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Abstract

Innovative teaching methods such as collaborative learning, teamwork and mind maps were introduced to a Statistics course at tertiary level and compared to traditional teaching methods. These innovative teaching strategies, which are considered generic and therefore applicable in any educational environment, proved to be successful. Collaboration and teamwork is an important factor in the development of lifelong learning skills. An adapted version of Soft Systems Methodology was used to manage the research process.

1. Introduction

The concept of “Life Long Learning” can be interpreted in many ways. It can be defined as the ability to adapt to and be prepared for an ever changing world implying the attainment of skills and attributes to become lifelong learners. This will necessarily have to include the acquisition of skills to access large repositories of, mostly electronically stored, information. To put it in a nutshell: “... learning is the new form of labour”[12]. The philosophy of life long learning must impact on the way classes are conducted in educational institutions.

A different teaching style, incorporating teamwork and cooperative learning, was adopted to promote life long learning skills, empowering the student to play an active role in his/her education. Learning in smaller groups is believed to promote both the development of communication skills and to help students to express themselves in the language of the subject. This study tries to understand the effectiveness of small group learning compared to the chalk-and-talk lecture method.

Small group learning was initially applied in Computer Science courses at the University of the Western Cape (UWC) and students reported positively on this new approach to learning [10]. It was therefore decided to expand the study to incorporate students from another scientific discipline in which computers play an integral part, namely Statistics.
The majority of our students come from disadvantaged backgrounds. In a South African context this inter alia means that:

- Many schools (38%) have no access to a telephone;
- 43% of all schools do not have electricity and
- Only 41% have water on the premises.

(Quoted from a survey published 1997 [2]).

For many of our second year Statistics students, this course is their first encounter with computers. It is thus not surprising that many UWC students find it difficult to become acquainted with technology and its terminology. A further impediment is the medium of instruction (English) which is not a home language for the majority of students. Due to these background disparities, it was postulated that students should benefit by incorporating cooperative learning and teamwork as a teaching strategy. Discussion groups allow students to explore their understanding of the work and can also improve language proficiency as Lotan and Benton experienced with Spanish-speaking Americans [7].

Research in education can be described as an endless cycle of experience leading to purposeful action. We have drawn on Soft Systems Methodology (SSM) to manage our research process[11].

SSM (as described by Checkland and Scholes [4]) is:

"an organized way of tackling messy situations in the real-world. It is based on systems thinking, which enables it to be highly defined and described, but is flexible in use and broad in scope."

Qualitative and quantitative (a self-administered questionnaire) instruments of measurement were implemented. Both these instruments were used as it was felt that research in education can be compared to a naturalistic study where inquiry demands a human as instrument, adaptive to an indeterminate situation. Qualitative methods, such as interviewing [9], observing and taking note of nonverbal cues, come more easily to the human-as-instrument. However the quantitative paradigm creates additional opportunities for the naturalistic investigator to obtain information [6]. By combining these measuring instruments it was felt that the research findings would be more comprehensive.

Students achieved significantly higher marks in the course in which group learning was implemented. They reported a gain on personal and social level and in general they enjoyed this more mature approach to learning. It thus seems as if this teaching strategy has merit.
2. Design and Method

The advent of 1997 posed an appropriate opportunity to compare the methods of chalk-and-talk teaching and cooperative learning, as some of the important variables (such as the lecturer and student-body) would remain constant for the duration of that year. The conventional chalk-and-talk method of teaching was used to instruct second year Statistics students during the first semester of 1997. At the beginning of the second semester, these students were allocated groups (i.e. “balanced” teams) of five to six members on the basis of their individual team-role profiles as identified by Belbin’s Interplace software. (The development of this application is based on his extensive research on the functioning of teams [1]). Past experience in the management development arena signals the need for carefully constructed teams in the learning environment as the learning experience of many teams has been observed as ineffective, and often disrupted, by an imbalance of personality traits. In an effort to control this variable, it was decided to use Belbin’s team-role methodology to construct the teams. (Belbin argues that no one person possesses all the qualities needed for optimal problem solving, but that the members of a well-constructed and balanced team collectively should display all the needed qualities. Belbin further argues that the repetition of traits in the same team can lead to (amongst others) disruptive arguing, excessive conflict and groupthink [1]). Students were provided with feedback on their team-role profiles and the role that can be played by each team member was explained. Following this, the principles of effective team functioning and cooperative learning were introduced.

