

STATISTICS TEACHING ENHANCED BY TEAMWORK – A MULTICULTURAL EXPERIENCE IN SOUTH AFRICA ®

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Students at the University of the Western Cape (UWC) come from diverse cultures and often disadvantaged communities where basic amenities, such as running water and electricity, are not a given. The majority (63% in 2001) of our students had their first exposure to computers at university. In order to fast-track these students to meet increasing technological needs, more effective methods of teaching Statistics needed to be explored. Since 1997 innovative teaching approaches such as collaborative learning, teamwork and the use of mind maps were introduced and used to aid students to become acquainted with the prescribed subject matter. These new approaches were compared to traditional classroom teaching in 1997. These interventions were successful in that students not only studied the prescribed material more efficiently, they also developed skills to function effectively in a multicultural team, preparing them for the working environment in South Africa.

INTRODUCTION

South Africa's historically disparate schooling system has produced many under prepared scholars. On entering university, most of our students are confronted with a deficient schooling background and the added hurdle that they need to study in a language other than their home language. English is a second or third language for most of our students (80% in 2001), and they find it difficult to verbalise their understanding of the prescribed text and therefore resort to memorising the work. A different teaching style, incorporating teamwork and collaborative learning, was adopted for a second-year Statistics course at UWC. With this study the aim was to evaluate the effectiveness of small group learning compared to the more traditional chalk-and-talk lecture method in a multicultural class setting.

In 1997 some of the important variables (such as the lecturer and the student body) remained constant during two semesters, which posed an appropriate opportunity to compare collaborative learning and teamwork with traditional classroom teaching. In the first semester students were instructed using the conventional chalk-and-talk method. In the second semester the same students were placed into balanced teams, and collaborative learning and mind maps were introduced.

The second-year Statistics course is given over two semesters of approximately fourteen weeks each, and comprises a theoretical and a computer component. In both semesters, the book of Wackerley, Mendenhall and Scheaffer - *Mathematical Statistics with Application* (1997) was used for the theoretical component. Two computer packages were used in the practical component. In the first semester the computer spreadsheet package Excel was used to train students to calculate some statistical procedures, and in the second semester students completed the internationally accredited SAS® Programming I course.

STUDY DESIGN

Soft systems methodology (SSM) was used to manage the research process (Checkland & Scholes, 1990), as it reflects the endless cycle of research in education. This methodology entails identifying real-world concerns, which yield choices of relevant systems of purposeful activities (the systems we used were group work, collaborative learning, teams and mind maps).

The model and perceived real situation are then compared and action is taken to improve the situation if necessary (see Figure 1). A progression of systems was implemented in a cyclical manner during our study (see Table 1). Each year from 1997 to 2001 was defined as a research cycle. The only year excluded during this period was 1998 when more than one lecturer was involved in teaching the course.

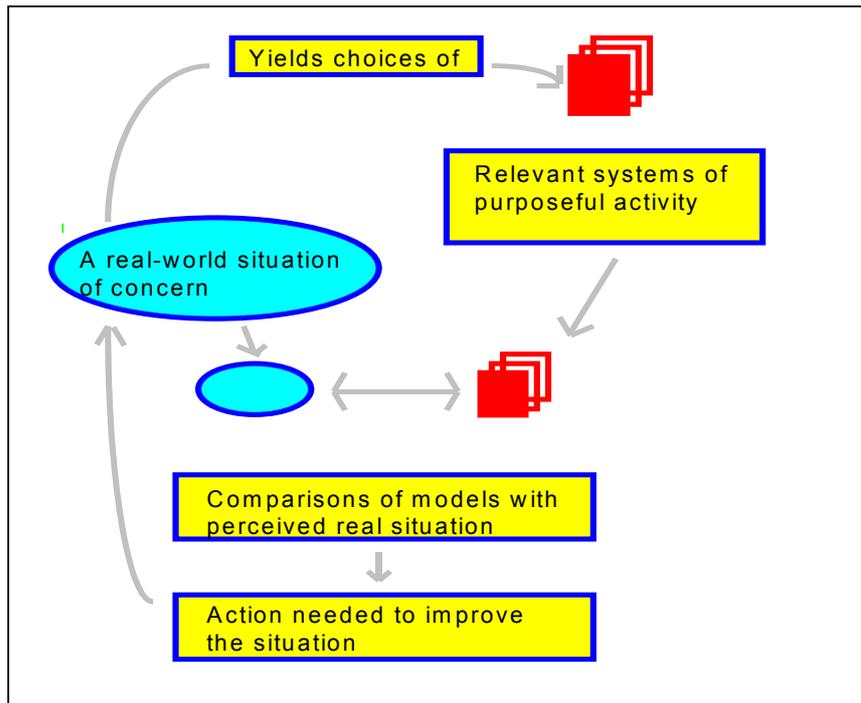


Figure 1. Basic shape of Soft Systems Methodology.

