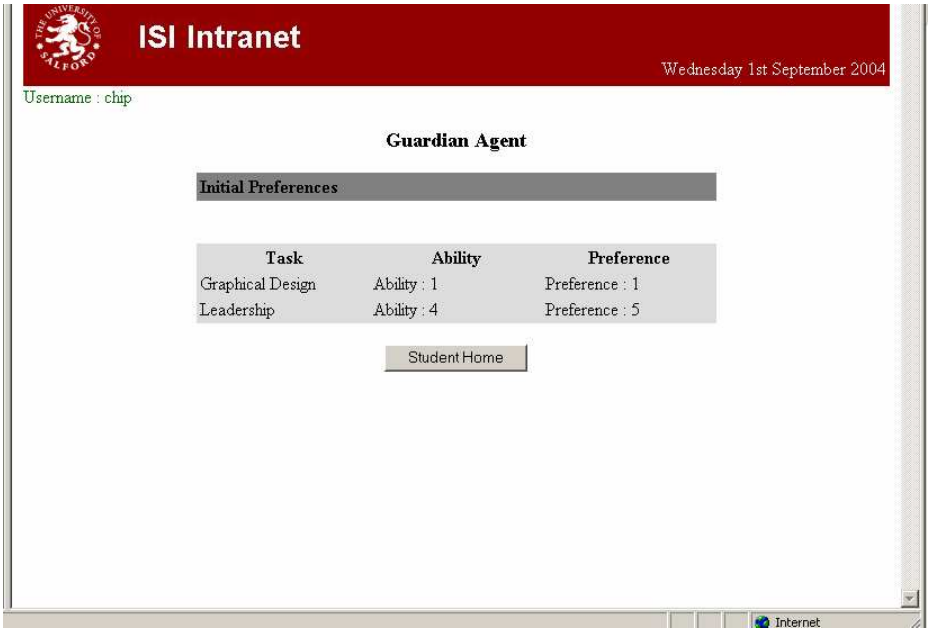
1. Choosing the generic skills you can offer to the project

The first selection you should make is the initial preferences of generic project skills:



For each task you should rate your ability from Poor to Good, by clicking on the radio button. Then in the same way rate your level of liking for that task. Consider each task in turn.

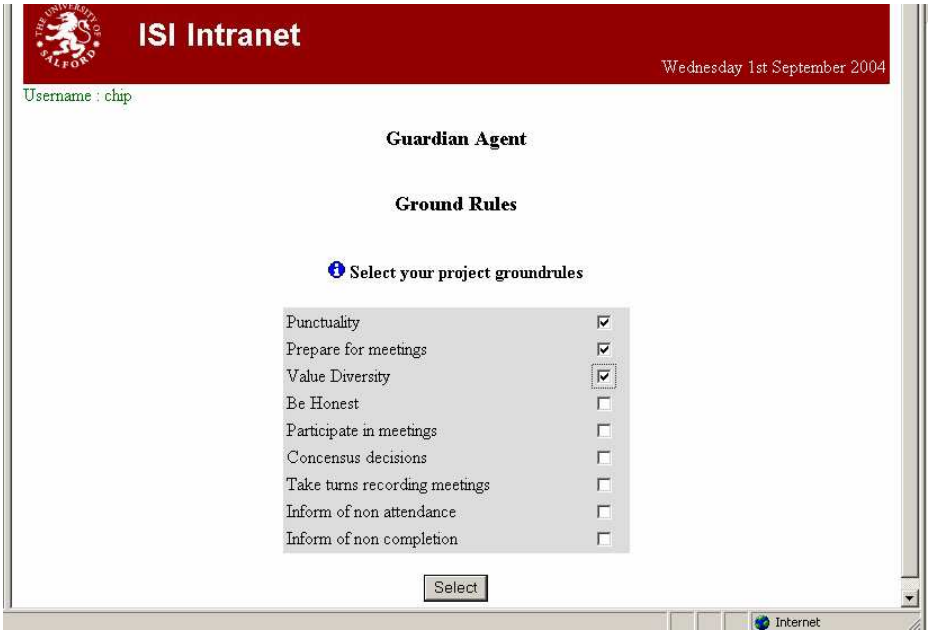
When you have completed the list of tasks, click the **Select** button to enter your preferences. A summary screen appears for you to check, then return to the **Student Home** page, shown below.



