Chapter 1

STATEMENT AND ANALYSIS OF THE PROBLEM

> *Learning is no longer a separate activity that occurs either before one enters the workplace or in remote classroom settings – learning is the heart of productive activity. To put it simply, learning is the new form of labour.*
>
> Shoshana Zuboff, *"In the Age of the Smart Machine: The Future of Work and Power"* [1988]

Introduction

The accessibility of information, the result of the enormous growth of the Internet and Worldwide Web (allowing remote access to powerful computers, digital libraries and information in general) as well as the growth of access to these international networks have changed the approach to university education. This paradigm shift away from the mere acquisition of knowledge to the demonstration of competence and skills [Denning, 1993] must impact on learning. Surface-level processing of texts in which students take a **passive approach** to learning is fast becoming *passe* and will have to be replaced with the **active approach** of deep-level processing. The classical approach of lectures with little contribution from the class has now become inappropriate as students (with such an approach) merely focus on the reproduction of information. Critical thinking, reasoning and reflection should replace rote learning, as knowledge gained today is outdated tomorrow. And this is especially true of the field of computing.

Academic programmes in computing and related disciplines have been in constant flux since the first official curriculum, Curriculum '68, was published and endorsed by the Association for Computing Machines

(ACM) and the Institute of Electrical/Electronic Engineers (IEEE) Computer Society. Most recently there has been the Curriculum '91 report ("Computing Curricula 1991" – Report of the ACM/IEEE – Computer Society Joint Curriculum Task Force, ACM Press, 1991) providing recommendations for Computer Science, and the IS '97 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems, completed in 1995 and published in 1997 by the ACM, the Association for Information Systems (AIS), and the Association for Information Technology Professionals (AITP). At the 1999 Americas Conference on Information Systems held in Milwaukee, Wisconsin, USA, the Information Systems Centric Curriculum 1999 (ISCC'99) was presented [Lidtke *et al.*, 1999].

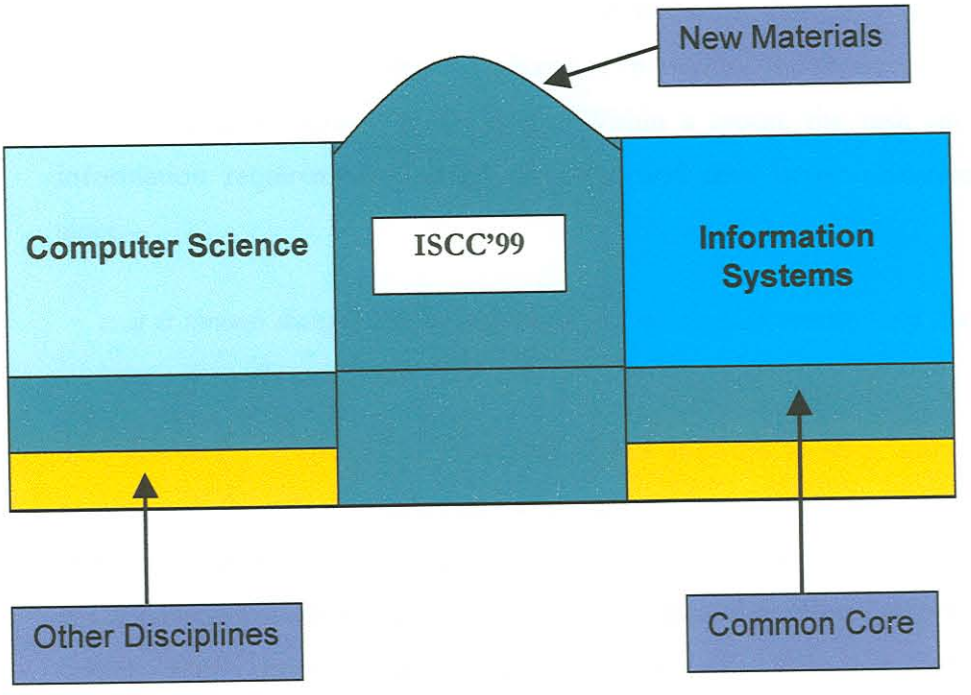

FIGURE 1: ISCC'99 [Lidtke *et al.*, 1999]

These recommended programme guidelines are applicable to existing and new degrees in Computing Information Science, Information Science,

Information Systems, Information Technology, Information Systems Specialists, Information Systems Engineering and related computing programmes. The relationship between Computer Science, ISCC'99 and Information Systems is shown in *Figure 1*. Contained in the **common core** are the courses IS'97.4 (Information Technology Hardware and Software which includes operating systems) and IS'97.6 (Networks and Telecommunications) underlining that topics such as operating systems and networks are common to all the above programmes.

