

THE UNIVERSITY OF  
CAPE TOWN

FACULTY OF EDUCATION

THE IMPACT OF CO-OPERATIVE LEARNING ON THE ACADEMIC  
SUCCESS OF EDUCATIONALLY DISADVANTAGED FIRST YEAR  
ENGINEERING STUDENTS AT THE UNIVERSITY OF CAPE TOWN

A research report submitted in partial  
fulfilment of the requirements for the  
degree of

MASTER OF EDUCATION

by

TREVOR TAFT

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**LIST OF ABBREVIATIONS**

ANC	-	AFRICAN NATIONAL CONGRESS
ASP	-	ASPECT
ASPECT	-	ACADEMIC SUPPORT PROGRAMME IN ENGINEERING
DET	-	DEPARTMENT OF EDUCATION AND TRAINING
DP	-	DULY PERFORMANCE
GLM	-	GENERAL LINEAR MODEL
HE	-	HIGHER EDUCATION
HBU	-	HISTORICAL BLACK UNIVERSITIES
HWU	-	HISTORICAL WHITE UNIVERSITIES
SA	-	SOUTH AFRICA
SFP	-	SCIENCE FOUNDATION PROGRAMME
SPSS	-	STATISTICAL PACKAGES FOR THE SOCIAL SCIENCES
TK	-	TRANSKEI
UCT	-	UNIVERSITY OF CAPE TOWN
USA	-	UNITED STATES OF AMERICA

## ABSTRACT

The aim of this research report was an attempt to measure the impact of co-operative learning workshops on the academic achievement of 1st year Physics 110w [ASPECT] students from the ex-Department of Education and Training [DET] and Transkei [TK] schools in the Faculty of Engineering at the University of Cape Town in 1995. At the time of doing the research for the investigation there were two concerns amongst the ASPECT staff at UCT. Firstly, how to address the issues of high failure rates and low retention of disadvantaged 1st year Engineering students, and low graduation rates. Secondly, what was the impact of the many innovative initiatives undertaken on the human resources that South Africa is thought to need in Engineering.

The Engineering Faculty at UCT established the Academic Support Programme in Engineering at Cape Town [ASPECT] with the aim of addressing the needs of the increased number of black students from disadvantaged education and social backgrounds. The Physics 110w course was introduced into the ASPECT programme in 1995 and the academic support was given in the form of co-operative learning workshops.

A study was undertaken, using 79 first year Physics 110w ASPECT "ex-DET and TK" students and 45 1st year Physics 110w "mainstream" students from ex-DET and TK schools out of a total number of 378 students from all ex-Departments.

The ASPECT Physics 110w students [79] and the "mainstream" Physics 110w students [45] academic achievement in the four standardised class tests, and June class test and November examination in 1995 were used as the dependent variables and the co-operative workshops were used as the independent variable.

The General Linear Model of statistical analysis was used to analyse if there was any or no significant differences between the mean scores [average] of the two above samples on their four standardised class tests, June class test, and November examination results. No significant difference was found in the comparison of means results between the ASPECT 1st. year Physics 110w "ex-DET and TK" students and "mainstream" 1st year Physics 110w "ex-DET and TK" students.

It is clear from this study that the ASPECT students did not do significantly better than “mainstream” students who had no support [co-operative learning workshops] as expected by ASPECT staff. However, the results clearly indicate although not conclusively that had the co-operative workshops not been introduced in Physics 110w more ASPECT students would possibly have failed or dropped out of their 1st year of engineering studies at UCT. Furthermore, the study concludes that co-operative learning workshops as applied in Physics 110w is still modest in scale and there is much room for expansion in order for disadvantaged students to benefit from the intervention model.

In conclusion, the co-operative learning workshops is an encouraging innovative initiative by the ASPECT staff to address the teaching and learning process in Engineering so as to make Engineering more productive in terms of students acquiring transferable skills, problem solving strategies, and analytical capabilities as well as address the economic and developmental challenges to produce more Engineers in South Africa.

## CHAPTER ONE

### THE AIM AND RATIONALE OF THE STUDY

#### 1.1 INTRODUCTION AND STATEMENT OF THE PROBLEM

The legal relaxation of racial restrictions on admissions to Historically White Universities [HWU] in 1985, saw an increase in the number of black students registering for the first year engineering course at the University of Cape Town [UCT] and a number of other engineering faculties of HWUs. Having gained admission to the engineering faculty at UCT, black students began experiencing the consequences of apartheid education, which had left them virtually unprepared for studies in fields such as engineering [Jawitz, 1994b; Pavlich, Orkin and Richardson, 1995; Hofmeyr and Spence, 1990].

The problems encountered by 1st year black students generally and more specifically in engineering are both academic and non-academic in nature. Academically disadvantaged students were unable to cope with the pace and work load, could not articulate basic concepts, and had limited skills in terms of communication, computing, critical thinking, problem solving and conceptualisation. Non academic problems encountered were financial constraints, an unstable political climate, transport problems, accommodation, self-confidence and alienation [Jawitz, 1994b; Hofmeyr and Spence, 1990; Grayston, 1995; Tema, 1988].

It is well documented elsewhere that the above problems encountered by 1st year disadvantaged students are not of their own making, but are broadly speaking a result of South Africa's apartheid legacy, which has left its imprint on socio-economic and political life, especially that of the black majority [Mehl, 1988; Tema, 1988; Scott, 1989; Hofmeyr and Spence, 1990]. The vagaries of the apartheid schooling system have left black students with a deficient background to tackle science and technology courses at tertiary level.

During recent years in engineering at UCT and several other engineering faculties have expressed their concern about the increase in the number of black students who are inadequately prepared for Higher Education due to the socio-economic legacy of apartheid and the difficulties they encounter during the first year engineering courses. In particular, concern was expressed at the high failure and low retention rates in 1<sup>st</sup> year engineering, and low graduation rates amongst disadvantaged black students [Jawitz, 1994b; Meyer and Sass, 1992; Sass, 1989; Laugksch, 1994].

This situation led to a number of studies being undertaken in the Faculty of Engineering at UCT. These studies cited several reasons for the above situation, which include low results in Maths and in Science, unjustified assumptions about students' previous curriculum, learning and life experience, second language medium of teaching instruction, lack of key cognitive skills such as critical thinking, problem solving, and conceptualisation, as well as poor learning and study patterns [Jawitz, 1992a; Cliff, 1992; Laugksch, 1994; Sass, 1989; Fraser, 1991].

Lecturers in the engineering faculty are aware that the inadequacies of disadvantaged students are a product of their socio-educational and culturally deprived backgrounds. As Parsons and Meyer [1990:323], put it: "...the level of concern that educational practitioners share, and the awareness that failure at tertiary level [however that failure is defined] is not simply a product of inadequate intellectual capabilities coupled with insufficient effort on the part of the student".

Furthermore, lecturers realised that an end to apartheid schooling would not automatically bring about the conditions to address these inadequacies, nor would easy access to the engineering faculty in itself solve the students difficulties, as these go beyond merely gaining admission [Hofmeyr and Spence, 1990; Scott, 1995].

Lecturers especially in the Academic Support Programme in Engineering at UCT [ASPECT] having learnt about the success of co-operative learning workshops at a number of engineering faculties in the USA universities, and after having invited Catherine Hudspeth from the California State Polytechnic University Pomona, and Karl Smith, a champion of co-operative learning in the USA to hold a workshop on co-operative learning, were convinced that co-operative learning workshops could enhance the academic performance of educationally disadvantaged students. In discussion, Jeff Jawitz, Bidy Greene and Howard Pearce [ASPECT staff] explained that the success [however that success is defined] of co-operative learning when applied in some of the tertiary institutions in the United States, together with the research conducted by Jeff Jawitz [1992b], was sufficient to convince them that co-operative learning workshops should be introduced into the Physics 110w course in 1995. This claim about the success of co-operative learning as an intervention strategy can be seen in Jawitz's recommendation to the Mechanical Engineering Department at Peninsula Technikon.

There is clear evidence that co-operative learning is an effective strategy for improving the academic performance of students, and at the same time making learning more enjoyable and meaningful for students [Jawitz, 1994a].

This study focuses specifically on the claim that co-operative learning is part of the solution to the learning inadequacies experienced by 1st year educationally disadvantaged students in the Engineering faculty at UCT. This investigation is therefore an attempt at assessing the above claim, since there are many claims made about the success of one or other intervention strategy but little research in terms of the effectiveness of the impact of such interventions on the academic success of educationally disadvantaged students [Hofmeyr and Spence, 1990].

## 1.2 THE PURPOSE OF THE STUDY

This study is an attempt to measure the impact of co-operative learning workshops on the academic achievement of 1st year Physics 110w [ASPECT] students from the ex-Department of Education and Training and Transkei schools "ex-DET and TK" in the faculty of Engineering at UCT. More specifically this investigation seeks to answer the following questions:

- 1.2.1 Do the pass rates (performance) of the ASPECT Physics 110w "ex-DET and TK" engineering students differ statistically significant to that of "mainstream" Physics 100w "ex-DET and TK" students with regard to the four standardised class tests, June class test and November examination?
- 1.2.2 What does the relevant literature on co-operative learning say with regard to the definition and characteristics of co-operative learning, conditions facilitating co-operative learning as well as the impact of co-operative learning on academic performance?
- 1.2.3 What does the relevant literature on co-operative learning have to say with regard to the retention rates and graduation rates of educationally disadvantaged students at tertiary level?

## 1.3 HYPOTHESIS TO BE TESTED

- 1.3.1 There is no statistically significant difference between the results of ASPECT 1<sup>st</sup> year Physics 110w "ex-DET and TK" students and "mainstream" Physics 110w 1<sup>st</sup> year "ex-DET and TK" students in the faculty of Engineering at UCT with regard to the 4 standardised class tests, June class test and November examination.

## 1.4 DEFINITION OF TERMS

In this study, the terms below were used as defined by the ASPECT staff members in the Faculty of Engineering at UCT.

### **Co-operative learning**

The involvement of students in their own learning through an active role in teaching and co-operating with their peers to enhance their own and other's learning.

### **Co-operative learning workshops**

A structured learning environment where students interact actively through group work with their peers in structured peer group activities where the facilitator has minimal input.

### **Educationally disadvantaged students**

Black students who have had most of their schooling at an ex-DET or ex-TK school. These students come from primarily disadvantaged social, economic and education backgrounds.

### **Academic success**

This means getting students to pass the examinations in their first year courses in engineering. However, it is also hoped that students would gain the necessary skills to see them through to graduation.

### **'Flyers'**

A designation for students who have excelled in the matric examinations and who are counselled by and ASPECT educational counsellor with the knowledge and agreement of their sponsors. These students are admitted to ASPECT on the insistence of their sponsors. These students took the standard mainstream first year curriculum and did not participate in the co-operative learning workshops.

## 1.5 THE IMPORTANCE OF THE STUDY

In recent months the South African mass media has continually bombarded the South African public with news about the 'brain drain' of skilled person power leaving South Africa for other countries, especially western countries.

According to the Weekly Mail and Guardian, 26% of the 8000 skilled person power who left S.A between January and September 1996 were engineers, leaving behind a professional gap in the engineering field [Weekly Mail and Guardian, 14-21/02/1997]. Not only the media, but also the academic literature [articles and books] highlights the shortage of scientific and technological human resources. [Cooper, 1994; van Vuuren and Pouris, 1992; Meyer and Sass, 1992]

One reason for the shortage of skilled person power is the fact that few scientists and engineers are produced in S.A relative to other disciplines. According to the South African Institute of Race Relations, 6% Africans, 1% Coloureds, 2% Indians and 8% Whites respectively held engineering degrees in 1994 [Monday Paper, 15[16], 1996: 1 and 7]. Dave Cooper's research reveals the seriousness of the crisis. By 1989 only 3% of SA students majored in engineering and 9% majored in science, compared to 64% majoring in other disciplines [Cooper, 1994].

