

Final report on a pilot research project for mathematics teacher
educators and teachers in Gauteng.

INVESTIGATING THE ROLE OF COOPERATIVE
GROUPWORK IN LEARNER ACHIEVEMENT IN
MATHEMATICS

PEI Research Project

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Project Leader: Dudu Mkhize

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EXECUTIVE SUMMARY

The pilot project aimed to investigate the role of co-operative groupwork in learner achievement in mathematics in high schools and colleges. Four high schools and one college in the East Rand townships were originally involved in the project. The design was experimental for schools and qualitative for the college. Time constraint as a result of prevalent disturbances in township high schools, as well as the lack of prerequisite knowledge for lessons meant to be part of the intervention aborted the original experimental design aspect.

The study, then focused on the investigation of the perception of cooperative groupwork held by educators and learners in three high schools and college. Based on these perceptions, inferences were made on what could contribute to the improvement of achievement in mathematics.

The study revealed that what high school learners know about cooperative learning is mostly through their own initiative (see responses to item 2, p18) The project found that school learners' experiences of cooperative groupwork were very close to what is expected from teaching mathematics in a cooperative groupwork approach in an OBE context. For example, "understanding and expressing this understanding were the main reasons why high school learners enjoy learning mathematics in cooperate groups. On the other hand through classroom observations and interviews it was found that both school and college educators use cooperative groupwork in a very limited manner for mathematics teaching. This led to the conclusion that teachers do not seem to know what makes their teaching a learning experience for their students.

The shocking finding was the discrepancy between the mathematical knowledge of grade level 11 students to the grade 11 mathematics curriculum.

The study also revealed that high schools lack basic knowledge on the implications of the impending OBE to their mathematics classroom practices and hence traditional teacher-centred methods are still prevalent. Lastly, the study found that cooperative groupwork in mathematics teaching has a potential of improving achievement in mathematics since understanding is a step towards achievement

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1 INTRODUCTION

1.1 Background

Apartheid promoted inequalities among South African citizens. Inequalities were more pronounced in the education system. Disparities in curricula for different races existed. Invariably, some learners were well equipped for life after school whilst the majority were ill equipped. In a move to address this problem, a national curriculum which is based on the outcomes was introduced in 1997. In launching the Curriculum 2005, Dr Bhengu who is the minister of education and training stated that, "The curriculum aims to equip all learners with knowledge, competencies and orientation needed for success after they leave school." Success after school was restricted to the select group in the country. Job reservation ensured this. The new constitution guarantees access to success for all citizens. The new curriculum therefore is set to provide preparation for the new citizens.

Translating the Curriculum 2005's aim into mathematics education means that learning mathematics should contribute to the success of the lives of learners by equipping them with the knowledge, competencies and orientation transferable to their work situation or life long learning. Therefore, mathematics learning should change for better as a result of C2005. One of the expected changes is the improvement in mathematics learner achievement. Application of mathematical knowledge into real life, in accordance with C2005' aim, requires higher levels of understanding which is far more than mere memorisation of definitions, theorems, algorithms with an aim of applying these to maths problems and exercises which do not relate to real life. Invariably, such an approach in teaching and learning should yield to higher achievement in the subject. Improvement in mathematics achievement would be a welcome shift from the generally low achievement evidenced by national average matric pass rates in mathematics of about 20% for black students for the past five years. In the Third International Mathematics and Science Study (TIMSS) coordinated in South Africa by the HSRC in 1995 for standards five and six students , South Africa performed worst of forty one countries which took part in TIMSS.

1.2 Aims and Objectives for the study

Cooperative groupwork is an approach of teaching and learning that is a vehicle of many benefits that are supposed to be brought about by the C2005.

The study aims to investigate the role of cooperative groupwork in mathematics learner achievement within the context of OBE-Curriculum 2005. Closely linked to the role of cooperative learning in enhancing achievement, is its perception held by educators. This has an impact on how cooperative groupwork is implemented in schools and colleges of education. This study will therefore, also investigate the perception of cooperative groupwork held by mathematics teachers, teacher educators, and learners.