Throughout this thesis, when reference is made to Computer Science, Information Systems or any specific part of the field of computing, the above more general meaning is intended.

Most work in the workplace is not done individually. Groups collaborate on tasks often because of the complexity of the task or the requirement for broader expertise [Olsen *et al.*, 1993]. Within a group, the task and its information requirements can be discussed and thus better understood, since –

> *...it is through dialogue that we accomplish and reaccomplish meaning, and thus bring order to the social world* [Boland, 1987: 366].

The formation of groups at university allows students to learn skills and concepts of the subject discipline, but groups also create the opportunity to learn about groups, thus developing abilities in co-operative work for later life. Students are adults - groups allow for an adult-adult relationship which brings about a more productive teaching and learning relationship between lecturer and student [Jaques, 1991].

This then is the background that needed to be sketched to establish **why** a **re-"think"** of the traditional teaching approach of subjects in the field of computing is necessary.

Framing the context

To frame the context of this study, it is necessary to tell the "story" of this longitudinal research effort. Even though the study was started in 1995 and is still evolving and continuing in 1999, it cannot be described as being longitudinal in the real sense of the word. Longitudinal research is defined as follows:

- Data is collected from the same group or population at more than one point in time.
- The variables are not experimentally manipulated. In short, the researcher has no control over the independent variables.
- Data is collected only; the researcher does not intervene in any way.
- And finally, the researcher may draw conclusions and attempt to find a correlation between variables by analysing the data.

To summarise, longitudinal research is ideal to research change over time in order to predict change in future [70]. The research methodology of this study is similar to a longitudinal research effort in the following ways:

- data was collected from the same population (students at UWC) at more than one point in time (from 1995 to 1999);
- it is a study where the investigator has practically no control over the dependent variables;
- and it was attempted to find a correlation between variables by analysing the data;

but the researchers did intervene in some ways. Thus the research cannot be considered to be nonexperimental and is therefore only a "*quasi*-longitudinal" study. In the account of the "teaching tale" I will adopt a confessional genre of representation.

The year this study was started, 1995, just over 50% of the student intake at UWC was African. The university was originally established in 1960 as an Afrikaans-medium university for so-called Coloured students but the student population has since evolved into a multicultural, multilingual population. The language of instruction is now by and large English; however, for most of our students English is still a second or even third language. Nearly all these students are first-generation university students. A small number will have come from well-resourced schools but most are from very poor families and with varying school backgrounds. Much of the schooling of these students will have been in an African language and school libraries, even access to a community library, will have been the exception [Hart *et al.*, 1996].

The initial idea to try group work with my third-year Computer Science students stemmed from my experience of lecturing to postgraduate students at a nearby business school. There the students were grouped into what was called a "syndicate", and they worked together as a group for the entire year of their Masters of Business Administration course. In many of their MBA courses, the syndicate had to produce a project which drew on the expertise from within the group and which would have been almost impossible to realise if it had been set for an individual student. Students in the MBA course are from a wide variety of backgrounds as the course is open to all postgraduate students. Thus it was not unusual to find a music graduate, a management science graduate, an engineer or even a professor of pediatrics in a syndicate, each bringing different expertise with him or her.

From course evaluation questionnaires I learnt that these students found the projects and presentations stimulating and challenging as these bridged the gap for them between the academy and business. It inspired me to apply the same concept here at UWC with the third-year courses I teach. I

believe that at third-year level students should have achieved the level of maturity to realise the importance of collaboration, as well as the establishment of working relationships with peers.

Thus in the third-year courses that I have been lecturing for several years now, I have always used group work as an approach to active learning. Students work in a group, constituting anything from three to six students, towards a combined goal such as presenting or writing a paper. Science students are seldom expected to write reports or verbalise their understanding of a concept. This is probably the reason they do not feel compelled to develop communication skills and why many lack the necessary skills needed to present or write a paper.

Students in a modern working environment will find that the knowledge gained at their tertiary institutions will mostly be insufficient to deal with unfamiliar challenges. This is the case for most students, but is **particularly** true for Computer Science and Information Systems students, since computer applications change very rapidly and knowledge gained today is outdated tomorrow. Therefore, it is unacceptable for students to memorize the prescribed work without the necessary understanding of the underlying concepts - it became apparent when students were examined that they could reproduce the prescribed text almost verbatim, sometimes inappropriately.