Similar findings were made by [Meyer and Sass, 1992; van Vuuren and Pouris, 1992; Millroy, 1985]. The urgency of the need to produce more engineers becomes even more evident when comparing S.A to other countries. Studies by [van Vuuren and Pouris, 1994; Millroy, 1985; and Cooper, 1994] reveal that by 1986 SA produced a paltry 35 engineers per million of the population compared to the USA [370], Japan [500], Britain [250], Germany [340] and Australia [220].

This situation is further exacerbated by the fact that black students have very few role models in their communities and have little engineering awareness [Hofmeyr and Spence, 1990]. Secondly, most black students enrol in the Arts, Social Science and Humanities faculties of HBWs and HWUs, a consequence of the high failure and graduation rates amongst black engineering students. [Laugksch, 1994; Jawitz, 1992a; Cooper, 1994].

For Higher Education [HE] this represents quite a challenge since it [HE] is been pressurised from all quarters [industry, government and the economy] to produce engineers if SA is to compete successfully with the rest of the world, especially the industrialised countries and particularly the technologically orientated countries of Asia [Cooper, 1994].

The present ruling party regards HE institutions as a national asset and a major resource for national reconstruction, and the development of S.A's capacity to contribute to the world wide advance in knowledge and skills [ANC, 1995]. The South African economy, particularly the industrial and manufacturing sectors, demands highly skilled and knowledgeable human resources to compete effectively in the globalised world economy. According to Hofmeyr and Spence, [1990], Anglo-American alone was in need of 100 engineers in 1990. Not only is there an urgent need to produce more engineers, but there is clearly also a need to make engineering education more productive.

The lecturers in the Engineering faculty at UCT are aware that as SA and the world move towards the twenty first century, engineering students should be equipped with decision making capabilities, advanced technical skills, problem solving skills, experimental skills, oral and written communication skills, and critical thinking skills. In addition, students would have to have a strong foundation in Science, Mathematics and Engineering fundamentals, as well as a sense of social, ethical, political and humanistic responsibilities meshed with an understanding of the corporate environment and business basics [Tsou, Thomas and Carmi, 1992; Sass and Meyer, 1992].

In response to the above challenges a number of Engineering faculties developed intervention programmes to bridge the gap between school and university. A number of these intervention programmes especially in engineering, are faculty based [see Scott, 1989; Hofmeyr and Spence, 1990 and Cliff, 1992 for a more detailed analysis of these programmes].

The Engineering faculty at UCT established the Academic Support Programme in Engineering at Cape Town [ASPECT]. This programme was established to develop an alternative curriculum structure to address the needs of the increased number of black students from disadvantaged education and social backgrounds. It was also intended to address issues of high failure rates and low retention rates in first year, and low graduation rates [Jawitz, 1994b; Jawitz, Kotecha and Setiloane, 1992; Greene, 1993]. Apart from developing an alternative curriculum, the ASPECT programme is also designed to give academic and non-academic support to disadvantaged students [Greene, 1993; see also Appendix A for the aims and objectives of the ASPECT programme].

Since its inception ASPECT has always been under pressure to accept an increased number of students due to the demand for academic support. In 1992 ASPECT accepted 65 students, 77 in 1993, 101 in 1994 and 107 in 1995 [Pearce, 1995]. The demand for academic support is clearly there.

The ASPECT programme extends over three years, which incorporate the first two years of the four year degree. The ASPECT students register for three full-credit bearing 1st year courses counting towards the degree. In 1995 ASPECT students registered for Mathematics 1, Physics 1 and Engineering 1 and wrote the same class tests and examination as "mainstream" students who took 4,5 courses. The reduced first year curriculum does not necessary mean that ASPECT students have more time because they have to attend extra tutorials and workshops. The reduced first year curriculum should be seen as a way of creating a space for intensive academic support. [Jawitz, 1992b; Meyer and Sass, 1992; Greene, 1993; Engineering Handbook, 1995].

The Physics 110w course was introduced into the year 1 curriculum in 1995 and the academic support is given in the form of co-operative learning workshops. These workshops are run by ASPECT staff. The workshops are compulsory and consist of a double period, once a week. Students engage with each other in peer groups of 3-4 to create a learning environment which is conducive to their own and others' learning [Meyer and Sass, 1992; Greene, 1993]. For a detailed exposition of the co-operative workshops [see Greene, 1993].

The co-operative learning workshops were introduced into the Physics 110w courses because of their 'success' in the Maths course and the deficiencies of disadvantaged black students in Physics due to their poor schooling background [Jawitz, 1992b; Jawitz, 1995; Pearce, 1995].

## 1.6 LIMITATIONS OF THE STUDY

This study is an investigation of the impact of co-operative learning on the academic success/achievement of 1st year Physics 110w ASPECT "ex-DET and TK" students. The primary objective is to analyse statistically whether the pass rates of 1<sup>st</sup> year Physics 110w ASPECT "ex-DET and TK" differ statistically significant to that of "mainstream" 1<sup>st</sup> year Physics 110w "ex-DET and TK" students. The limitations of the investigation are as follows:-

- \* Only quantitative [hard data] research using pass rates was used. No direct effect of co-operative learning could be tested or assessed. No qualitative assessment [questionnaires, interviews, etc.] was used to illustrate what actually happened in the co-operative learning workshops to deduce whether these workshops increased the pass rate

- \* This study is limited to Physics 110w 1995 1st year results only because no pre-intervention performance data could be used as the co-operative learning workshops was only introduced in Physics 100w in 1995.
  
- \* The study is not concerned with non-academic outcomes [interpersonal relations, social skills, communication skills etc.] which are important to co-operative learning.

University of Cape Town

## CHAPTER 2

### REVIEW OF THE LITERATURE ON CO-OPERATIVE LEARNING

#### 2.1 INTRODUCTION

Although co-operative learning has been researched for 20 years and has produced 600 studies, very little has been written on its usefulness at tertiary level. Research into the usefulness of co-operative learning at tertiary level began in earnest in the United States of America [USA] during the 1980s, but very little, if any, has been done in South Africa to show that co-operative learning results in higher academic achievement than does competitive, individualistic or traditional learning methods [Kagan, 1992; Treisman, 1985; Johnson, Johnson and Smith, 1990]. Co-operative learning is regarded by its practitioners as one of the oldest, but least used learning strategies at tertiary level, especially in engineering education [Ercolano, 1994; Wankat and Oreovicz, 1994].

This chapter therefore seeks to review the literature on co-operative learning; to provide the theoretical and conceptual background to the analysis of the data used in this study; and to show how co-operative learning is said to benefit disadvantaged students and improve their academic performance and what predicts its success at tertiary level.

#### 2.2 WHAT IS CO-OPERATIVE LEARNING

There is a substantial body of research on co-operative learning which has focused on such diverse outcomes as...

- "[a] achievement, higher-level reasoning, retention, achievement motivation, transfer of learning,
- [b] interpersonal attraction, social support, friendships, value differences, and social support, and
- [c] Self-esteem, social competencies, and psychological health [Johnson and Johnson, 1987: 10 - 11]". Most researchers agree that social interaction, beyond mere 'chalk and talk', is important for learning and development, for more active learning situations, and for student control over learning and knowledge. Furthermore, researchers agree that traditional [lecturing and tutorials] methods of teaching and learning can be effective only in certain contexts. They are said to be no longer effective for meeting higher cognitive objectives in higher education such as critical thinking and problem solving [Wankat and Oreovicz, 1994; Hartman, 1995].

Traditional, remedial and counselling approaches have rarely achieved significant success in assisting educationally disadvantaged students through the critical first year of university [Treisman, 1985; Johnson, 1991]. In order for students to maximise their achievements at tertiary level, they should not be allowed to be passive learners, with lecturers the sole monopolisers of knowledge [Hartman, 1995].

### 2.2.1 Definition and characteristics

Leading advocates of co-operative learning are in support of the definition of co-operative learning put forward by [Johnson, Johnson and Smith, 1990:3].

"Co-operation is working together to accomplish shared goals. When engaged in co-operative activities, individuals seek outcomes that are beneficial to themselves and to all other members of the group. Co-operative learning is the instructional use of small groups so that students work together to maximise their own and each others' learning".

Co-operative learning usually refers to situations where students interact on a task which none would be able to solve alone, but on which they make substantial progress together. This entails students being actively involved in and taking responsibility for the learning process [Sharon and Sharon, 1975; Slavin, 1983; Ruddock, 1978; Grayson, 1995]. As Fred Hart puts it: "The collaborative method asks students to help themselves" [ASEE PRISM, 1993:18].

These co-operative situations usually demand that students develop co-operative relations with their peers which will allow them to: communicate freely; express, modify and explore each other's ideas and definitions; be responsible and accountable to each other; identify their own and others strengths and weaknesses; share learning and performance strategies and skills; respect each other's thinking; value independence of learning; and teach and learn from each other [Green 1994; Sharon and Sharon, 1975; Ruddock, 1978; Pearce, 1995; Brodie, 1994; Johnson, Johnson and Smith, 1990]. However, students are not left totally on their own but are under the guidance of a facilitator [lecturer or competent peer], whose instruction is kept to a minimum. The ideas of cognition and learning which underpins co-operative learning determine the kinds of task employed and the nature of the interaction that is expected to occur.

Research on co-operative learning has been generally informed by three theoretical frameworks:- social interdependence, cognitive development and behavioural theories [Johnson and Johnson; 1992]. A number of studies reviewed for this study focused on cognitive development theory which integrates Piagetian and Vygotskian theories of learning which purport that "...learner - centredness is contained within the developing learner because knowledge is individually constructed [Piaget].

In Vygotskian terms, "...learner - centredness is constructed in the zone of proximal development, that is, outside of the developing learner [Flanagan and Sayed, 1992:112]. In this understanding, group work is a technique used for specific tasks in which interaction and dialogue between a lecturer [or more competent peer] and other students can occur in structured ways. For further insight into the theoretical perspective on co-operative learning and its notions of cognition and learning [see Johnson and Johnson, 1992; Grayson, 1995; Brodie, 1994 and Sharon, 1990]. From the literature it is expected that students would maximise their achievements in a structured way which would generate problem solving strategies, encourage better learning, deepen their understanding of the material and the concepts involved, practice the skills required and derive benefits such as improved retention of material and increased quality of academic performance [Ercolano, 1994; Jawitz, 1992a; Pearce, 1995; Sharon and Sharon, 1975]. Furthermore, long-term benefits would be derived, such as increased pass rates, retention rates, graduation rates and lower attrition rates [Treisman, 1985; Johnson and Johnson and Smith, 1990].

By sharing their knowledge and expertise, students gain insight into the process by which they and others learn and develop knowledge [metacognition] (Grayson, 1995; Greene, 1993]. The efficacy of co-operative learning apart from the process and developing of subject knowledge, lies in allowing individual students to pass tests and complete assignments at a later stage of tertiary level.

### 2.2.2 Approaches to co-operative learning

Research on co-operative learning approaches has revealed that variations in the methods employed usually vary from institution to institution, faculty to faculty, and even subject to subject. For an account of the similarities and differences between various co-operative approaches, [see Johnson and Johnson 1992; Slavin, 1983; Sharon, 1990]. The conceptual approach developed in the USA has a particular appeal for ASPECT study and South African tertiary institutions in general, and so will be further explored here.