PRESET institutions such as colleges of education are responsible for equipping future teachers with the necessary skills, knowledge and values required for good performance in their careers. Classroom practices for teachers is linked to the quality of teacher training they had. In fact, poor performance in mathematics has been blamed on poor college teacher preparation by the National Audit on Teacher Education (1995) and by the EduSource Survey on Mathematics and Science Teachers (1996) in South Africa. Therefore, the study has an objective to give a holistic view of what is perceived as cooperative group work by mathematics educators at Pre-Service and at In-Service levels.

1.3 Limitations

The prescribed duration of the study was a serious limitation. Meetings and negotiations with possible participants started in 1998 May. June is an examination month and July is a holiday month. Teachers spent about two weeks marking June scripts after winter holidays. Thus the actual field work only began in August. Unforeseen disturbances in colleges and schools occurred during the set period for the project which inhibited satisfactory progress for the study.

The week of the 13th June was to be used to visit individual schools as a follow-up on the joint meeting that had been held with both the principals and mathematics teachers. However, the looming national strike for teachers, organised by SADTU, made communication or contact with schools impossible.

The culture of boycotts prevalent in schools and colleges exacerbated difficulties with the time frame for the research project. Class boycotts and the threat of the national strike impinged on the schedule of activities for the research project. During the period of negotiations with the schools and the colleges, there were two class boycotts by students in the Rand College and in one high school

2 THEORETICAL FRAMEWORK

Cooperative groupwork formulates one of the critical outcomes in OBE-Curriculum 2005, namely, "learners will work effectively with others as members of a team, group, organisation and community". Cooperative groupwork is also implicitly encouraged in the definition of mathematical literacy, mathematics and mathematical sciences; "...this understanding is expressed, developed and contested through language, symbols and social interaction". Social interaction provided by groupwork provides an ideal opportunity for expression and debate by learners.

Jarwoski (1998) contends that Curriculum 2005 is only a framework that requires an agenda of action. Cooperative groupwork in the context of the OBE curriculum should be treated as a priority of this agenda of action. The reason being that, cooperative groupwork invokes various curriculum issues which will have to be transformed as a consequence of OBE, for example, assessment. However, of interest to this study is the perception of cooperative groupwork and its relationship with learner achievement in mathematics.

2.1 What should cooperative groupwork be like in the South African context? Dictionaries reflect a variety of meanings of the word "cooperative". According to the new edition of Oxford Dictionary of the 1990s to cooperate means to work together or to concur in producing an effect whereas according to the pocket Oxford Dictionary; to cooperate means to be helpful and do as one is asked. The later does not seem to support independent thinking. The motivation for introducing a new national curriculum came from the need to transform the fragmented curriculum which sought to repress and confine the potential of the majority of the country's learners by perpetuating the authoritarian approach of teaching and learning.

Obedience to the authorities was a desired outcome for education for many citizens who were destined to be semi or unskilled servants in the country. The new curriculum seeks to develop the potential of all South African citizens. This transformation has to be in accordance with recommendations made by new policies in education and training such as the White paper on Education and Training (1995):

The curriculum, teaching methods and textbooks at all levels and in all programmes of education and training, should encourage critical thought and independent thinking, the capacity to question, enquire, reason, weigh evidence and form judgements, achieve understanding, recognise the provisional and incomplete nature of most human knowledge.

Therefore the meaning of "cooperative" that fits in with this study is given by Webster's dictionary, i.e., to cooperate is to work together for a common purpose." Cooperation in this study is viewed in the light of the aimed development and transformation of the country's education. Encouraging critical and independent thought, the capacity to question, enquire, reason, weigh evidence and form judgements in order to achieve understanding in mathematics learning, will formulate the common purpose of cooperative learning for this study.