Learning in teams at university enhances the acquisition of skills related to, and internalizing concepts of the subject discipline in a more relaxed atmosphere. This approach also exposes the students to group dynamics, thus developing abilities much needed in adult and work life. Furthermore, learning in team situations enables the student to recognize and appreciate the individual team-role strengths and weaknesses of fellow team members, as well as those of the self [1]. It is our understanding that knowledge of own team-role strengths and weaknesses empowers the individual to optimize his/her learning experience, because the individual is then more prepared to listen actively to the contributions of others and expresses personal opinions more confidently.

In cooperative learning situations, students do work together in teams and can draw on the strengths of one another to complete assignments. To facilitate this, students were expected to prepare prior to team sessions during which they discussed their understanding of particular aspects of the work.
Students were also expected to brainstorm a section of the work in order to produce a mind map (a graphical presentation of relevant, associated, categorized and hierarchical ordered information [3]). All participating team members could use this (A3-sized) mind map during written examinations.

An encompassing chalk-and-talk lecture was presented at the beginning of each week. All other periods and tutorial sessions were used for teamwork activities. Each team completed a weekly assignment and a fortnightly computer practical assignment. These were marked to provide feedback to the students and contributed to their continuous evaluation mark.

Both qualitative and quantitative instruments of measurement were used to collect data. The quantitative method used, entailed the use of a self-administered questionnaire. Unstructured interviews using Schön’s Reflective Conversation Protocol [9], the lecturer’s field notes and students’ e-mail messages, were used to collect the qualitative data.

3. Results

3.1 Quantitative Research Findings

Fifty two students attended the Statistical courses. They were from varied cultural and socio-economic backgrounds. Their home languages were: Xhosa-, English-, Afrikaans and other African languages such as: Zulu, Sotho, Ndbele, etc. (See Figure 1).

![Language Distribution](Figure 1: Mother tongue distribution)
To clarify, we should perhaps mention that until 1994, Afrikaans and English were South Africa’s official languages. The only recent recognition of African languages as official tongues, has not yet translated into the local availability of an abundance of academic literature in all official languages.

Although English is the medium of instruction it is the second, or even third language, for 63.5% of the students. It is thus not surprising that most significant differences were found when the different language (cultural) groups were compared. Due to similar mark profiles the English and Afrikaans speaking students were grouped together and compared to the African language speakers. When comparing the African home language students with the others, it was found that they obtained significantly lower marks in the second semester Statistics module (Mann-Whitney tests p=0.0026), Matric Mathematics (p=0.0001) and Matric Average (p=0.0017). (Matric is a school leaving certificate).

Eighty six percent of students indicated that they enjoyed cooperative learning and teamwork. Sixty eight percent of the students said that working in a group improved their self esteem. Only 14% said they preferred conventional (chalk-and-talk) lectures to this method of lecturing. Fifteen percent found it difficult to express themselves in English, as well as to grasp concepts due to language barriers. Ninety eight percent said the lecturer's attitude was positive when approached. Eighty eight percent said they were always well informed of what was expected of them. Ninety percent felt that enough opportunity was given to discuss problem areas with the lecturer.

Eighty two percent reported that they almost always attended lectures - we found this quite remarkable. Team functioning requires students to be prepared and especially to be present, but only ten percent said they had read the relevant sections before attending class whilst 57% said they only prepared occasionally.

In both semesters the male students (42.3% of the class) outperformed their female counterparts in the computer examinations. Nineteen percent of all students used their own computer at home, fifty percent said they used e-mail and the Internet was accessed regularly by 27% of the students. Students with a non-African mother-tongue accessed the Internet more regularly (Fisher’s exact test p=0.0058).
The majority of students (See Figure 2) accepted the individual team-role profiles.

![Belbin team-role concept](image)

**Figure 2: Acceptance of team-role profiles**

Although the entire group reported positively on mind maps (See Figure 3), more of the African language students felt that mind maps increased their understanding of the subject (Fisher’s exact test $p=0.045$) and students enjoyed the creation of these mind maps more (Fisher’s exact test $p=0.021$).

![Mind Maps](image)

**Figure 3: Acceptance of the use of mind maps**
In 1997 a significant improvement was found when comparing the final marks of the first semester (Talk-and-chalk method - STA215) with those of the second semester (team, cooperative learning method - STA225) (Paired T-test = 5.647, p = 0.0001) (See Figure 4). A similar trend was noted when comparing the marks of 1994 and 1995, although the improvement was not statistically significant. Only first and second semester marks of students enrolled for both semesters were compared and then only in cases were the same lecturer presented both courses.

We would like to believe that the significant increase in academic achievement in 1997 can be ascribed to teamwork and cooperative learning. It should be kept in mind that dimensions of learning such as lifelong learning skills are not adequately measured by conventional methods such as written examinations.