My decision to make group work an integral part of the courses that I lecture stems from the fact that I consider it to be important to foster and promote the acquisition of lifelong learning skills and to address the deficiencies of the traditional teaching methods. In the first semester of 1995 students were grouped into teams "geographically". That is: students who lived near to one another were grouped together to allow them to work together even when not on campus. In addition, I decided to enhance teamwork by introducing cooperative learning in the classroom.

Reginald Revans states in his model of Action Learning that knowledge which is a given can be acquired as individual (P-learning) by rote learning but that evolving knowledge is best acquired through interaction with colleagues "in adversity" (Q-learning) [Revans, 1980]. Olsen *et al.* are of the opinion that what is called for, is the analysis of group work to guide research of computer scientists on the aspects of technology that seem to impact most on the group interaction [Olsen *et al.*, 1993].

The cooperative learning approach I chose was that of Johnson *et al.* [1994]. According to Johnson *et al.*, five basic elements form the essential elements of **cooperative learning**:

Positive interdependence. Members perceive that they are linked in such a way that one cannot succeed unless everyone succeeds.

Individual and group accountability. The group is accountable for achieving its goals and each member for contributing his or her share of the work.

Promotive, face-to-face interaction. Students do real work together in which they promote each other's success by sharing resources, helping, supporting, encouraging and praising each other's efforts to learn.

Interpersonal and group skills. The acquisition of social, conflict resolution, management and leadership skills.

Group processing. This allows the group to reflect on how effective their team is functioning and if goals have been achieved, but also if relationships are conducive to effective group functioning [Johnson *et al.*, 1994].

In the second semester of 1995 Belbin's validated and standardised questionnaires were used to determine each student's psychometric profile. These profiles were then used to constitute so-called "balanced teams" based on Belbin's team-role theory. The students' lack of communication

and interpersonal skills, their inability to articulate the knowledge that they had gained and then possibly the way groups were constituted often resulted in students being excluded from their group, groups falling apart or groups not being able to deliver on time. When a team excluded a student, this student was literally "out in the cold" and had to present his or her own presentation as he or she would typically not be allowed to share in any of the team's achievements. Although I usually tried to mediate and intervene in such cases, the group in some instances were adamant that this excluded person did not contribute and therefore could not benefit from the group's efforts. There is obviously nothing wrong with this reasoning from the group's perspective but for the excluded student this can result in unnecessary hardship.

To understand why this sometimes happened and to try to prevent it, I drew on Belbin, who developed the **team-role concept**. He argues that to constitute an effective team, the team members of a team should *collectively* have certain intrinsic personality traits. Some of these traits should, however, not be duplicated amongst the team members as it could cause tension and consequently result in a dysfunctional team. He remarks that people need to know how they relate to others in order to succeed in establishing working relationships [Belbin, 1993]. In a similar study focusing on group work (teamwork) conducted by Michael R. Poppleton of Coventry (UK) over a 13-week period, it was found that students develop enterprise skills, team function and appreciation for each student's role within the team [Poppleton & Robinson, 1994].

The teamwork and cooperative learning of this study is thus based on a **combination** of insights derived from Johnson *et al.* [1994] and Belbin [1993]. The reader may now ask how these methodologies have been combined and implemented.

To facilitate cooperative learning in my classes, the five basic elements (of cooperative learning according to Johnson *et al.* [1994]) are discussed with the class:

Positive goal interdependence. The learners are told that they will truly cooperate if they feel that they will only succeed if everyone succeeds.

Face-to-face promotive interaction. Students are instructed to sit in a circle (face-to-face) and are encouraged to facilitate each other's learning in order to reach the group's goals.

Individual accountability. The students are told that each student will eventually be tested on his or her individual knowledge. Thus they will be tested individually on the work that was learnt within the group.

Social skills. Students are asked to respect differences within the group. They are instructed in ways to communicate effectively.

Group processing. Students are encouraged to reflect on the group's achievements and to find ways to improve their effectiveness.

According to Johnson and Johnson [1990: 30] –

> *People do not know instinctively how to interact effectively with others. Nor do interpersonal and group skills magically appear when needed. Students must be taught these skills and motivated to use them.*

Thus in order to achieve mutual goals students should be instructed how to communicate accurately and resolve conflicts constructively.

Groups were constituted with the aid of Belbin's team-role methodology. Belbin maintains that optimal team functioning is only possible once team members delegate tasks related to their personal weaknesses to other team members who have these skills as strengths, and when team members

accept responsibility for those tasks related to their personal strengths. Belbin identified these strengths and weaknesses as **team roles**. He maintains that each of the nine team roles has a distinctive contribution to make to successful team functioning. These team roles are summarised by Stoltz [Venter & Stoltz, 1995: 4] as follows:

The **Plant** should do most of the problem-solving or be responsible for generating any new strategies or ideas and proposing solutions to the rest of the team.