Within the context of teaching and learning, cooperative group work is a general teaching strategy which can be used with any age group and any subject matter where students work in small learning teams, helping each other, to accomplish individual and group tasks. Graves and Graves (1990) cite the following as the basic indicators of cooperative groupwork: "face-to-face heterogeneous learning teams, positive interdependence, individual accountability, explicit training in interpersonal skills and reflection". These indicators concur with Lazear's (1994) key elements of cooperative groupwork which are:

- ? Bringing in higher-order thinking and reasoning to a lesson. Ensuring individual learning.
- ? Creating positive interdependence. Activities must create a sense of "We need one another for this lesson".
- ? Providing reflective time for students to look over the content and their cooperative behaviour.
- ? Development of the necessary social skills.

These elements bring together some of the outcomes of education as a result of the implementation of C2005.

2.2 Democracy and Cooperative group work.

South Africa's past is not well-endowed with experiences of democracy. The political events in 1990 paved the way to the country's democracy. Democracy is characterised by social equality and tolerance within society, which was a far cry from the South African society prior to 1990. The education system in SA, (as in the case across the globe), has an obligation to educate the country's citizens in accordance with the country's new constitution (launched in 1997) which upholds democracy. OBE- Curriculum 2005 purports to introduce some of the democratic principles, for example, the principle of equality: "all students can succeed". More importantly for this study, OBE's advocated approach of teaching, cooperative groupwork, provides an opportunity to expose learners to the democratic principle of tolerance and equality. When learners are working in cooperative groups, an emphasis is made that members' opinions are equally valued and therefore they have to tolerate one another.

Malcolm also (1997) asserts that learners can gain experience about democratic principles and processes by practising these in the classroom through cooperative group work.

2.3 Cooperative groupwork and its location in the OBE-Curriculum 2005

Bhengu's statement about the new curriculum is in fact a reiteration of what William Spady, the OBE proponent says. According to Spady (1985) the fundamental purpose of OBE is to equip all students with the competencies, knowledge and orientations that enable them to lead successful lives following their school experience. The only way to succeed in this is to have the learning centres as the practice grounds for life roles. In any case knowing the content knowledge without applying it in real life limits the value of the knowledge in improving the quality of life. Spady claims that outcomes cover three broad areas namely, competencies, knowledge and orientations.

1. Competencies: Include not only the foundation skills of literacy, mathematics, psychomotor abilities, and an essential base of cultural and practical knowledge; but also the higher order skills of analysis and interpretation, reasoning and problem solving and

creatively formulating ideas and translating them into tangible results.

2. **Knowledge:** In both the academic subjects areas and in the essential life roles which students will be occupying as adults.
3. **Success-orientations:** Which include the essential affective, attitudinal, motivational, and social orientations and qualities which enable individuals to relate well to themselves and to the world around them.

Linear programming was chosen by participants as the content area to exemplify the cooperative groupwork mode of teaching. Even though, its choice was motivated by the difficulty teachers normally experience in teaching this topic, it was an excellent example to illustrate three areas of outcomes stated by Spady.

Traditionally, students are taught linear programming without an awareness of its application in their possible future lives, such as, chemical engineers, dieticians, businesspeople etc. In which case the knowledge of the life roles that can be practised as a result of the skill acquired in designing a linear program is ignored. Constraints in a linear program provides opportunities for different members of the team to work around each constraint with a purpose of arriving at an acceptable program (feasible region). Cooperative groupwork became the pillar of modelling OBE! In any life situation, development, progress and productivity for a particular team or community or society or nation depends on contributions made by its members. Thus knowledge about life roles is in essence, knowing about each members' role in a cooperative setting.

Generally, the view of mathematics held by educators influences the way it is taught and consequently, the way it is learnt. The definition of mathematics in the Curriculum 2005 Document provides a fresh view of the subject .

Mathematics is the construction of knowledge that deals with qualitative and quantitative relationships of space and time. It is a human activity that deals with patterns, problem-solving, logical thinking, etc. in an attempt to understand the world and make use of that understanding. This understanding is expressed, developed and

contested through language, symbols and social interaction. (NDOE, 1997)

This is a shift from the popular notion of mathematics as an absolute body of knowledge which does not leave much room for debate and hence teachers has to do their best in transmitting it to the learners. In which case, lecture method in a whole class approach is suitable for teaching. However, if learners have to create knowledge , express and contest their understanding; cooperative groupwork as a stage for social interaction becomes one of the essential approaches of teaching mathematics.