The conceptual approach provides instructors with a theoretical framework on which to build their own approaches for co-operative activities. Using the basic conceptual principles, faculties and departments could develop co-operative learning models for the lecture theatre and academic workshops in congruence with their curricula, students and institutional goals [Johnson and Johnson, 1992; Johnson, Johnson and Smith, 1990]. The appeal of a conceptual approach is that faculties and departments at tertiary level could develop their own insights on the basis of their own experience, and begin to formulate a systematic theoretical base to inform their models.

Co-operative learning models usually incorporate informal, formal or base co-operative learning groups, depending on the tasks and the particular outcomes desired. For a detailed account of the types of co-operative learning groups used in co-operative learning, [see Johnson, Johnson and Smith, 1990; Ercolano, 1994; Smith, 1989]. The co-operative learning workshop model devised by Uri Treisman (1985) and later adapted in over 30 college and universities in the USA and by the Engineering Faculty at UCT is usually structured to supplement and complement course instruction in the classroom [Watkin, 1989; Hudspeth, 1990; Wankat and Oreovicz, 1994; Greene, 1994].

These workshops are structured to improve the academic performance of educationally disadvantaged and minority students [African American and Hispanic students in the USA] and to address the first year failure rate, especially in engineering [Treisman, 1985; Ercolano, 1994; Hudspeth, 1990; Jawitz, 1992a].

The value of the above conceptual approach is that it could be revised, refined and re-evaluated in order to mould it to the requirements of the faculty, department, students and curricula.

### 2.2.3 Conditions for co-operative learning

Popular conceptions of group work by simply placing individuals randomly in a group to work on their own does not promote learning, higher achievement and productivity [Johnson, Johnson and Smith, 1990; Flanagan and Sayed, 1992; Hudspeth, 1990]. It is clear from the literature that co-operative learning could only be effective and productive under highly structured conditions. Practitioners are in agreement that a highly structured co-operative environment is particularly important for the first year courses at university [Jawitz, 1994a; Ercolano, 1994; Wankat and Oreovicz, 1994].

Unstructured group work could so easily result in: passivity amongst group members, a free rider effect, a rich-get-richer effect, self-induced helplessness, diffusion of division of labour and social loafing, inappropriate dependence on authority, destructive conflict, which could lead to poor performance of groups and individuals [see Johnson, Johnson and Smith, 1990, Dansereau, 1978; Slavin, 1983; Sharon, 1990]. Although, disadvantaged and minority students usually benefit from a highly structured co-operative environment, there is no need to sacrifice high achieving students at the expense of the above group of students [Kagan, 1992].

Researchers and practitioners concur that the following elements are essential for effective co-operative interaction and learning: clear learning goals and objectives, challenging problems, structured discussions, and a clear understanding by students of their responsibility in the process [Wankat and Oreovicz, 1994; Ercolano, 1994]. Most proponents of co-operative learning agree with the following five basic elements [conditions] identified by [Johnson, Johnson and Smith, 1990: 11 - 12].

“Positive interdependence [all members must co-operate to complete the task]; individual and group accountability [each member is accountable to achieve group goals]; face to face interaction [all members support each other's efforts to learn]; collaborative skills [all members must ensure that the group functions well]; and group processing [all members must co-ordinate and integrate their efforts to achieve group goals]”.

## 2.3 CO-OPERATIVE LEARNING AND EDUCATIONALLY DISADVANTAGED STUDENTS

Numerous studies locally and internationally have shown that educationally disadvantaged and minority students who enter university with hopes to pursue professional careers in science and engineering, fail to cope with the rigours of first year studies and usually fail first year courses such as Mathematics, Physics and Chemistry, etc. as I have already observed above [Treisman, 1985; Hudspeth, 1990; Hofmeyr and Spence, 1990; Millroy, 1985; Potter and vd Merwe, 1993; Sass, 1989; Meyer and Sass, 1992]. The literature has revealed that traditional, remedial and counselling approaches have had little effect in improving the academic achievement of educationally disadvantaged students in engineering [Fraser, 1991; Pearce, 1995; Jawitz, 1992a; Treisman, 1985].

Some studies indicate that socially, intellectually and academically disadvantaged and minority students are more receptive to co-operative learning than academically able students because their cultures emphasise co-operation rather than competition, have experienced oppressive political and economic conditions which have fostered co-operative relations, link self-esteem closely to getting along with peers, and favour co-operation above competition when given a choice [Slavin, 1983; Kagan, 1992]. However, researchers agree that further research needs to be done on the above relationships between co-operative learning and disadvantaged students.

Several studies [Fraser, 1991; Watkins, 1989; Jawitz, 1992b; Hudspeth, 1990; Treisman, 1985; Grayson, 1995; Kagan, 1992] on co-operative learning, especially co-operative learning workshops, have revealed that disadvantaged students attain a number of positive outcomes:

- i] higher achievement;
- ii] greater success in the first year of study;
- iii] enhanced problem solving skills and conceptualisation and long-term benefits such as, greater retention rates and graduation rates.

Despite the benefits disadvantaged students derive from co-operative learning, practitioners warn that co-operative learning strategies should not be perceived by its participants as remedial. Hudspeth [1990: 2] says that students could easily perceive themselves as, "dumb bunnies". Furthermore, such initiatives could also be perceived as, racist, patronising, condescending and meant for someone else [Pavlish et al, 1995; Jawitz, 1992a; Treisman, 1985; Tema, 1988; Mehl, 1988]. It is clear from the literature that co-operative learning models should have legitimacy, help students excel than avoid failure, be complementary to regular course structures and not compromise educational standards and quality [Green, 1993; Pavlish et al, 1995; Hudspeth, 1990; Watkins, 1989].

## 2.4 CO-OPERATIVE LEARNING AND ACADEMIC PERFORMANCE

Research on the relationship between co-operative learning and academic performance of students at tertiary level suggest that co-operative learning is more successful than competitive, individualistic, and traditional learning methods [Johnson, Johnson and Smith, 1990; Kagan, 1992; Slavin, 1983; Watkins, 1989].

In 1992, Johnson and Johnson conducted a meta-analysis of 122 achievement-related studies at college level which revealed that co-operative learning promoted greater individual achievement than did competitive or individualistic learning [effect sizes of 0.61 and 0.35 respectively].

Slavin [1983] found that students at college level whose group rewards were based on each member's academic performance showed the superiority of co-operative learning over individualistic, competitive and traditional learning methods.

Studies conducted on the impact of academic co-operative learning workshops demonstrate that structured co-operative learning could dramatically improve the academic performance of educationally disadvantaged and minority students.

In the USA where academic co-operative learning workshops [especially in Science and Engineering] were instituted at a number of tertiary institutions such as the University of Minnesota, Worcester Polytechnic Institute, New York State University, etc., all show an improvement in the academic performance of minority students.

Treisman's study [1985] at the University of California at Berkeley shows that between 1979-85, 55% of workshop students [231] compared to 21% non-workshop students [234] had earned B - or better in first year Calculus.

Hudspeth's [1989a] study at the California State Polytechnic University, Pomona shows that 60% of minority students in the workshops attained A's and B's in courses such as Chemistry, Physics, Maths and Engineering Mechanics as opposed to previous scores of D's and F's before the workshops were introduced.

A study conducted by Jacqueline McCaffrey at the University of Texas shows that 80% of workshop students obtained A's and B's compared to non-participants only 40% of whom obtained A's and B's, [Watkins; 1989].

In South Africa where co-operative learning tutorials and workshops were introduced there was an improvement in the academic performance of disadvantaged students. A study conducted by Huddle, Bradley and Gerrans [1992] at the University of Witwatersrand on the effectiveness of co-operative learning tutorials, found participants in these tutorials made statistically significant gains [higher results] than non-participants. The Chemistry 110 [non-participants] class tests and examination results were compared to the Chemistry 111 [participants]. From 1988 - 1989 Chemistry 110 students consistently outperformed Chemistry 111 students. In 1990 when the co-operative learning tutorials were introduced the Chemistry 111 scored an average 58% for class tests as compared to Chemistry 110 who scored 44%. It was also the first time in many years that the Chemistry 111 students average final mark [53.3%] was greater than the Chemistry 110 students [49.8%].

Grayson [1995] found, in her evaluation of the performance outcomes of disadvantaged students at the University of Natal's Science Foundation Programme [SFP], which emphasises co-operative learning, found that they outperformed those disadvantaged students who were not part of the programme.

Jawitz [1992b] found that ASPECT [ex-DET] students in Maths and Applied Maths significantly outperformed NON-ASPECT [ex-DET] students during their first year of study in the Faculty of Engineering at UCT [1989-1992]. By 1992 ASPECT students outperformed NON-ASPECT students in standardised tests and examinations after the co-operative learning workshops were introduced in 1990.

Research has shown that educationally disadvantaged and minority students who were identified as potentially at risk using cognitive predictors [Matric results, aptitude tests, school performance indices] sometimes outperformed the better prepared non-workshop students. Other benefits such as retention rates, lower attrition rates and increased graduation rates can be attained [Treisman, 1985; Grayson, 1995; Jawitz, 1992b].

Although researchers and practitioners are in agreement that co-operative learning activities do increase academic performance, which features [individual accountability, group rewards, group goals, etc.], have the primary effect on the performance outcomes of students is still obscure to researchers and practitioners, [Sharon, 1990]. Sharon [1990] suggests that micro-analytic and ethnographic studies could possibly illuminate some of the effects of co-operative learning. Knight and Bohlmeier [1990] have identified a number of variables [goal structure, group responsibility, motivation, the nature of the interaction, etc.] representing the causal mechanisms through which co-operative learning may promote higher achievement [see Knight and Bohlmeier, 1990]. It is clear from the literature that further research needs to be done as to how co-operative learning produces such positive and increased academic performances.

## 2.5 ASSUMPTIONS ABOUT THE SUCCESS OF CO-OPERATIVE LEARNING

Using an independent variable [co-operative learning methods] and dependent variables [standardised tests and examination results], researchers and practitioners have shown gains on tests achievements.

The literature has shown that isolation and alienation are clear factors in failure, and active participation in the learning process shows that students learn more, remember longer, develop superior reasoning and critical thinking skills, feel more support and acceptance and like the subject matter [Smith, 1989; Johnston, Johnston, and Smith, 1990]. But why? Advocates of co-operative learning cite some of the underlying factors for these outcomes as the following:

- 1] Student interaction by sharing different approaches and experiences to learning, thinking, arguing, and explaining the problem. Through organising, summarising, elaborating, justifying, the student learns.
- 2] Peer support and encouragement, gaining insight into others' ideas and understanding which result in acceptance and confidence in their own ideas, result in more learning.
- 3] Improved problem solving strategies through students explaining, understanding and developing methods to solve problems as well as using technical dialogue and asking more sophisticated questions which result in increased intellectual, conceptual and cognitive development.
- 4] Learning in an informal, social context, and focused on meaningful problems, empowers students and creates a sense of ownership of knowledge [insider-knowledge].
- 5] Preparation for co-operative learning workshops helps create an environment where students enjoy and understand things they are doing.

- 6] Facilitation which allows students to grapple, predict, investigate and get behind the difficulties of the problem ensuring students get involved in the learning process.

Co-operative learning researchers and practitioners have shown that the above factors have impacted positively on academic performances of students. However, what is not shown is the cognitive dynamics of student co-operation such as subjects' task definitions, reasoning and assumptions of responsibility for various aspects of the task [Brodie, 1994].

It is clear from the literature that no clear definitive explanation exists on why co-operative learning produces positive effects on student learning and academic performance [Kagan, 1992]. Furthermore, researchers agree that careful micro-analytic studies on student exchanges in co-operative learning groups can enhance our understanding of these factors and of the learning process as a whole and could have an impact on achievement scores [Sharon, 1990].