The **Resource Investigator** should be responsible for developing outside contacts and exploring any new opportunities. The Resource Investigator needs to be given a chance to conduct negotiations.

The **Co-ordinator** may be the last person to co-operate group effort, ensure that everyone has a useful role and that the team works towards a common and agreed goal.

The **Shaper** is the person best suited to overcoming obstacles and opposition, creating a sense of urgency and ensuring that talk is turned into worthwhile action.

The **Monitor Evaluator** should be made responsible for ensuring that all worthwhile options are considered by the team, needs a key role in planning and can act as an arbiter in the event of a controversy.

The **Teamworker** should play a floating role, using his/her versatile qualities to help with any features of the work that others cannot manage. The Teamworker has diplomatic skills which should be used to overcome conflict.

The **Implementer** should be appointed as the organizer, responsible for procedures and practical steps to be taken once the team reaches significant decisions.

The **Completer-Finisher** should ensure that the team's work meets the necessary deadlines and conforms to the highest standards, and should be responsible for ensuring that there are no inaccuracies or errors.

Belbin does not allocate a specific team task for the **Specialist**, because when a person operates in this mode, he/she tends to be a solo performer. However, it should be remembered that each team member usually has more than one strength (team role) and therefore the Specialist does not need to be excluded from the team.

Furthermore, a team need not consist of nine members only. According to Belbin, a team of three or four members can also be very successful if their collective dominant roles represent the nine team roles.

Although Johnson *et al.* [1994] also mention categories of roles that can be *assumed* to enhance team performance, roles such as:

- Forming
- Functioning
- Formulating and
- Fermenting

the Belbin approach in which team roles are *identified* by psychometric tests and are allocated to each team member in line with his/her intrinsic personality traits, was the preferred method for role allocation in my own class.

The Computer Science major in 1995 consisted of four blocked modules. The subject Operating Systems was lectured in the first part of the first

semester and each team had to present a short paper on new developments in the computer environment after the short midsemester recess. For the second semester module (Communication and Computer Networks) the teams were expected to set up a small network as a practical, but also to write a project on the acquisition of a small network for a fictional (or real) company. Finally each team had to give a short (10-minute) presentation on how they tackled the project, difficulties experienced, and why they decided on certain products. The tasks set for the team are almost impossible to attain individually, thus making the team effort imperative. Cooperative learning was used to share personal insights gained through individual learning. Thus each student learnt or read through the work before attending the class so that they could share their insight into the work with the group in a group situation. This was done for the purpose of conceptual insight but also to foster effective oral and written communication.

Qualitative data on the study was collected in the form of interviews (using Schön's "Reflective Conversation" protocol [Schön, 1983]), evaluation questionnaires, minutes of team meetings and field notes. Quantitative methods were used to analyse a questionnaire administered each semester from the second semester of 1995 onwards.

In both semesters of 1995 and the subsequent years of the study (1996, 1997 and 1998), the lectures deviated from the traditional presentation style. Students were expected to come prepared to class and were seated in their respective teams/groups (see *Figure 2*). The groups had to discuss areas that they found problematic. If none of the team members could provide a satisfactory explanation for the problem, the team could call upon the lecturer who would then give a brief presentation-style lecture on that particular section of the work.

To prevent students from rote learning the study material and to help students to get the "overall picture" and not to get bogged down by all the technical detail, the concept of "mind mapping" was introduced. (A mind map is a clear and concise graphical representation of relevant, associated, categorized and hierarchically ordered information.) Students were expected to brainstorm a section of the work and to produce a mind map as a group.

FIGURE 2: Students seated in their respective teams

The use of mind maps was first advocated by Tony Buzan. In his book "The Mind Map Book" he devotes a chapter to the group mind map.

In it he says that it is –

> *... extremely beneficial to work in a group, rather than studying alone, and to engage in active conversation about the material you are studying, rather than studying in silence -- very active verbalising leads to greater efficiency in the processing of the information, and to a greater recall.*

He contends that –

> *...working with others will result in the unique perspectives and associations of each individual contributing to a greater overall mind map and a much more comprehensive and integrated learning* [Buzan, 1995].

In all the years of the study (1995 – 1998) I have used cooperative learning, teamwork, mind maps and a more informal class situation to study the effect it had on the individual's perception of the work, but also to broaden the students' learning experience.