2. Choosing the ground rules for the team to work with

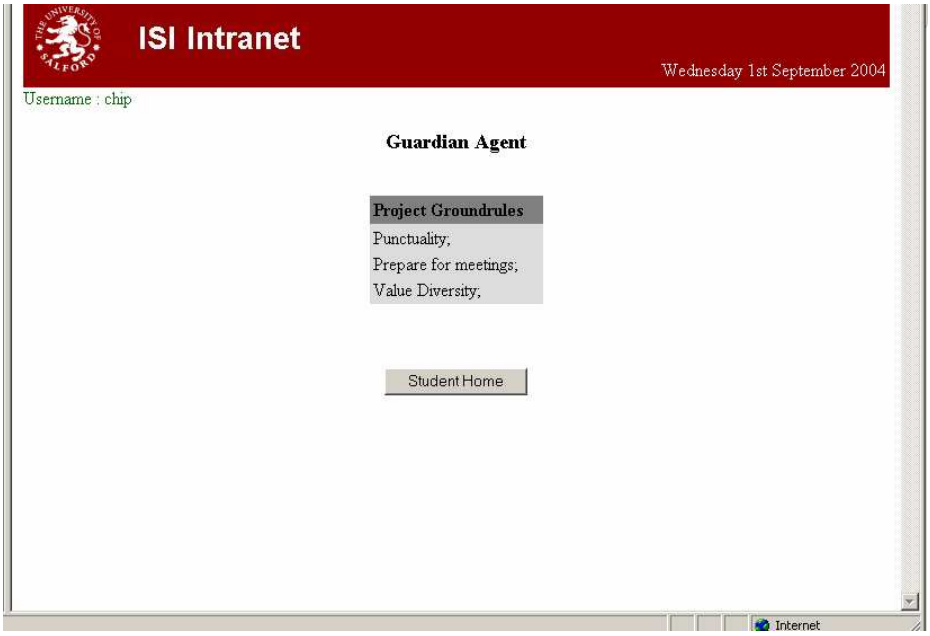
The next selection you should make is the ground rules you feel that a project team should adhere to in their day to day operation, in order to generate trust and cohesion among the team members.

Click on Set in the Project Groundrules section.



A list of possible groundrules is shown, for you to choose by checking the box. Choose the groundrules that you would like to see all members of your team follow, including yourself.

When you have considered the list, click on **Select** to save them. Again a summary of your choices is given for you to check.



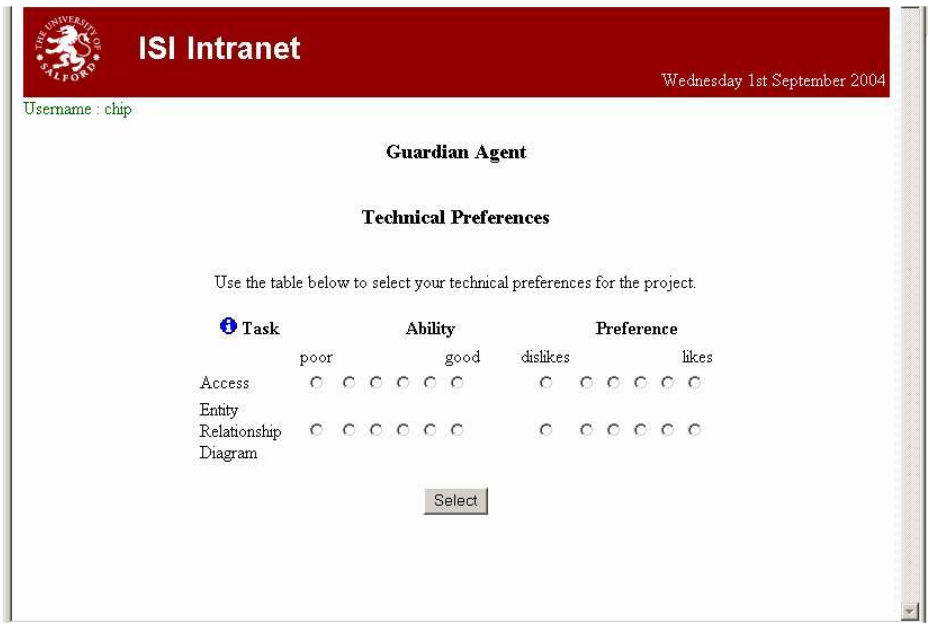
At this stage your team leader will advise you to wait until most of your team members have entered their preferences.

The team leader will, in consultation with the team, appoint individual team members to general roles within the team.

When the details of the team project have been identified, the team leader will set up the agent system with skills appropriate to your particular project. At this stage you should log into the system again to select your preferences.

3. Choosing the project specific skills you can offer

Click on the Set button for the Project Specific skills to take you to this part of the system.



In the same way that you chose the generic project tasks, you should consider the project specific skills. For each skill rate your ability from **poor to good**, and your liking from **like to dislike.**

When you have considered each skill, click on **Select** to finish. A summary of your selections will appear, for you to check.

The software advises recommendations as to which members should perform which tasks. It does this by taking into account which tasks each team member likes or dislikes, and is good or bad at. When most of your team members have entered their preferences, your team leader will consider the results in order to appoint each team member to a suitable task within the project.

It is your responsibility to be honest in your selections, so that you do not let your fellow team members down.

Making Allocations

The system has been designed so that the suggested allocations are processed when more than half of the team members have selected their preferences. In this way the team leader can start the job of team structuring even though not all team member have expressed their preferences. Finer tuning can then be made as the last team members use the system.

For your information the rules used by the Guardian Agent for generating allocations of tasks are:

Allocation of task -

If a team member likes X and is able at X
Then this team member should do X.

Or If a team member is good at X and has not expressed a dislike of X
Then this team member could do X

Allocation of tutoring -

If a team member likes X, but is unable at X
Then this team member could be offered training in X

The rule for suggesting acceptance of groundrules is:

If more than half of the team members think a rule is important,
then it is recommended for acceptance.