## 2.6 CONCLUSION

Whilst there are clear indications from the wealth of research on co-operative learning published thus far that co-operative learning could benefit disadvantaged students - not least in the co-operative methods applied both internationally and locally by engineering faculties and their various departments - there are also many challenges and questions which remain unanswered within the research literature on co-operative learning. For example, if such large gains reported in some of the research are true, why is it not common practice, since lectures want good results and students want to pass?

It is clear that certain conditions [structured co-operative environment, meaningful and positive interaction amongst students, good facilitation, etc.] should exist for co-operative learning to work. There seems to be consensus amongst advocates of co-operative learning that there are five basic elements [conditions], positive interdependence, group accountability, face to face interaction, collaborative skills and group processing for group-learning to be successful. The design of worksheets used in the workshops should allow students to unpack the problems, allowing them to get more deeply involved in the learning process. The format [in terms of time and numbering period] of the co-operative learning workshops is another area which needs to be taken into account. Would one expect large effects from short [as % of time-table] interventions?

Another question is, how does one exclude the Hawthorne effects which some of the more 'populist' champions of co-operative learning advocate about the success of co-operative learning. A number of claims are made by these advocates about the higher achievement scores acquired by disadvantaged students, but higher achievement scores do not necessarily reflect logical or critical thought or even better understanding of the subject matter. What is not clear in the literature on co-operative learning is what actually produces the positive effects on student learning.

The factors identified in the review which assumes the success of co-operative learning require further extensive research [Lazabowitz and Karsentz, 1990]. What produces the enhanced academic performances of students is a question researchers will continue to study for years to come. Not only is it a highly complex challenge but also calls for researchers to develop an understanding of the internal dynamics of co-operative learning groups and be much more specific about the precise relationship between variables in their study [Knight and Bohlmeier, 1990].

Finally, it is clear from the literature that co-operative workshops could possibly make a difference in the teaching and learning process at university in general, and more specifically with regard to students who come from disadvantaged social, educational and economic backgrounds. Although lessons can be learned from other countries, engineering faculties in South Africa should develop their own models of co-operative learning taking into account the context in which they find themselves. The above literature review on co-operative learning provides the conceptual framework for this research report..

## CHAPTER 3

### RESEARCH DESIGN AND METHODS

#### 3.1 INTRODUCTION

In this chapter the setting for the investigation is presented, and the selection and characteristics of the two samples for the study are described. The research methods employed in the investigation are identified and the design of the 4 standardised class tests, and the June class test and November examination is described. The statistical method is used to check the comparability of the data outlined.

#### 3.2 THE SETTING FOR THE INVESTIGATION

The investigation was conducted in the Faculty of Engineering at the University of Cape Town, and focuses specifically on the co-operative learning workshops which forms part of the ASPECT programme. The number of Black students registering for first year Engineering at U.C.T increased from 14% of the total enrolment in 1985 to more than 60% in 1995. All the first year Black Engineering students who are admitted to the ASPECT programme come from "ex-DET and TK" schools and disadvantaged socio-economic and educational background [Jawitz, 1994b; Greene, 1994]. In 1995 107 students were accepted into the ASPECT programme of which 79 students were from the "ex-DET and TK" schools [Pearce, 1995]. A total number of 378 students from all ex-Departments registered for Physics 110w of which 79 were ASPECT students from the "ex-DET and TK" schools and 45 mainstream from "ex-DET and TK" schools.

Students registering for B.Sc.[Eng.] can graduate with one of the following degrees, Chemical, Civil, Electrical, Materials and Mechanical Engineering [Engineering Handbook, 1995]. ASPECT students register for a 5 year degree programme whereas mainstream students do a 4 year degree programme.

ASPECT students register for 3 courses: Mathematics 1, Physics 1 and Engineering 1 as well as mainstream students who register for an additional 12 courses. Only ASPECT students attend the co-operative learning workshops which are compulsory, they write the same class tests, and June class test and November exam as “mainstream” students. The ‘flyers’ (high matric achievers) although they were under the auspices of the ASPECT programme took the standard mainstream first year curriculum and did not attend the co-operative learning workshops.

### 3.3 THE POPULATION

The two samples below were selected from a total of 378 Physics 110w students and only included students from “ex-DET and TK” schools who were accepted into the ASPECT and mainstream Engineering programme. Both groups wrote the same four standardised class tests, and the June class test and November exam. The minimum requirement for admission into the Engineering faculty which is a D in Maths (higher grade) and Physics (higher grade) and 40 matric points. Those students who obtained a C in matric Physics (higher grade) were allowed automatic entry. Those that did not qualify for the minimum admission requirement could enter via the University’s ‘alternative admission’ testing [Greene, 1994].

#### **Sample 1 [1995 experimental group]**

This group consisted of 79 first year Physics 110w ASPECT “ex-DET and TK” students. All these students matriculated prior to registration at UCT in 1995. All these students received bursaries from sponsors and were automatically admitted to ASPECT. However, they still had to meet the minimum admission requirements [Pearce, 1995].

They were all English speaking second language students and were all sponsored by industry and in residence at UCT.

Of the total 79 ASPECT students 62% gained automatic [C pass] entry into the faculty, 29% had the minimum requirement of a D and 40 matric points, and 9% were admitted via the alternative admission testing. Their Physics matric symbols were as follows: 6[8%] had As, 18[23%] had Bs, 25[32%] had Cs, 23[29%] had Ds and 7[9%] had Es.

### **Sample 2 [1995 control group]**

This group consisted of 45 1st year Physics 110w “mainstream” students “ex-DET and TK”. All these students matriculated the year prior to registration at UCT in 1995. They were all English speaking second language students. They all had some form of financial support in the form of loans or bursaries. These students were also given the choice to join ASPECT but chose to go in the mainstream programme [Pearce, 1995]. Of this 16 were ‘flyers’ [excellent matric pass] but due to an agreement made between sponsors and ASPECT staff, were admitted into the ASPECT programme and took the standard mainstream first year curriculum.

Of the total of 45 mainstream students 80% gained automatic entry into the Engineering faculty, 16% had the minimum D and 40 matric points, and 4% were admitted via UCT’s ‘alternative’ admission procedure. Their matric Physics results were as follows: 10[22%] had As, 16[36%] had Bs, 10[22%] had Cs, 7[16%] had Ds, and 2[4%] had Es.

It is important to note that the Engineering Faculty at UCT uses matric symbols and not raw scores to determine entry into the faculty. These symbols are converted into matric points dependant on the students’ matric symbols to gain entry into the engineer faculty. The matric point profile of the 79 first year Physics 110w “ex-DET and a TK” students shows a mean of 47.7 and a standard deviation of 5.44 as compared to the 45 first year Physics 110w “ex-DET and TK” students matric point profile which shows a mean of 50.4 and a standard deviation of 7.18 [see table 1 on p 36]. The matric point profile of the two groups show that there is no statistically significant difference between them in terms of academic ability. The overwhelming majority of both samples had the minimum D and 40 matric points on entry. It is well known that matric results of “ex-DET and TK” schools are bad indicators of academic success at tertiary level [Hofmeyr and Spence, 1990; Pavlich etal, 1995].

### **3.4 SELECTION OF DEPENDENT AND INDEPENDENT VARIABLES**

The ASPECT Physics 110w students' [79] and the “mainstream” Physics 110w students' [45] academic achievement in the four standardised class tests, and June class test and November examination were used as the dependent variables.

The four standardised class tests, and June class test and November examination papers were designed, checked and moderated by the Physics Department in the Engineering Faculty. The standardised class tests were written in March [test 1], April [test 2], August [test 3] and September [test 4] 1995 and each test was written for a duration of one hour. The November examination is written for a duration of three hours. The four class tests and June test counts 25% and the November examination counts 50% towards the final mark.

The co-operative learning workshops which are structured and organised by the ASPECT staff were used as the independent variable. The co-operative workshops are held twice a week usually on a Monday and Wednesday and last for about 2-3 hours per session in the afternoon. The workshops usually consist of 30 students and one facilitator and each student receives a worksheet which is specially prepared by ASPECT Physics 110w staff for a specific week. Students are divided into groups of 3-5 depending on the number of students in the workshop. Each group is expected to produce an answer to each question on the worksheet. The worksheets focus mainly on the work covered in lectures for that specific week. The co-operative workshops are held in rooms where the tables and chairs are arranged in such a way to facilitate group work [Greene, 1993; Greene, 1994; Pearce, 1995]. It is important to note that other independent variables [tutorials, study groups and other academic support, etc.] might produce the difference between scores. Given the scope of the research no other independent variables were taken into account.

### 3.5 SELECTION OF STATISTICAL TEST

This study used an existing data base consisting of the students in ASPECT Physics 110w and mainstream Physics 110w students, and the original 1995 Physics 110w results obtained by both groups which were compiled by ASPECT administrative staff. Permission to use the above data was given by Dr. Howard Pearce, ASPECT co-ordinator. The General Linear Model [GLM] of statistical analysis was used to analyse if there was any or no significant differences between the mean scores [average] of the two samples on their four standardised class tests, June class test, and November examination results. The GLM was used as the sample sizes for the two groups were too disparate to use the students T distribution. There is not much difference between the T-Test and the GLM, it is only that the GLM corrects the difference in group variance. This t-test form therefore does not assume that the variances of both populations are equal. This analysis tool and its formula perform a paired two - sample student's t-test to determine whether a sample's means are distinct [Baker, 1998; Hyper Stat Online, 1998]. The GLM procedure plots a linear relationship between the group using the method of least squares. The gradient of the slope indicates the degree of relationship between the samples [SAS Institute, 1989].

This statistical test was used because the research simply sought to find out if there was a statistically significant difference between the two groups across the class tests and examination. Unfortunately the research only looked at the first year (1995) in which the co-operative learning workshops were introduced in the Physics 110w course therefore there was not enough data to go into deeper statistical analysis. As Baker [1998:1] puts it '... if there is not enough data to do the analysis of variance, the only valid inference that can be made is that at least one population mean is different from at least one other population mean.' The research should be seen as a statistical model as the co-operative learning workshops are implemented over time which will make a broad spectrum of data available to do trend analysis and analysis of variance [Hyper Stat Online, 1988]. Whilst basic qualitative analysis could have been used to complement the quantitative data this could have led the research in a different direction. It was for the above reasons that the means of the two groups were compared to determine if there were or weren't any significant differences across the class tests and examination.

A comparison of the mean scores of each test was made to test for any significance or not between the two samples, e.g ASPECT students class test 1 results were compared to the mainstream students test 1 results. In 1992, Jeff Jawitz of the ASPECT staff used the comparison of means, to test for significance between the results of the ASPECT Maths 1 and Applied Maths student to that of Non-ASPECT Maths 1 and Applied Maths students between 1988 - 1992. Jawitz's research revealed that when the co-operative workshops were introduced in 1990 the ASPECT students pass rate was significantly higher than "mainstream" students [Jawitz, 1992b]. The tests and examination results [data] were analysed using the SPSS computer package.

### 3.6 CONCLUSION

The above methodology was used to test if there was any significance between the mean scores of the two samples to determine if there was a difference in the performance of the two samples. Given the scope of this research no detailed analysis of the correlation of individual ASPECT students' results across the class tests and examination were made given the number of extraneous variables which could have influenced individual student performance across the class tests and examination. The thrust of the research was whether the results of the ASPECT Physics 110w "ex-DET and TK" students differed statistically significant from the "mainstream" "ex-DET and TK" students across the four standardised class tests, June test and November examination.