The group mind map could be used during the writing of tests. For the final examinations each group/team was therefore allowed to use their own two mind maps (both sides of an A4-sized paper) which covered all the work.

Team functioning did not always go smoothly, even though Belbin's method was used to constitute so-called balanced teams from the latter half of 1995. During interviews of the 1995 cycle, students indicated that teams gelled sooner in the second semester (when Belbin's team-role theory was used to constitute teams) than they did in the first semester (when teams were constituted geographically). This could be ascribed to the fact that the students had gained some experience in teamwork during the first semester and could therefore adjust sooner to the new teams. Or it could be that by using Belbin's theory in the second semester the teams were more balanced and therefore team functioning was more harmonious. It was interesting to

note that a student who was excluded in the first semester of 1995 (when teams were constituted on a non-Belbin basis), had no problems with the new team in the second semester (when Belbin's method was used). Another student had problems with both his teams, during the first semester as well as in the second semester of 1995. Most students (during this longitudinal research effort) indicated that they found the team-role profiles uncannily true. Some had their reservations but the majority indicated that they gained new insights into themselves and it made them realise their strengths and weaknesses.

The introduction of the group mind map was received very well. At the start of each course the mind maps were not inspiring at all, but as the groups/teams developed, their mind maps became more interesting. Eventually most teams produced excellent mind maps (see *Figure 3*). In the interviews students commented that the mind maps, but also the presentation of the mind maps by other teams, especially the repetition, helped them with the understanding of the underlying concepts. I found that the students attended classes regularly, perhaps because of a feeling of responsibility towards the group or possibly because they had to produce mind maps each week for presentation.

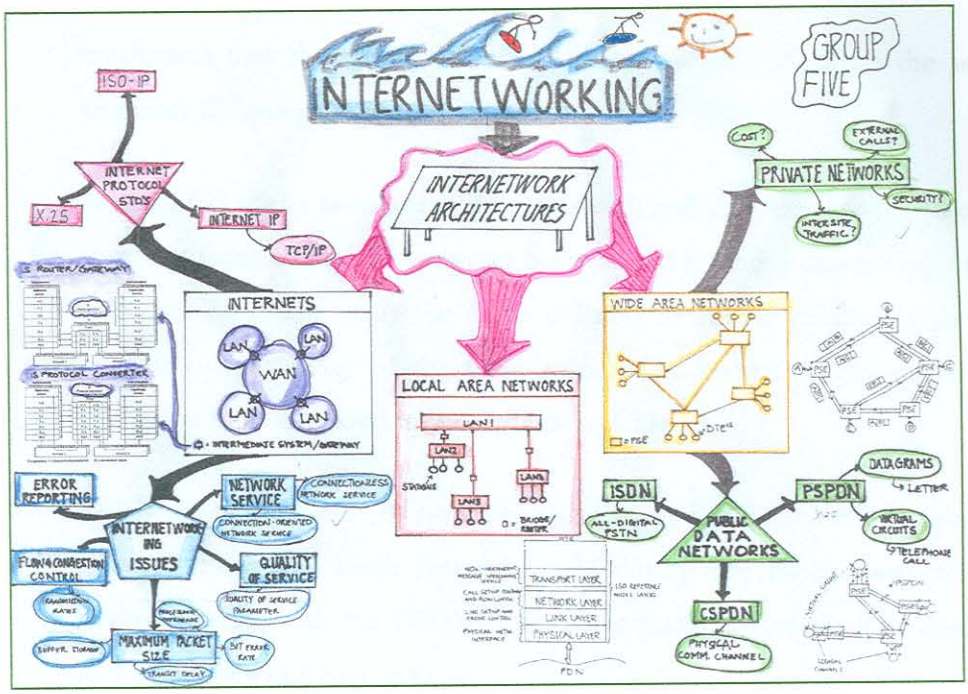

FIGURE 3: An example of a group's mind map

As this method of teaching seemed to be effective it was continued with slight adjustments in the next cycle. For example, Belbin was now the preferred method used to constitute the teams and the number of formal lectures was reduced. In the 1996 cycle it was decided to use a self-administered questionnaire to collect quantitative data to complement the qualitative data (only qualitative data was collected in 1995).

In the second semester of 1997 my colleague, who teaches Statistics and who helped me with the quantitative analysis, decided to implement this teaching method with her class as well. She had already lectured to this specific group using the traditional "chalk-and-talk" method during the first semester of 1997 and we were interested to see how the class would adapt to the group method. In this case study the lecturer, the class (student body) and the subject remained constant and it was the ideal opportunity to see if the new method had any academic merit. Our quantitative data

confirmed that the students in fact did significantly better in the second semester [Blignaut & Venter, 1998b: 6].