The method of learning was changed from a predominantly chalk-and-talk approach to one of group work within the classroom. In collaborative (cooperative) learning situations, students are able to draw on one another's strengths and counterbalance one another's weaknesses, to complete weekly assignments (Johnson et al., 1994). With collaborative learning students can become more involved with their learning and develop skills in working in teams (Garfield, 1993). It has been found that when students are involved in collaborative groups they are more engaged in the course material and learn the material better compared to traditional lecture methods (Keeler & Steinhorst, 1995).

Belbin's methodology (Belbin, 1993) was used to constitute balanced teams from 1997 to 2000. 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. In 2001 it was decided to allow students to select their own teams (four to five members). The only condition was that the team had to be non-homogeneous with respect to home language. The aim of this condition was to encourage students to interact with peers from various cultures. At the end of the first semester of 2001 students were encouraged (for bonus marks) to complete the Belbin questionnaires; however, the response rate was disappointingly low. The idea was to use Belbin's methodology retrospectively to investigate the effectiveness of the self-selected teams.

Mind maps (Buzan, 1995) were introduced to enable students to summarise rather than memorise the work. A mind map is a clear and concise representation of relevant, associated, categorized and hierarchically ordered information. The concept of "mind mapping" gave learners an effective method of coming to grips with a large body of information. As a group, students discussed the material to extract the most important concepts in order to create a group mind map. All participating group members could use the group's mind map during tests (A4 paper size format) and examinations (A3 paper size format). The concept of mind mapping was introduced to help the students get the overall picture and not get bogged down by the technical detail. This specific intervention was not used during the second semester of 2001 as departmental pressure prohibited the use of mind maps during tests and examinations.

Table 1 *Systems Implemented in a Cyclical Manner*

Year cycle	Systems implemented			
1997 1 st semester	Classroom lectures - chalk&talk			
1997 2 nd semester	Group work within the classroom – lectures kept to a minimum	Collaborative learning	Teamwork (Belbin teams)	Mind maps
1999 1 st semester	Group work within the classroom – lectures kept to a minimum	Collaborative learning	Teamwork (Belbin teams)	Mind maps
1999 2 nd semester				
2000 1 st semester				
2000 2 nd semester				
2001 1 st semester	Group work within the classroom – lectures kept to a minimum	Collaborative learning	Teamwork (Self-selected teams)	Mind maps
2001 2 nd semester				No mind maps

Both qualitative and quantitative instruments of measurement were used to monitor the research process and to collect data. Self-administered questionnaires were used to collect quantitative data, and student comments, interviews (Schön, 1983) and e-mail messages constituted the qualitative data.

RESULTS

Quantitative Results

Fifty-two students, who enrolled for both semesters in 1997, participated in the study. In 1999, 64 students participated in the study. During both 2000 and 2001, 59 students enrolled for both semesters and participated in the study. Initially, in 1997, female students constituted the majority of the class. Since 1999 the proportion of male students has increase from 45% to 58% in 2001.

Although computer access at home has increased slightly from 1997 to 2001 (20% to 27.5%), a huge increase in cellphone ownership can be seen (16% in 1999 compared to 61% in 2001). In spite of a small increase in exposure to computers at school level, more than 60% (in 2001) of our students enter university without any prior computer knowledge. In 2001, 62% of our students had their first exposure to computers at university, whereas in 1999 this percentage was 72.5%.

When the home languages of the year groups were compared, Xhosa (39% in 2001) has been the predominant home language since 1998. In 1997, English (37%) was the predominant home language. It can also be seen that the majority of our students (80% in 2001) are not taught in their mother tongue. English is the medium of instruction and we have found that many of our students find it difficult to verbalise their understanding of the subject matter in English and to comprehend problems posed in English.

Although the majority (more than 80% in all years) of students agreed that mind maps increased their understanding of the subject matter, it was decided by the Statistics department that mind maps should not be used during written examinations or tests in the second semester of 2001. Students could still use mind maps to study and summarize their work, but they were not permitted to use mind maps during examinations.

In the research cycles from 1997 to 2000, close to 75% of students indicated that they enjoyed working in a group. Students also felt positive about the Belbin-constituted teams. In 2001 the teams were constituted by self-selection and not by using Belbin's methodology. With the self-selected teams, 81% of the students said that they enjoyed working in a group. An advantage of the self-selected teams is that the process of team constitution was less complex, less expensive and quick to implement. All the teams, except one team consisting of repeat students, functioned well without any intervention from the lecturer or tutorial assistants. In all the research

cycles, students liked the more informal format of the lectures and they indicated that they enjoyed the course.