## CHAPTER FOUR

### RESULTS

#### 4.1 INTRODUCTION

In this Chapter the results and analysis of the investigation are presented. The results are taken in order of the hypothesis, one which includes class tests 1,2,3,4, June class test and November Examination. A discussion of the emerging differences, if any, are presented in Chapter Five.

#### 4.2 HYPOTHESIS 1

"There is no significant difference between the results of ASPECT 1st year Physics 110w "ex-DET and TK" students and mainstream 1st year Physics 110w "ex-DET and TK" students in the four standardised tests, or in the June and November examinations."

##### 4.2.1 Class Test 1

On average the mainstream students performed better than ASPECT students [See table 4 on p.37]. The average test score for the mainstream students was 43.17% compared to 32.09% for ASPECT students which resulted in an average difference of 11%. In terms of the average scores both groups failed the first test. There is no statically significant difference [ $>0.75$ ] between the mean test score of the two groups [see table 4 on p.37].

This result was not surprising as "ex-DET and TK" students would still have carried over deficiencies from their schooling. Of the total 77 ASPECT students 61 [79%] failed and 16 [21%] passed the first test as compared to the total 45 mainstream students of which 27 [60%] failed and 18 [40%] passed [see table 2 on p.36]. Two ASPECT students were absent from the first test.

Looking at the results in more detail, 51% of ASPECT students scored between 0-30%, compared to 30% of mainstream students, and 56% of mainstream students scored between 50-90% compared to 33% of ASPECT students. The top end [above 50%] of the test scores are skewed in favour of the mainstream students while the lower end [below 50%] is skewed towards ASPECT students [see figures 1a, 1b on p.32 and 2 on p.33 as well as table 3 on p.37].

#### 4.2.2 Class Test 2

The average score of both groups is better than the average scores of test 1. ASPECT students' mean score was 56.46% and the mean score for the mainstream was 61.07% with a mean score difference of 5%. There was no significant difference [ $>0.86\%$ ] between the mean scores [see figures 1b on p.32 and 3 and table 4 on p.37].

Whilst the averages of both the mainstream and ASPECT students fluctuate in terms of their own averages across the tests and exams, from here on the mean score difference between the two groups never drops below 10% indicating a general trend of convergence from here onwards. The mean score difference between the two groups is smaller than class test 1 [see figure 1b on p.32 and table 4 on p.37] which might suggest an initial positive effect of co-operative learning on ASPECT students.

Of the total 79 ASPECT students 65% passed and 35% failed as compared to the total of 42 mainstream students 76% passed and 24% failed [see table 2 on p.36]. One mainstream student withdrew from the Physics 110w course and two were absent from the test.

Of the 32 mainstream students who passed the test 14 obtained a first class pass, 8 obtained a second class pass and 10 a third class pass. Of the 51 ASPECT students who passed the test, 13 obtained a first class pass, 24 a second class pass and 14 a third class pass [see table 3 on p.37]. "Mainstream" students are still performing better at the top end. Students who obtain a mark of 75% and above will obtain a first class pass, between 65% and 75% an upper second class pass, 60-65 a lower second class pass and 50%-60% a third class pass.

#### 4.2.3 June Test

The mean score difference between the two groups has not changed much from the previous test. The mean score for ASPECT students was 47.39% and the mainstream had a mean score of 52.63% with a mean difference of 5.24% [see figure 4 on p.34].

The majority of ASPECT students who failed the June test obtained an average of 47%, just 3% under the 50% critical level (the % needed to pass). There was no significant difference [ $>0.71$ ] between the mean test scores of the two groups.

Of the 79 ASPECT students who wrote the test, 49 failed and 30 passed compared to the 44 "mainstream" students of which 19 failed and 25 passed [see table 2 on p.36]. At the top end of the test scores, especially between 50-60% ASPECT students are retaining their achievement momentum. Of the 30 ASPECT students who passed the test 3 obtained a first class pass, 11 obtained second class pass and 16 third class passes. Of the 25 mainstream students who passed 2 obtained first class pass, 12 second class pass and 11 third class pass. One "mainstream" student did not write the test [see table 3 on p.37].

At the lower end [below 50%] a large proportion of both ASPECT and mainstream students scored between 40-49%. There remained a statistically insignificant difference between the means of the two [see figures 1a and 1b on p.32 as well as table 4 on p.37].

#### 4.2.4 Class Tests 3

Both groups performed poorly on this test. The mean score for the ASPECT students was 49.13 and the mean score for the mainstream students was 42.45 [see figure 1b, 5 on pp.32 and 34 and table 3 on p.37]. The difference in the mean scores between the two groups was not significant. Interestingly [ $>0.54$ ] the ASPECT students improved slightly [2%] from the June test while mainstream students deteriorated by 10% [see table 4 on p.37].

Of the total 79 ASPECT students 32 [41%] passed and 47 [59%] failed compared to the total of 42 "mainstream" students of which 11 [26%] passed and 31 [74%] failed [see table 2 on p.36]. 6 ASPECT students obtained a first class pass, 14 second class pass and 12 third class pass.

1 “Mainstream” student obtained a first class pass, 2 second class pass and 8 third class pass. 1 “Mainstream” student was absent from the test and two received a nought [see table 3 on p.37].

ASPECT students are still retaining the achievement momentum from the two previous tests at the upper end. This seems to give some indication that ASPECT students might be coming to grips with what it means to work co-operatively in groups, although one cannot conclusively put this down to the co-operative workshops without doing some observational schedules and tutors of these students have gained more experience in running co-operative learning workshops. Although, one says this with uncertainty since the study did not consider possible alternatives lecturers were offering to students. In discussion, Dr. Howard Pearce, co-ordinator of the ASPECT programme, confirmed that he instructed tutors to do intensive coaching and drilling of students on the work they completed for the third test, which could possibly account for the general improvement from the June test. However, it must be noted that the coaching or drilling of students is not consistent with co-operative learning as reviewed in chapter 2.

What is interesting to note here is that the mainstream students' results plummeted by an average of 10% from the June test, although this is not statistically significant [see table 4 on p.37]. Mainstream students might have become complacent by the third test because they were doing quite well in Physics in the 2nd and June tests or they might have not understood the work for the 3rd test. There remained a statistically insignificant difference between the means of the two groups [see table 4 on p.37].

#### 4.2.5 Class Test 4

Although ASPECT students average score had not changed from the 3rd class test, they are maintaining their performance. Of the total of 79 ASPECT students who wrote the test 40 [51%] failed and 39 [49%] passed. The ASPECT students pass rate had increased from the June test to the 4th test. Of the total of 42 mainstream students 21 [50%] failed and 21 [50%] passed. Despite the improvement of the pass rate of ASPECT students, they are on average still below the official critical level of 50% while the mainstream students are just above this level [see figure 6 on p.35 and table 4 on p.37].

The mean score for the ASPECT students was 48.93 and the mean score for the mainstream students 50.76. The mean score difference between the two groups had narrowed to point 1.83% from the previous 3 tests of 5-6%, which was not significant. At this stage the convergence of the average marks between the two groups is clearer. 2 [5%] ASPECT students obtained first class pass, 15 [38%] obtained second class passes and 22 [57%] third class passes, compared to 5 [24%] "mainstream" students who obtained a first class pass, 6 [28%] a second class pass and 10 [48%] a third class pass.

The bulk of ASPECT students who failed the test scored between 40-49% [see table 4 on p.37]. One "mainstream" student scored nought in the test.

#### 4.2.6 November examination

The majority of students in both groups passed the final examination. Of the total 77 ASPECT students 67 [87%] passed and 10 [13%] failed compared to the 41 "mainstream" students 35 [85%] passed, 6 [15%] failed [see table 2 on p.36].

The mean score of the two groups was almost identical, with the ASPECT students obtaining a mean of 59.74 and the mainstream a mean of 59.73, the difference clearly not statistically significant. The previous extremes had fallen away [see table 4 on p.37 and figures 1b and 7 on pp.32 and 35].

The examinations revealed that of the 67 ASPECT students who passed 8 [12%] achieved a first class pass, 29 [43%] obtained second class pass and 30 [45%] third class pass. Of the 35 mainstream students who passed 3 [9%] obtained a first class pass, 18 [51%] a second class pass and 14 [40%] obtained a third class pass [see table 3 on p.37].

A closer examination of the results revealed that the number of ASPECT students achieving first, second and third class passes had increased quite substantially when comparing the fourth test to the November examination. A similar increase is seen amongst mainstream students in second and third class passes as compared to the fourth test [see table 3 on p.37]. One mainstream and one ASPECT student were absent from the examination, and one ASPECT student did not obtain a DP [Duly Performed Certificate referred to at UCT as a 'DP'].

Although the claim that co-operative learning would enhance the academic success of educationally disadvantaged students was not directly tested in this study, one could draw some indirect conclusions from the results. It is difficult to claim that the co-operative learning workshops for ASPECT students is the reason for the success of ASPECT students at the end of the year because it was not directly tested, but looking at the results from the beginning of the year to the end of the year one could say with some conviction that something was affecting the averages of ASPECT students and adding to the learning process.

Both groups started the year poorly with a gradual improvement during the course of the year. ASPECT students showed greater improvement across the tests throughout the year relative to mainstream students despite the fluctuation in mean scores [see tables 2 and 4 on pp.36 and 37 and figures 1a and 1b on p.32]. The first test compared to the November exams shows that

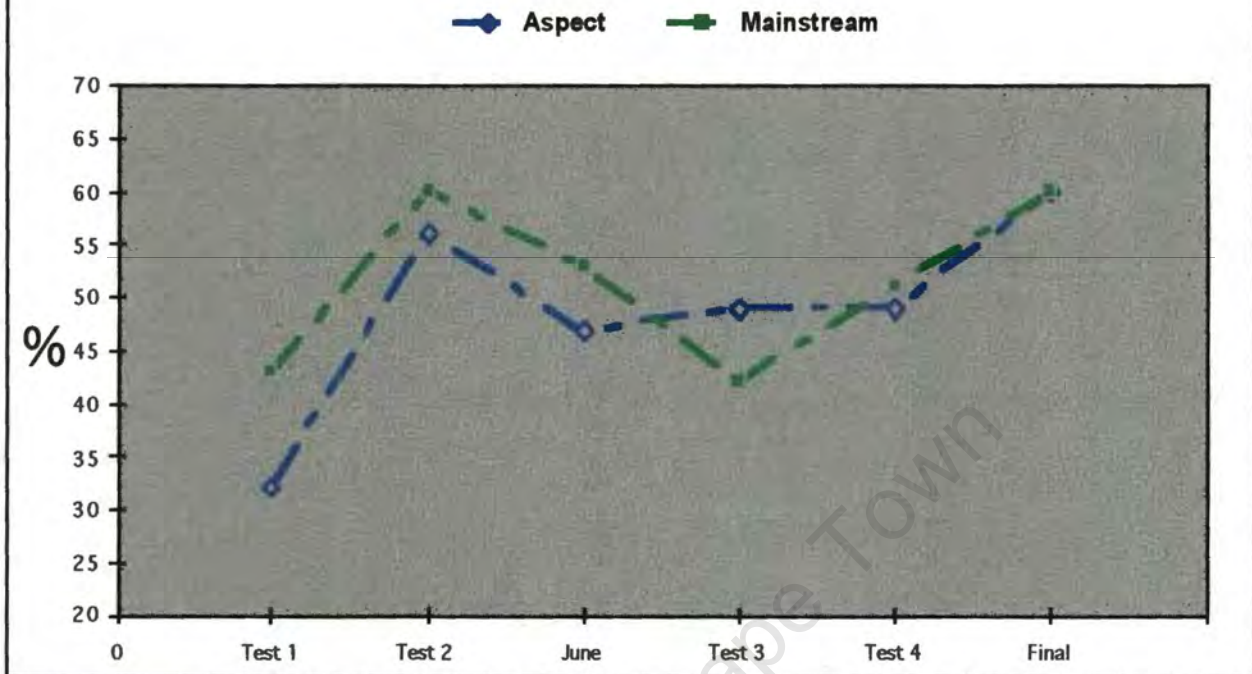
ASPECT students showed a mean score improvement of 28% compared to mainstream students with a mean score improvement of 17%. From the June test to the November exams the ASPECT students improved by an average of 12% compared to mainstream students 7% [see table 4 on p.37]. This also accounts for the convergence of the mean scores of the two groups. Despite the variations across tests the general trend of results was upwards amongst both groups. However, some students in both groups are still lagging behind [see table 3 on p.37]. It seemed that workshop tutors and ASPECT students had gained more experience in what is expected of them in the workshops and might be coming to grips with the idea of working together co-operatively. On the other hand the intensive coaching and revision done with ASPECT students before these tests and exam could also account for the general trend of convergence between the two groups. There still remained a statistical insignificance between the mean scores of the two groups.