In the 1998 cycle, assessment was reviewed, and data was again collected – this time from both the Computer Science and Statistics classes. The team-role data of all the years has been collated to enable reliable quantitative analysis on groupings of the team roles. The results of this quantitative analysis will be discussed in more detail in Chapter 4.

This then is the "tale" of how the study started and how the longitudinal research evolved. Each research cycle during the longitudinal research period, starting with the 1995 first semester research cycle, will be discussed as a case study in Chapter 4.

The specific problem studied

At UWC (and now probably at most universities in South Africa) students are linguistically and culturally diverse and their prior educational backgrounds and experience are often not on par. For example: some of the students that enter for a first-year Information Systems or Computer Science course would have done Computer Studies at school whilst others would have had very little or no exposure to computers. This educational backlog is most pronounced in the first year but is mostly eradicated by third-year level. However, only a small percentage of students reach the third year within three years. The majority of students take four or more years to complete a three-year degree. In the 1998 research cycle 67.8% of the third-year students had been registered for four or more years and many of these students did not complete their studies in 1998, but were still – in 1999 - in their third academic year.

Teamwork was initially introduced in the third year of the Computer Science course (at UWC) to enable students to complete large tasks which required broader expertise. These teams were often observed as being

ineffective and disrupted by an imbalance of personality traits. However, it would be simplistic to place all the blame for dysfunctional teams on the imbalance of personality traits. Most of the students do not speak English at home and therefore they find it difficult to verbalise their understanding of concepts in English. This inability of some students to express themselves well in English contributed negatively to their team function in that it sometimes created the impression that the student did not understand or was "slow" in understanding the subject matter. Furthermore, students with a poor use of English resort to verbatim studying of the text, as they do not have the vocabulary to express their understanding in words other than those that appear in the text.

The "dated" method of lecturing exacerbates this inclination to memorise material, as students are never expected to communicate in the language of the subject, but rather to be passive listeners. The half-life of the contents of most subjects is diminishing and thus learning, just to stay abreast of events, is increasingly becoming an occupation for everyone [Kolb, 1984]. To memorise chunks of information is thus totally counterproductive. The exponential growth of knowledge requires of the "*learning species*" to *learn* to adapt to a changing world. Students should thus rather learn to learn and come to grips with new material quickly than to "*accumulate a storehouse of facts*" [Kolb, 1984: 26].

Since many students resort to verbatim studying of the prescribed text, it was felt that cooperative learning could foster more effective oral and written communication and thus limit the need for memorisation. According to Craig –

> *Dialogue, conversation, debate, discussion and argument among peers seem a neglected and yet an obvious move in the case of unprepared students* [Craig, A.P., 1989].

It could thus be argued that cooperative learning, where students are expected to converse with peers, is a more desirable teaching method for these students who typically come from varied academic and socioeconomic backgrounds. However, cooperative learning requires of teams to spend more of their time working together. It becomes more important therefore to constitute *balanced* teams, or rather, teams that function effectively and where the team members interact efficiently.

Research questions

The specific problem of group constitution for small group learning in the field of information technology raises some research questions, which will be raised now. In Chapter 3 it will be shown *how* these questions were derived and *why* they are important. The research questions are addressed throughout Chapter 4 and are revisited in Chapter 7.

Team constitution

How should teams be constituted? Should it be fluid in the sense that teams change for each setting? Can teams be put together in such a way that learning/work is enhanced and not influenced by team dysfunction?

According to Johnson *et al.* [Johnson, 1994] there is no ideal group membership. They are of the opinion that a group's productivity *"is not who its members are, but rather members' teamwork skills"*. And these skills can be acquired through training. They do, however, give consideration to the group's diversity and feel that there are advantages to heterogeneous groups in some cases and advantages to homogeneous groups in other cases, depending on what needs to be achieved. When students group themselves, they usually form homogeneous groups – if the lecturer forms the groups it may be either.

Jaques [1991] is of the opinion that as the size of a group increases, its characteristics become more fixed. For instance, in large groups positive leadership is vital to success.

In this study several methods of team constitution have been investigated. Teams were initially constituted to allow students in geographical proximity to work together even when not on campus. These teams, however, often fell apart because members never gelled into a synergistic team. (Senge is of the opinion that a synergistic team reinforces or changes groupthinking patterns effectively. When team members discuss notions and assumptions, a deeper understanding and insight may result [Senge, 1990].)