![Figure 4: Box plot of final marks for 1997](image)

### 3.2 Qualitative Research Findings

#### 3.2.1 Interviews

To obtain additional information, interviews (using the “Reflective Conversation” protocol [8]) were conducted with two members of each team.

It transpired that language was definitely a hurdle:

“…I had a problem when it comes to submitting it in English …”
Students indicated that they now reflected more on their learning,

“...you develop your own understanding.”;
“...it summarises your work ... so, ... tend to understand it, ... it helps a lot”

preferred active learning and creating mind maps,

“...while doing the mind map actually you are discussing it and if I don’t know something they (the group) will explain it to me. We actually learned more in class.”;
“...group work, compared to last semester, it is easier doing it this way.”;
“...When you see it on the mind map - you actually see that the work is not so much and that it is linked together ...”.

Students felt empowered:

“Group work, yes compared to last semester ... it is easier doing it this way”;
“... so you learn to stand on your own two feet.”;
“We at least came prepared to class”;
“I did the course last year but it is much better this year”;
“... my mark ... shot up by like 40% ... ... so I can go to the exams with a 70% DP (semester average) ... because I was working in a group it went up”.

They acquired life long skills such as, social- conflict resolution-, management- and leadership skills:

“...the class became more close”;
“It is actually better, a bit more personal”;
“...there is problems but I learnt to work with them - and understand them”;
“...we became friends - we socialised”;
“I personally prefer to work individually but it was a good exercise .. it was scary... but of course we had good times”; 
“... we learnt more about other people”; 
“...we have some mixed feelings, of course, but on the whole it was a group effort from all the individuals”.

Some had their reservations about the Belbin team-roles but the majority indicated that they had gained new insights into themselves and it had made them realise their strengths and weaknesses. As one student said:

“You think you have these strong points, because you don’t realise your weaknesses. So if at least anybody else sees a weakness in you, you can work on it. ... you always think you’re perfect...”.

3.2.2 Field-notes

In order to monitor the various relevant systems implemented, the researchers kept field-notes (daily observational reports). If it was deemed necessary, controlled action was taken. In general the groups reported positively on their team functioning. Initial problems arose from the different
interpretation of team member’s commitment. However this was easily resolved by a discussion-session between lecturer and team. Minutes of meetings, e-mailed once a week to the lecturer, were also an indication of how well the team was functioning. With this method of teaching students felt much more at ease with their teaching/learning environment. After being exposed to this – what students experience as a more grown-up approach to learning – they now find it difficult to revert to the classical lecturing style.

4. Discussion & Conclusion

UWC is committed to the concept of lifelong learning. It implies a fresh approach to knowledge, a holistic view of education, the integration of formal and informal types of learning and an appreciation for learning which should be a lifelong endeavour. As resources are not likely to increase, innovative learning and teaching strategies will have to be developed to meet increasing needs.

English is a second or third language for most of our students. They find it difficult to verbalise their understanding of the prescribed text and therefore they resort to memorising the work. 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.” [5] It could thus be argued that collaborative learning, where students are expected to converse with peers, is a more desirable teaching method for these students who typically come from different academic and socio-economic backgrounds.

The majority of students indicated that working in teams contributed to their understanding of the subject. They gained on personal and social level and learnt more in the group than they would have, by learning individually. Confirming that whilst most people find it easy to learn, many find it difficult to be taught [8]. Most felt that the Belbin team profile provided them with insight into the contribution they can make to a team. The more informal format of the lectures and the preparation and presentation of Mind Maps were positively experienced by most students, they learned new ways of ordering facts and information which enhanced their understanding of the work. Students with a language disadvantage seemed to enjoy the creation of mind maps more and felt that it increased their understanding of the subject. The successful implementation of collaborative learning requires students to prepare before attending class. Although an unusually (for UWC) high attendance rate was monitored, students did not prepare adequately prior to class. Students achieved significantly
higher marks in the second semester proving that this teaching strategy has merit. Present structures of examinations fail to adequately test the dimensions of learning we wish to measure, therefore new and innovative assessment techniques need to be explored.

Only a small proportion of our students have access to computers at home. The Internet was accessed on a regular basis by a small percentage of our students. One would expect that students would be interested and excited to become acquainted with modern technology such as the Internet and the use of e-mail. To address the marked imbalances in the genders, females need to be empowered in the use of technology. The incredible growth of access to the World Wide Web necessitates the creative use of computers. Communication, through electronic media, is becoming an important life long skill needed to function in a modern society. Cooperative learning within a team can therefore be considered a bridging methodology for students from a disadvantaged background.

References