Individual variation of ASPECT students across the tests was largely indicating differing facility with different components of the syllabus. Four flyers as well as four ordinary ASPECT students obtained first class passes. One 'flyer' made the Dean's merit list whereas no mainstream students did.

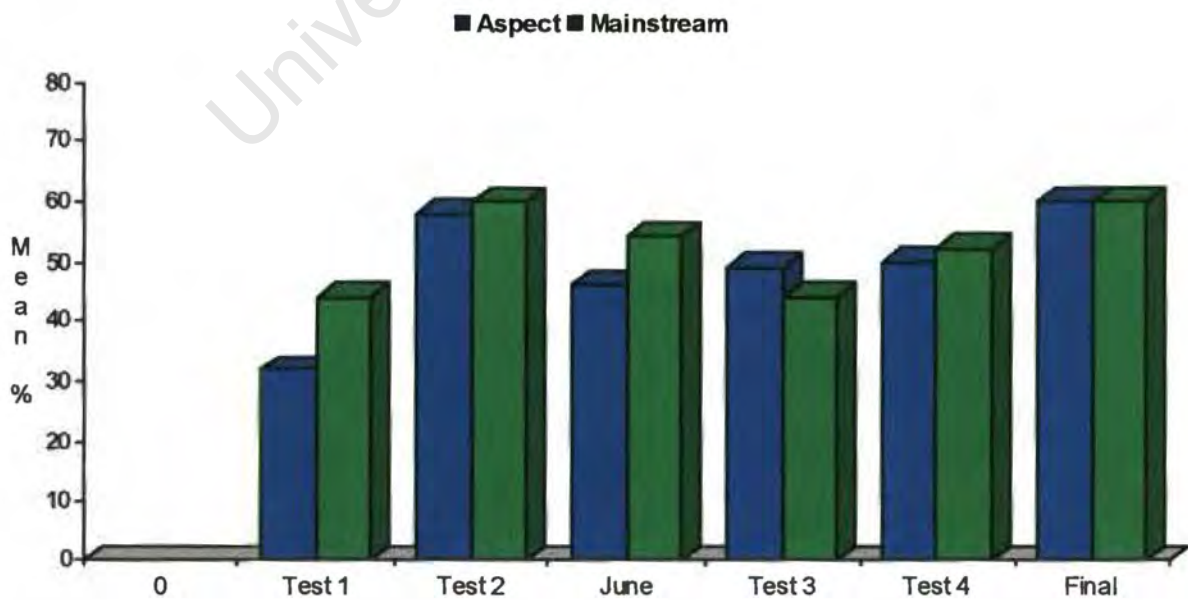
Of the 10 ASPECT students who failed the Physics 110w course, 6 failed consistently throughout the year, 4 failed 5 tests and passed 1, 2 students had no DP and were absent from the November exam. Of the total of 67 ASPECT students who passed the course, 16 passed 1 test and the November exam. Of the 6 mainstream students who failed, 4 failed consistently throughout the year and 2 were absent from the final exam. Of the total of 36 mainstream students who passed, 4 passed 1 test and the final exam. It is important to note that borderline candidates [48-49%] are sometimes pushed over and candidates who score between 45-49% in the final exam are allowed to write a supplementary examination.

It might be inferred from the above results, that the co-operative workshops are not doing all that much in terms of the success of ASPECT students. However, it is also not clear that had there been no co-operative learning workshops more ASPECT students might have failed the Physics 110w course. Individually the ASPECT students might have done as well as expected by the ASPECT staff, but as a group they do appear to have improved, relatively. There is still much debate as to whether co-operative learning does or does not increase individual student's results [see Sharon, 1990].

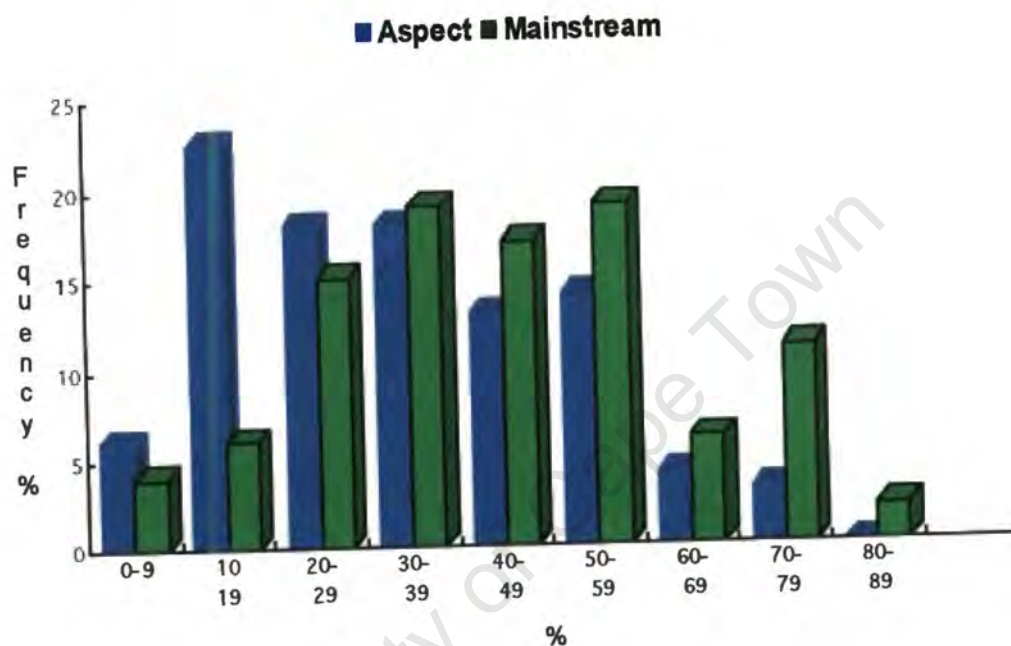
**Figure 1a:**  
**1st Year Physics 110W (ex-DET and TK student**  
**Test and Exam results 1995: graph of means**



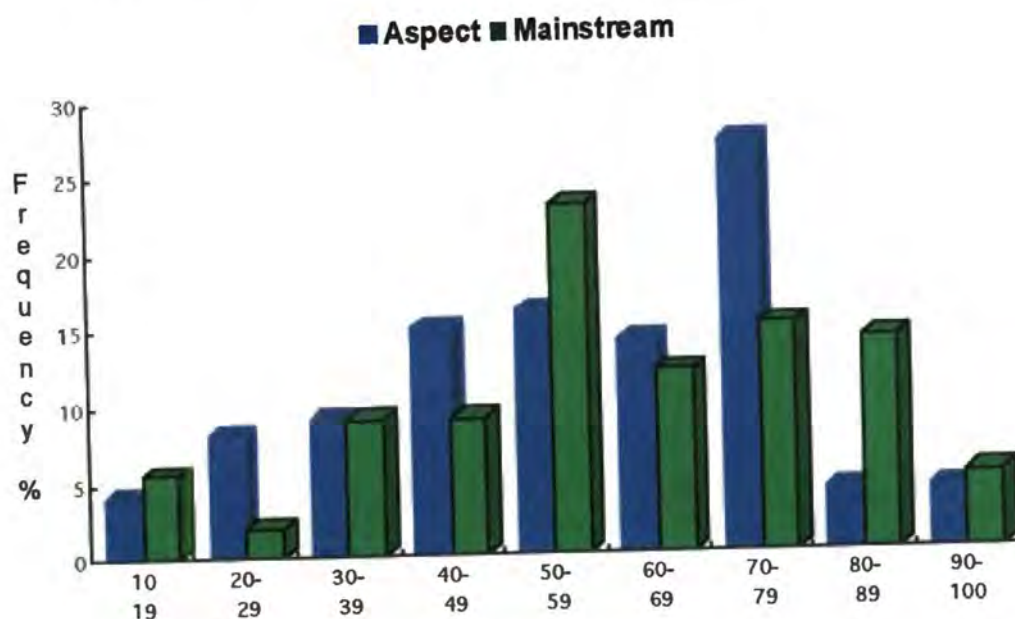
**Figure 1b:**  
**1st Year Physics 110W (ex-DET and TK students)**  
**Tests and Exam results 1995: histogram of means**



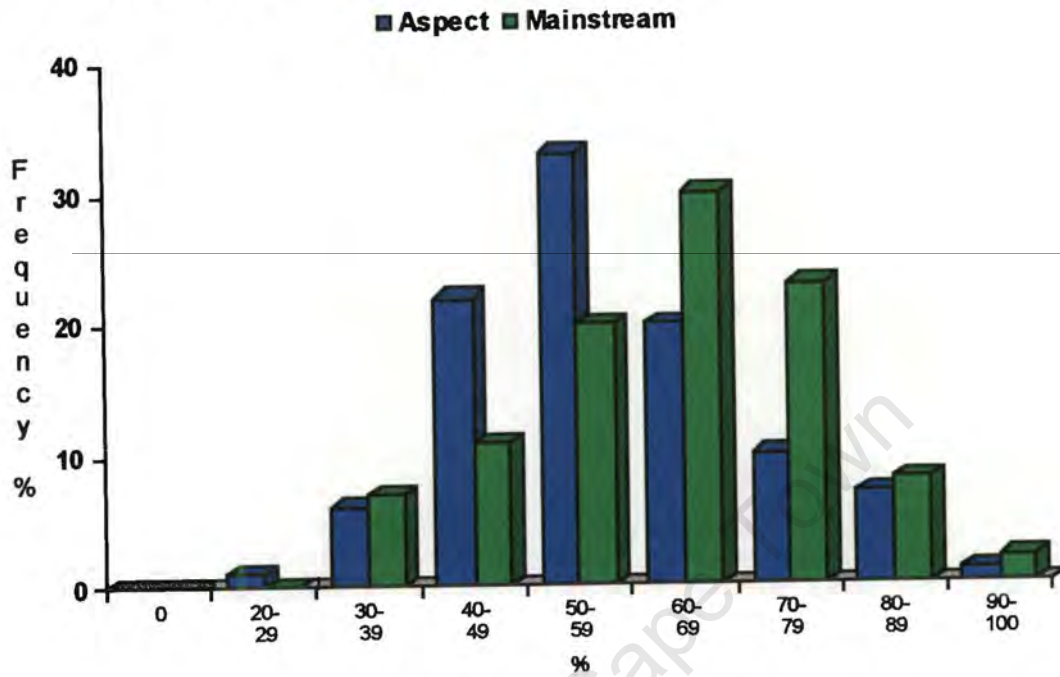
**Figure 2:**  
**1st Year Physics 110W (Ex-DET and TK students):**  
**Test 1 1995: histogram of frequencies**