To remedy the above-mentioned shortcomings in team construction, teams in the latter part of the study were all constituted using Belbin's team-role theory. Belbin's validated and standardised questionnaires (a self-assessment as well as the minimum of four observers' assessment questionnaires) and the software Interplace IV, were used to determine each student's psychometric profile. These profiles (without any reference to either gender or academic achievement) were then used to constitute so-called "balanced teams" based on Belbin's team-role theory. In the current application of Belbin's method of team constitution, care is taken that students within groups are academically diverse (thus that there is a good mix of high achievers and low achievers in a team).

Belbin, who developed the team-role concept, identified nine team roles, each with its associated strengths and weaknesses. He argues that to constitute an effective team, team members should *collectively* have certain intrinsic personality traits. Each person's profile will be a combination of these roles; therefore a team need not consist of nine members to be balanced [Belbin, 1993].

A consultative session is used to explain to students why they are grouped in a particular way; at the same time feedback is given to each student on the psychometric tests conducted. It is made clear to them that in their work environment they will not necessarily have a choice with whom they want to work. Time is set apart in the course to explain the underlying concepts of teamwork as well as cooperative learning (as defined by Belbin and Johnson *et al.*) to the class. It is emphasized that they will probably gain insight into the role they will be able to play in a team and will gain personal growth through this exercise. Each student receives a summarised report of his/her rating of himself/herself compared to the ratings of his/her four observers and a final weighted rating indicating his/her dominant team roles. They receive a further personalised report, which highlights the student's traits that will positively contribute to a team as well as his/her allowable weaknesses within the team.

In general, our teams have five members, with the odd exception where a team will consist of six members. The size of the team is mostly determined by the size of the class and the available resources such as computers, etc. A group size of six is considered to be the largest group where leadership can be fluid or where it can be democratically shared among the members of the group. Democratically-led groups, compared to authoritarian-led and *laissez-faire* groups, although slower in getting into production, are believed to be more motivated and productive with time and learning [Jaques, 1991].

Teams will be a unit for the period of instruction. This period is usually a term - approximately seven weeks - or a semester - thirteen weeks. Johnson and Johnson [1994] refer to such groups as "formal cooperative learning groups", as opposed to "informal groups".

It is felt that this longer period will allow the team to develop the required elements of cooperative learning as suggested by Johnson and Johnson [1994], namely:

- Positive goal interdependence
- Face-to-face promotive interaction
- Individual accountability
- Social skills
- Group processing.

Similar to the Belbin team roles, Johnson *et al.* also mention categories of roles that can be assigned to team members, namely:

- Explainer of ideas or procedures
- Reader
- Recorder
- Encourager of participation
- Checker of understanding
- Observer
- Support giver
- Clarifier/Paraphraser, etc.

Students are instructed in the use of social and interpersonal skills such as **forming** (staying with the group, using quiet voices), **functioning** (contributing, encouraging others to participate), **formulating** (summarising, elaborating) and **fermenting** (criticising and asking for justification of ideas). Each of these skills has its associated roles. The rationale of assigned roles is that team members get the opportunity to develop a variety of skills. (Different skills are needed for each of the roles.)

However, these roles, as advocated by Johnson and Johnson, are assigned to students arbitrarily and in a "role-playing" mode. In contrast, Belbin team roles are the roles assumed naturally by a team member. It is "natural" in that it is the role he/she will normally assume in a group and it is in line with his/her intrinsic personality traits.

Formal/informal lecture ratio

How often should discussion groups/teamwork be alternated with plenary sessions and formal lectures to make learning successful?

Although students need to accept responsibility for their own learning and group work is the ideal environment for the fruition of this ideal, formal lecturing can still be of value when in certain cases the whole class has problems understanding a section of work. Plenary sessions allow groups to share comments with other groups on problematic topics or topics of shared interest.

A plenary session and formal lecture are scheduled for approximately 20% of the total lecture time. Plenary sessions will be used only to clarify work that is not understood in the group sessions. This may be subsequent to the group discussions or it could also be anticipated that a section will be difficult to grasp. It is being recognised that tertiary education is not solely the ability to understand, analyse and know the subject material, but also the ability to communicate, apply and interpret the material. These skills can best be acquired by practising [Jaques, 1991]. Talking about these skills, as would be done in a formal lecture, is therefore not ideal. Small group learning is a vehicle to transfer these abilities and to aid learning in more than the perfunctory sense.

Students who experience this teaching method for the first time in their second or third year at university find it difficult to adapt. However, with careful monitoring, the majority find the method satisfactory once they are

accustomed to it. They experience small group learning as a more mature approach to learning.