The following statistically significant results were found when comparing the African home language speakers to the non-African mother tongue group. The non-African mother tongue group accessed the Internet more frequently (Fisher's Exact test $p=0.0058$). In 2000, the English home language group was the only group where the majority of students were exposed to computers prior to entering university (Chi-square=24.3, $p=0.018$).

The male students outperformed their female counterparts in the computer examinations only in 1997 (Mann-Whitney test=7.15, $p=0.0075$). In both 1999 and 2000 the females were more inclined to feel that the Belbin team role concept had helped them to gain insight into their team role strengths and weaknesses.

In 1997 a statistically significant improvement was found when comparing the final marks of the first semester (chalk-and-talk method) with those of the second semester (when using collaborative learning and teamwork) (Paired T-test = 5.647, $p=0.0001$). In 1999 teamwork was used in both semesters, but no significant differences in the marks were found (Paired T-test=-1.904, $p=0.06$). This confirmed our 1997 finding that teamwork; collaborative learning and the use of mind maps improved the achievement of students. However, in 2000 a significant difference between the two semester marks was again found (Paired T-test=-7.412, $p=0.001$). This refuted our previous claim that if teamwork, collaborative learning and mind maps were implemented in both semesters there should be no difference in achievement. During the second semester of 2000 additional tutoring was introduced to aid students with a substandard achievement. Any intervention and variances between year groups make comparisons like these difficult or even impossible.

Qualitative Results

To obtain additional information, we interviewed two members of each of the 10 teams in 1997. During 1999 to 2001 additional information was obtained by open-ended questions and e-mail messages. From the interviews it transpired that students who normally only crammed before a test did not find this method of continuous studying satisfactory – it probably interfered with their social life. Language was a hurdle highlighted by some students. The majority of students were positive about this new learning experience. As one student said:

“ ... you develop your own understanding ... ”

Another student was not as positive and said:

“ ... group work depends on the people you work with ... ”

Students were very positive about the mind maps:

“ Mind maps are a great help – without them I am lost. ”

“ The mind map was of great use, it puts the entire course that we did into a very simple, short and understandable format. ”

Social skills were developed, as can be seen from the following comments:

“ ... I gained some experience working with students of different colour. ”

“ ... the group also gave me an opportunity of understanding other people's behaviour. ”

Students acquired some lifelong learning skills that were transferred to other courses studied:

“ Group work is very important; it taught us to have group discussions in all our courses which we do, in order to explore different ways of solving a problem. ”

After students had been exposed to this new method of teaching, many indicated that they enjoyed studying with peers, but some had reservations about the constitution of the groups using Belbin's methodology:

“ I find the group that I have been placed in, is a good group to be in. We work well together and if I don't understand anything, somebody always takes the time to explain while all the other members will give their input. ”

“ I don't like the fact that you have chosen us for the group; we should group ourselves. ”

“ ... I strongly support the idea of group work ... ”

“ Working in a group has made me understand some other work I didn't understand on my own. ”

CONCLUSION

The University of the Western Cape is committed to the concept of lifelong learning and therefore this method of teaching, which develops additional learning skills, has some merit in the university's ethos. English is a second or third language for most students, and they have indicated that they find it difficult to verbalize their understanding of the prescribed text and therefore resort to memorising the work. It could be argued that collaborative learning, where students are expected to converse with peers, is a more desirable teaching method for our students from diverse and often disadvantaged backgrounds (Craig, 1989).

The majority of students indicated that working in teams contributed to their understanding of the subject matter. Teamwork not only provided a foundation for future teamwork in a multicultural working environment, but also aided students to become acquainted with the subject matter. Collaborative learning within a team seems to speed up the acquisition of communication skills and can therefore be considered an important bridging methodology for students from disadvantaged backgrounds.

The idea of a mind map is to organise information logically in order to form a graphical representation of the theoretical concepts; thus the emphasis is on understanding procedures rather than the memorization thereof. As research team we feel that without mind maps students invariably revert to the memorization of the work without understanding the underlying concepts.

We need to investigate if the team construction using Belbin's methodology (1997, 1999, and 2000 cycles) provides the student with a superior team experience compared to that of the self-selected teams (2001 cycle). The Belbin approach provides the student with a perspective on his/her own team strengths and weaknesses and the contribution he/she can make to the team. This approach develops the student's appreciation for other team members' contributions to successful team functioning. This added rich experience is lacking in a self-selected team.

It was found that the same group of students (taught by the same lecturer) achieved significantly higher marks when using mind maps and the collaborative learning and teamwork approaches compared to traditional classroom teaching (Blignaut et al., 1998; Blignaut & Venter, 1998). Was this result just a coincidence? It should also be asked if comparisons of student performance over two semesters would result in meaningful or even valid results when many factors (some unknown) influence the learning environment. Which intervention contributed most to the increase in marks – collaboration and teamwork or mind maps? Will the 2001 research cycle (when competed) answer some of these questions?

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