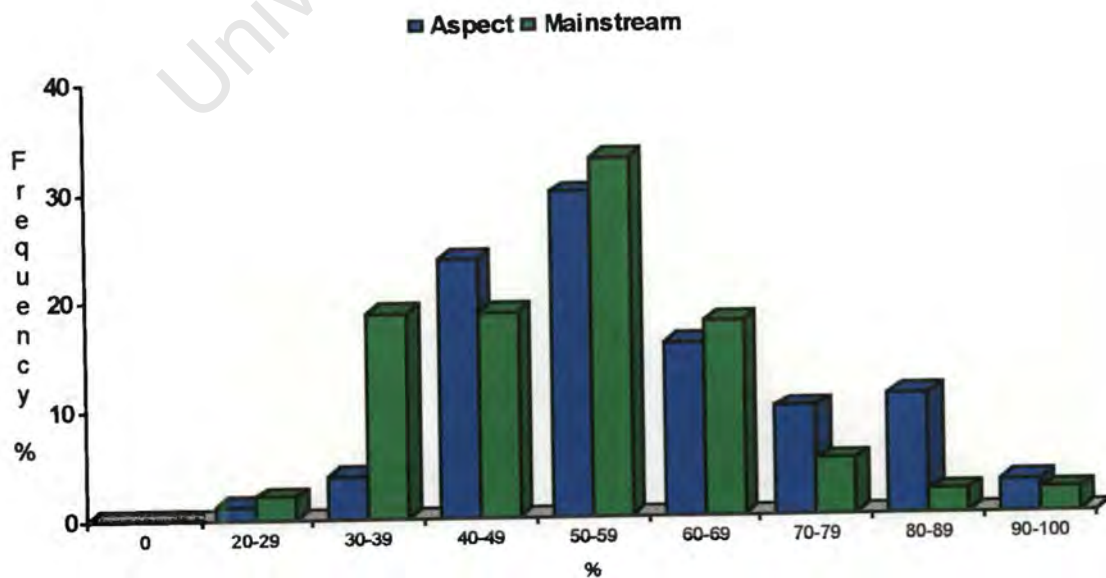
**Figure 3:**  
**1st Year Physics 110W (ex-DET and TK students):**  
**Test 2 1995: histogram of frequencies**



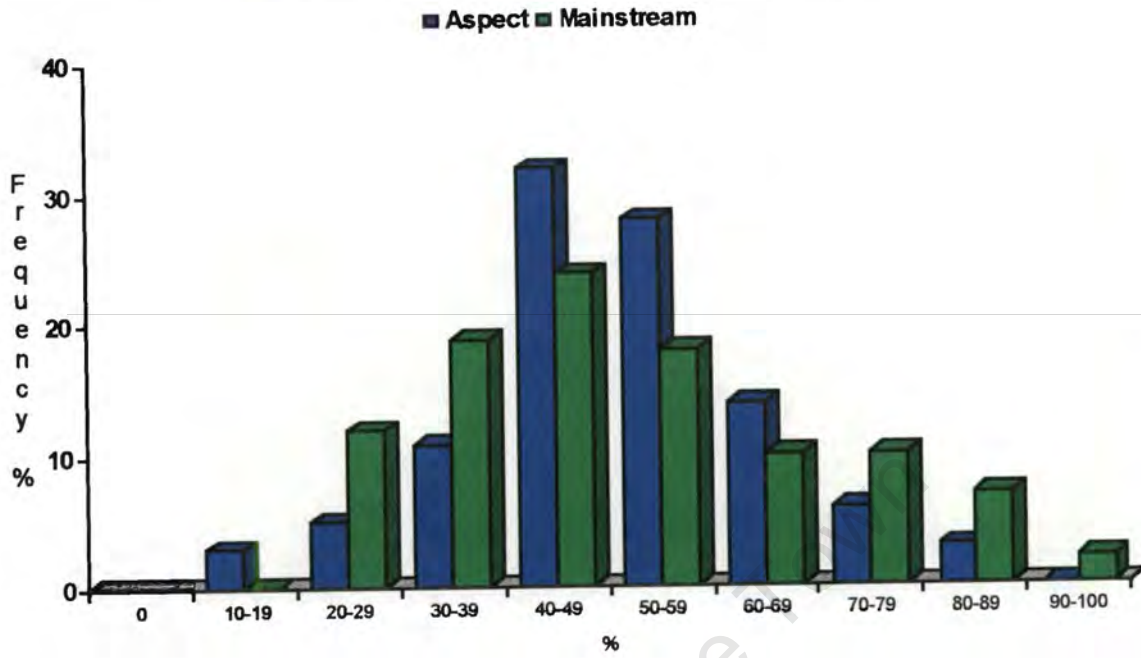
**Figure 4:**  
**1st Year Physics 100W (ex DET and TK students):**  
**June Test and Examination results 1995: histogram of frequencies**



**Figure 5:**  
**1st Year Physics 110W (ex DET and TK students):**  
**Test 3 results 1995: histogram of frequencies**



**Figure 6:**  
**1st Year Physics 110W (ex DET and TK students):**  
**Test 4 results 1995: histogram of frequencies**



**Figure 7:**  
**1st Year Physics 110W (ex DET and TK students):**  
**Final Exam results 1995: histogram of frequencies**

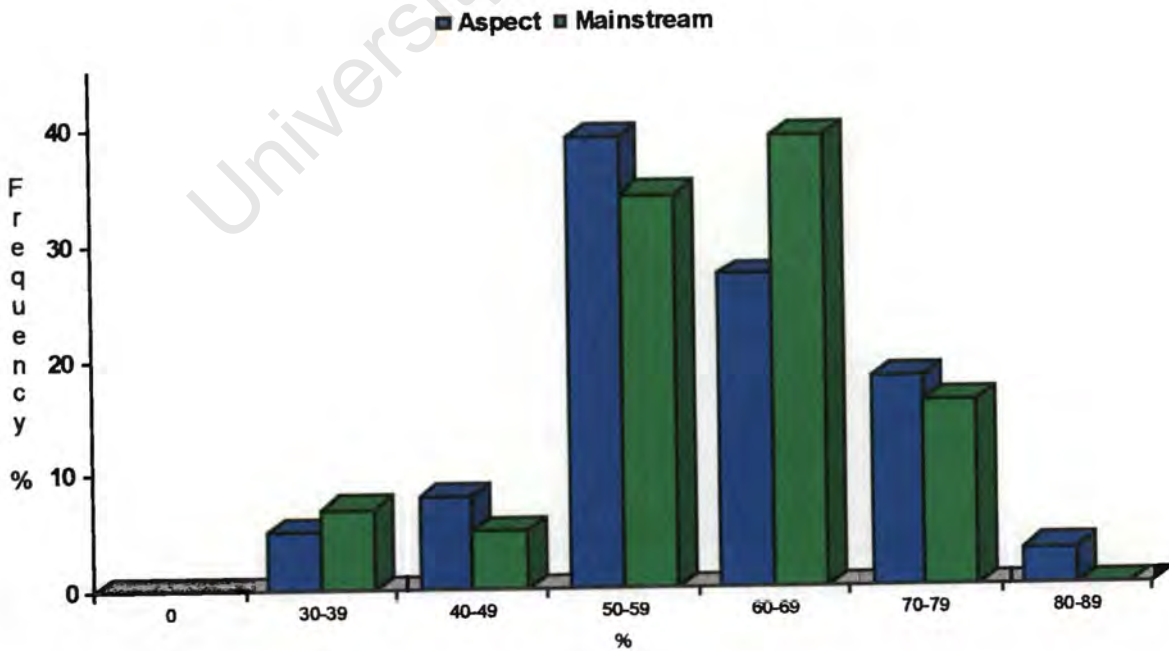


TABLE 1: MATRIC POINT PROFILE OF ASPECT AND MAINSTREAM STUDENTS IN 1995

ASPECT WITH "ex-DET and TK" MATRIC		MAINSTREAM WITH "ex-DET and TK" MATRIC	
X	SD	X	SD
47.7	5.44	50.4	7.18
			45

TABLE 2: A COMPARISON OF THE NUMBER OF PASSES AND FAILURES OF TESTS AND EXAMINATIONS OF ASPECT AND MAINSTREAM STUDENTS

	ASPECT STUDENTS			MAINSTREAM STUDENTS		
	N	TOTAL	%	N	TOTAL	%
FAILURES 1995						
TEST 1	77	61	79	45	27	60
TEST 2	79	28	35	42	10	24
JUNE TEST	79	49	62	44	19	43
TEST 3	79	47	59	42	31	74
TEST 4	79	40	51	42	21	50
NOVEMBER EXAM	77	10	13	41	06	15
PASSES 1995	N	TOTAL	%	N	TOTAL	%
TEST 1	77	16	20	45	18	40
TEST 2	79	51	65	42	32	76
JUNE TEST	79	30	38	44	25	57
TEST 3	79	32	41	42	11	26
TEST 4	79	39	49	42	21	50
NOVEMBER EXAM	77	67	87	41	35	85

TABLE 3 A COMPARISON OF TESTS AND EXAMINATION GRADES OBTAINED BY ASPECT AND MAINSTREAM STUDENTS

GRADES %	75%		60-75		50-59		40-49		30-39		20-29		10-19		0-09	
	T	%	T	%	T	%	T	%	T	%	T	%	T	%	T	%
T-TOTALS %	1	6	3	19	12	75	11	18	14	23	14	23	18	29	4	7
ASP. TEST 1	3	17	6	33	9	50	8	30	8	30	7	25	3	11	1	4
MS. TEST 1	13	25	24	47	14	28	12	43	7	25	6	21	3	11	-	-
ASP. TEST 2	14	44	8	25	10	31	4	40	2	20	2	20	2	20	-	-
MS. TEST 2	3	10	11	37	16	53	26	53	16	33	5	10	2	4	-	-
ASP. JUNE TEST	2	8	12	48	11	44	9	47	6	31	2	11	2	11	-	-
MS. JUNE TEST	6	18	14	44	12	38	24	51	19	40	3	7	1	2	-	-
ASP TEST 3	1	9	2	18	8	73	14	45	8	26	6	20	1	3	2	6
MS. TEST 3	2	5	15	38	22	57	24	60	9	22	4	10	3	8	-	-
ASP TEST 4	5	24	6	28	10	48	9	43	7	33	4	19	1	5	-	-
MS. TEST 4	8	12	29	43	30	45	6	60	4	40	-	-	-	-	-	-
ASP. NOV. EXAM	3	9	18	51	14	40	1	17	4	66	1	17	-	-	-	-
MS. NOV. EXAM																

TABLE 4 A COMPARISON OF MEAN TESTS AND EXAMINATION SCORES AND STANDARD DEVIATIONS OF ASPECT AND MAINSTREAM STUDENTS

	ASPECT			MAINSTREAM			F	DF	P
	X	SD	N	X	SD	N			
TEST 1	32,09	18,06	77	43,17	18,76	45	1.08	44.76	> 0,75
TEST 2	56,46	19,65	79	61,07	20,02	42	1.04	41.78	> 0,86
JUNE TEST	47,39	13,26	79	52,63	13,88	44	1.09	43.78	> 0,71
TEST 3	49,13	15,69	79	42,45	14,36	42	1.19	78.41	> 0,54
TEST 4	48,93	14,18	79	50,76	18,18	42	1,64	41,78	> 0,05
NOVEMBER EXAM	59,74	10,89	77	59,73	10,49	41	1,08	76,40	> 0,80

## CHAPTER FIVE

### DISCUSSION AND CONCLUSION

#### 5.1 INTRODUCTION

In this Chapter, the results of the statistical analysis are discussed, and conclusions are drawn about the effectiveness of the co-operative learning workshops as an intervention model at tertiary level.