Successful learning

What could be considered a successful learning experience? Perhaps the following quote says it all:

> *The things we know best are the things we haven't been taught.*
>
> Vauvenargues, "Reflections and Maxims" [1746]

Ross is of the opinion that while most learn easily, many find it difficult to be taught –

> *All normal, healthy children learn happily and naturally, yet schooling no longer builds on this* [Ross, 1997].

If students can nurture their individuality and build on their talents and achieve this in an informal way, learning can be considered to be more natural. Can informal learning therefore be considered a successful experience? According to Kolb, we will have to –

> *...cast our lot with learning, and learning will pull us through*

– if we want to keep up with a rapidly transforming world.

> *But this learning process must be reimbued with the texture and feeling of human experiences shared and interpreted through dialogue with one another* [Kolb, 1984: 2].

Unfortunately the reality is that daily school and university practice is "*learning to the test*" and students usually equate successful learning with high scores [Dochy & Moerkerke, 1997]. It is therefore important to investigate the "real" definition of a successful learning experience.

Measuring "success"

According to De Villiers [1996b] the success of cooperative learning depends on the ability of learners to teach each other. However, how is this measured?

Cohen, on the other hand, suggests that the productivity, effectiveness or successfulness of teamwork and cooperative learning can be measured using the following criteria [Cohen, 1994]:

- Academic achievement – this type of achievement stresses basic skills such as memorisation of factual materials
- Conceptual learning and higher-order thinking - stresses learning through thinking
- Equity or equal status within the group – this is typically measured by noting the participation rates of students of differing statuses
- Positive intergroup relations (in a multi-ethnic setting) and desirable prosocial behaviours such as being cooperative and friendly.

Assessment

A new teaching paradigm necessitates new assessment instruments. But how should students then be assessed? Johnson *et al.* suggest involving the students in the assessment process. This can be implemented as peer evaluation and can be used in conjunction with the lecturer's evaluation. However, it is accepted that students gear their learning according to the method of evaluation. If evaluation is a written examination, students tend to work through previous papers, giving rise once again to rote learning.

Dochy and Moerkerke are of the opinion that assessment should be integrated with learning and instruction. Reform in assessment leads to changes in instruction [Moerkerke, 1996], but the opposite is also true - changes in instruction will lead to changes in assessment.

Raters and candidates need to know the criteria of assessment and the rater needs to give a rating which is valid with respect to the skill being assessed [Dochy & Moerkerke, 1997]. There is thus a need to reconceptualise assessment instruments. The question that can be raised is thus: what evaluation method reflects learning best?

New types of evaluation instruments are required that allow the assessment of understanding (or misunderstanding) as well as the differences in learners' approaches to challenging learning situations [Dochy & Moerkerke, 1997]. On the other hand, do present structures of examinations adequately test the dimensions of learning we wish them to?

Conclusion

In the first chapter of this thesis the "story" of a longitudinal research effort has been told. (The study cannot be considered a true longitudinal study as the definition of a longitudinal study rules out any intervention implemented. However, the research was done over a long period, namely from 1995 to 1998.) The "story" of the study paints a picture of how a linguistically and culturally diverse student population can be drawn together and accommodated by a different approach to the teaching of subjects in computing. This approach included teamwork, cooperative learning, mind maps and a methodology of team construction designed by Belbin. The problem areas that necessitated a new approach, namely underprepared students, the language barrier, the "dated" method of lecturing and verbatim studying, were stated and analysed.

In the second chapter, the literature on teamwork, cooperative learning, learning styles, mind maps and assessment will be discussed. The research approach used in conducting the five case studies (which will be discussed in Chapter 4) was that of Checkland and Scholes [1990]. This methodology, as well as the grounded theory approach, is presented in the

third chapter. The research problem is revisited as case studies in the fourth chapter. Each study period (considered as a case study of a particular intervention) with its quantitative and qualitative results will be stated and explored in more detail in this chapter. In Chapter 5 the results, obtained from the case studies, will be inductively interpreted. Chapter 6 contains the results of this induction in the form of a framework. Finally, in the last chapter, the findings and the contribution of the research are evaluated.

It should be noted that no claim is made that the results of this study are particularly relevant to the field of Information Technology rather than any other discipline. The researcher happened to work in the field of Information Technology, where the research problem presented itself. The case studies should also be seen in this light: not planned to represent the or a discipline, but rather to help the researcher gain an understanding of the problems related to group constitution for small group learning.

These practicalities implied that the researcher did not "plan" a longitudinal action research programme, but rather utilised elements of action research during the series of cases studied from 1995 - 1998.