#### 5.2 DISCUSSION OF FINDINGS

In this study no statistically significant difference was found between the results of the ASPEC 1 st year Physics 110w "ex-DET and TK" students and "mainstream" 1 st year Physics 110w "ex-DET and TK" students across the four standardised class tests, June class test and November examination for 1995.

The results clearly indicate an increase of results amongst ASPECT students especially after the third class test to the end of the year examination [see figure 1a. p32]. However, the pass rates of ASPECT students still remained below the 50% critical level [pass percentage] for class tests one, three, four and the June class test. By the end of the year the pass rates of the ASPECT and "mainstream" students are identical. There remained a statistically insignificant difference between the mean scores of the two groups across the four standardised class tests, June class test and November examination.

Unfortunately no trend analysis or analysis of variance could be done given that there was no pre-intervention performance data available, only one Physics 110w class comprising of ASPECT and "mainstream" students was analysed, it was the first year that co-operative learning workshops were introduced and no qualitative research was done made it difficult to identify specific outcomes or effects of the co-operative learning workshops. This research should rather be seen as a basis for doing further research on the effects of co-operative learning workshops on the performance of ASPECT students in the Physics 110w course over time.

A number of other variables could have influenced the number of ASPECT students passing at the end of the year, such as : fear of failing; fear of losing their bursaries or of not being readmitted or admitted to any other engineering course. ASPECT students could also have resorted to rote learning. A number of border-line cases also existed which meant that some ASPECT students could have been promoted. It is therefore difficult to claim that the co-operative learning workshops are the reasons for the majority of ASPECT students passing at the end of the year.

It is clear from the study that the effects of co-operative learning on the academic success of disadvantaged students is a complex question which is not easily answered by comparing mean scores only. More qualitative studies need to be conducted which includes interviews, observations, surveys, and so one, as well as longitudinal studies (over a period of 3 or more years), to establish whether co-operative learning does enhance academic performance [Sharon, 1990]. There is also a need for a better experimental design which controls for other factors and can show a causal relation to co-operative learning.

### 5.3 CONCLUSION

As stated at the beginning of this study the primary objective of the investigation was to analyse statistically whether the pass rates of 1<sup>st</sup> year Physics 110w ASPECT “ex-DET and TK” differ statistically significant to that of “mainstream” 1<sup>st</sup> year Physics 110w “ex-DET and TK” students in the Faculty of Engineering at UCT.

The two groups were relatively evenly matched in terms of socio-economic and education background and there was no statistically significant difference between the mean scores of their matric point profile. The hypothesis was confirmed that there was no statistically significance between the results of the two groups. Given the limitations of this investigation and the fact that there were to many other factors which might have contributed to the majority of ASPECT students passing at the end of the year as pointed out above; it is therefore difficult to claim that it was the co-operative workshops that caused the majority of ASPECT students to pass.

Furthermore, the co-operative learning tutors were asked to do intensive revision of course material, especially after the June class test, which could have contributed to the general improvement and the majority of ASPECT students passing the November examination.

As Webster [1988 : 301] puts it, "... 'success' means getting students through exams and in some situations because of time and other constraints on meeting needs, this is all one can hope to achieve'. Furthermore, given the fact that the first year Physics course has a heavy content load, students might have resorted to rote learning given the time and other constraints of the engineering course [Moulder, 1991].

The statistical results of this investigation could be used as a starting point for further study over a longer period by the ASPECT staff to assess the impact of co-operative learning on the Physics 110w course.

Valuable lessons could also be learnt from the local and international literature reviewed in this investigation. The study conducted by Jeff Jawitz [1992b] found a statistically significant difference between the pass rates of ASPECT Maths students and that of Maths students in the regular "mainstream" programme. The data used for this study was between 1988 - 1992 and showed a higher increase in pass rates amongst ASPECT students than all other students after the introduction of co-operative learning workshops in 1990 [see Jawitz, 1992b; Greene, 1994].

Because the co-operative learning workshops might have helped 1<sup>st</sup> year disadvantaged students in Maths does not necessarily mean that it would help Physics students to succeed since unlike Maths, it is claimed, Physics is a more conceptually based subject [Sahadeo, 1988]. Evidence suggests that one intervention model might not be appropriate for all subjects especially if one takes into account the type of knowledge involved [Pavlich et al, 1995, ]. Whilst ASPECT staff are enthusiastic about the success of co-operative learning workshops in a number of engineering faculties in the USA, the South African context is totally different. In the USA students have access to well resourced students centres, co-operative learning groups are smaller, focus is primarily on monitoring students, incentives are given to students, and co-operative learning workshops are voluntary [Hudspeth, 1990; Smith, 1989; Johnson and Johnson, 1992]. It is perhaps important that the ASPECT staff also consider creating the kind of environment and conditions as their US counterparts.

It is important that ASPECT staff ask themselves some policy questions. What is happening in the co-operative learning workshops especially if the average score is the same for “mainstream” students and ASPECT students at the end of the year? Perhaps they need to change their focus and concentrate on weaker students amongst both “mainstream” and ASPECT students.

There is clear evidence from studies conducted locally and internationally that co-operative learning is an effective strategy for improving the academic performance of students as compared with traditional methods of teaching and learning [Johnson and Johnson, 1987; Treisman, 1985; Jawitz, 1992b; Grayson, 1995]. Students who engage actively with each other in subject courses usually come to grips with skills and concepts they would otherwise not have learnt [Johnson and Johnson, 1992; Greene, 1994; Jawitz, 1994a; Hudspeth, 1989a].

It is evident from a number of studies conducted on co-operative learning that there are a number of considerations which should be taken into account of when using co-operative learning as an intervention model to enhance the academic success of 1<sup>st</sup> year disadvantaged students. Firstly, one should take into account the theoretical underpinnings of co-operative learning and not some rudimentary understanding of what co-operative learning is. Secondly, those wanting to use co-operative learning as an intervention should develop a clear conceptual framework based on studies conducted on co-operative learning as well as experiences of local and international practitioners of co-operative learning so as to understand what co-operative learning is in a particular context and not one based on gut feelings [experiences] and anecdotes from students, since this can be highly subjective.

Such a conceptual framework should inform practice. Extensive planning, selection of students, orientation programmes for students, training for ASPECT staff and tutors, and workshop programme development are also important [Treisman, 1985].

It is evident from the literature in this study that one could only infer that co-operative learning workshops might contribute to 1<sup>st</sup> year disadvantaged students academic success and given the fact that its practitioners claim that it could be a new broom to sweep away the legacy of apartheid schooling [Jawitz, 1994; Greene, 1994; Grayson, 1995]. The effects which co-operative learning have on academic success is a complex question, one which is going to need further research by way of combing hard data (quantitative) research and soft data (qualitative) research through observations, interviews, questionnaires, and so on [Hofmeyr and Spence, 1990; Knight and Bohlemeyer 1990].

The wealth of research on co-operative learning and its achievements published thus far demonstrates the academic benefit of co-operative learning compared to other traditional methods [Johnson and Johnson, 1987; Knight and Bohlemeyer, 1990; Lazarowitz and Karsents, 1990].

Furthermore, given the concerns of the ASPECT staff about 1<sup>st</sup> year engineering students' high failure and low retention rates, as well as the science and technology needs of South Africa in terms of person power [Pouris, 1989; Cooper, 1993; Weekly Mail, 20/02/1997, Monday Paper 15(16), 19996], there is not only a need to produce more engineers but also to make engineering education more productive in terms of the South African economy.

The ASPECT staff will have to decide how to optimally utilise the co-operative learning workshops to improve the success rate of 1<sup>st</sup> year disadvantaged students in engineering at UCT. There are enough lessons and experiences to draw from the wealth of literature, experience and research on co-operative learning workshops both locally and internationally. The urgency of producing more engineers in South Africa which is part of the overall technological needs and economic development of South Africa; highlights the importance of implementing an intervention strategy which will address this urgency. Overall, however, it appears that the co-operative learning workshops is an encouraging initiative by the ASPECT staff to address the teaching and learning process in engineering as well as to address the low level of success of disadvantaged students in their first-year course in engineering at university.

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## APPENDIX A

### THE ASPECT PROGRAMME AND CO-OPERATIVE LEARNING WORKSHOPS

#### Aims and Objectives of ASPECT PROGRAMME

Allows ASPECT staff to look critically at their teaching and students learning;

To create an environment that is sensitive to students academic and non-academic needs;

Address the issues of retention, academic success and graduation rates of 'disadvantaged' students;

Structured support environment;

Change the learning behaviour of students from 'surface' to 'deeper' learning;

Correct undesirable learning behaviour;

Address the issue of cultural alienation;

Provide external structures that will help students to internalise attitudes and behaviour that are likely to help them succeed;

### COLLABORATIVE LEARNING WORKSHOPS

#### Aims and Objectives

- \* To become an integral part of the teaching programme;
- \* Create a structured support environment;
- \* Attain high levels of pass rates in the first year;
- \* Change the learning behaviour of students' from 'surface' to 'deeper' learning
- \* Encourage independent learning [group];
- \* Develop students' attitude to learning and learning behaviour that will help them succeed;
- \* Develop skills and abilities to conceptualise;
- \* Emphasis a conceptual understanding of Science [Physics];
- \* Increase student participation;
- \* Discourage individualism [in terms of isolation];
- \* Minimum input of facilitators, withdrawal of the teacher;
- \* Help weaker students improve problem-solving skills;

- \* Allow students to think for themselves, justify their positions, reason logically and rationally, explain ideas to peers and facilitators, and to tackle an experiment or solve a problem; [each one teach one];
- \* Empower students in the learning context;
- \* Develop cognitive skills:- critical thinking, communication and reasoning skills;
- \* Develop practical and metacognitive skills [reflect on their own learning];
- \* Develop students knowledge of Physics content and processes by which they learn Physics;
- \* Develop a deep approach to learning, i.e to search for inner core of the argument and to question, perhaps develop a challenging attitude to material as opposed to superficial and surface approach.

#### Curriculum change

Greater exposure to engineering, especially for those students not exposed to engineering art and facts, jargon and concepts; To unjam the Physics 1 course.

#### Communications Course

Allow students to acquire the language of the discipline [Engineering] - writing and speaking skills.

FACSIMILE COVER SHEET

24 Frances Street  
DEL JUDOR x 4  
WITBANK  
1050

P O Box 20157  
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WITBANK  
1034

TO: Fax No: 011-7553167 Attention: MR FERDI KONIG

Institution: LOWVELDESCARPMENT DISTRICT COUNCIL

Remarks: INTERVIEW & QUESTIONNAIRE SCHEDULE WHITERIVER

WED/30/06/99: 50% of staff from outlying municipalities  
Nkomazi E & W, Pilgrims Rest etc

10:00 - 11:30 - questionnaire & individual interviews

14:00 - 15:30 - The second group of staff from above  
areas

Thurs/1/07/99 = 50% of H.O staff: 9:00 - 10:30

Include: Barbaton's Lydenburg " " " : 14:00 - 15:30

FRI/2/07/99 = Interviews with H.O. staff +  
meeting with the steering com. at 12:00

No. of pages: 1 (including cover page)

FROM: Mr Trevor Taft

Tel. No: [013] 692 8149

Fax No: [013] 656 2885/6

Signed by: .....

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Date: 29/06/99

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TO: Fax No: 012-3282595 Attention: Dr T. Williams

Institution: DEO-EU

Remarks: Request to fax tender specifications

Contact person: Trevor Taft

Telephone and fax details are written below.

Thanks

Trevor

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