Lastly, the development and the practice of four skills articulated in the critical outcomes of Curriculum 2005, namely, problem-solving, teamwork, research and communication (both mathematical and language) can be attained through cooperative groupwork. These can be

SKILLS	CRITICAL OUTCOMES
PROBLEMS -SOLVING SKILLS	<i>Identifying and solving problems in which responses display that responsible decisions, using critical and creative thinking, ave been taken.</i>
COOPERATIVE SKILLS	<i>Working effectively with others as member of a team, group, organisation, community.</i>
RESEARCH SKILLS	<i>Collecting , analysing, organising and critically evaluating information.</i>
COMMUNICATION SKILLS	<i>Communicating effectively using visual , mathematical and /or language skills in the modes of oral and /or written persuasion.</i>

Table 1

2.4 Reconstruction and Development in mathematics education

The theme permeating the transformation of the country's education is Reconstruction and Development. As a consequence of the view of mathematics which comes with the new curriculum, reconstruction and development is expected in mathematics education. One of the vehicles can be cooperative groupwork. Through this approach, the teacher centred mathematics lessons has to be reconstructed into learner centred lessons which give learners opportunities to ask questions, discuss ideas, listen to others' ideas and defend their ideas. This will enable

learners to make more sense of mathematical concepts. On the other hand, teachers will begin to listen to their students more than they have ever done before. The change in mathematics learning and teaching will be inevitable! Lerman (1993) refers to this change as the deconstruction of the unproductive classroom. The change is mainly from docile, inactive learners and authoritarian teachers to active, communicative learners and teachers.

2.5 Cooperative groupwork in mathematics education in other countries

In the United States of America, the role of cooperative groups in developing mathematical processes is explicitly addressed in the Curriculum and Evaluation Standards for School Mathematics by the National Council of Mathematics (1989):

Small groups provide a forum for asking questions, discussing ideas, making mistakes, learning to listen to others' ideas, offering constructive criticism, and summarizing discoveries in writing. Presentation of individual or group reports provide an environment in which students can practice and refine their growing ability to communicate mathematical thought, processes and strategies.

As a result most innovative projects which sought to implement the Curriculum and Evaluation Standards for School Mathematics in the United States, advocated cooperative learning as an important methodology in learning and teaching mathematics. For example, "The Math Solution", is an-service program which was created by Marilyn Burns. It is dedicated to the improvement of mathematics education. Cooperative groups are an integral part of the program. Because of its success it spread nationwide in the USA during the late eighties.

According to Terwel (1990), in the Netherlands cooperative learning is reported to have been an integral aspect of the innovation in mathematics education. Freudenthal, a well known Dutch mathematician proposed heterogeneous groups within the heterogeneous class as an alternative to unsuccessful approaches such as streaming and interclass differentiating which were introduced by German's mathematics educationists in the early seventies. Freudenthal argued that the discussion of different ways of solving a problem by students who worked together as a group, may significantly assist them in learning

influenced the innovative mathematics curriculum (Realistic Mathematics) developed by the Freudenthal Institute the Netherlands in 1981.

Reporting the results of the project, Terwel (1990) contends that cooperative learning is like a rich gold mine. However, Terwel admitted that it took twenty years of researching and developing strategies of implementing cooperative groupwork to the level where significant improvement in achievement in mathematics could be observed!

2.6 Cooperative groupwork and constructivism

Vygotsky (1978) contends that social relations among people underlie all higher cognitive functions and their relations. Also other proponents of constructivism view cooperative groupwork as an ideal environment for learners to construct knowledge. These include Cobb, Wood & Yackel (1990) who claim that social interaction through cooperative groupwork, according to, constitutes a crucial source of opportunities to learn mathematics through constructing individual's mathematical knowledge.

Constructivism asserts that all knowledge is constructed by the individual. Therefore what constitutes knowing can only be interpreted as that which the individual conceptualises. Much of what happens during group work forms the basis of construction and conceptualisation of knowledge. "To a large extent, constructivism underpins C2005, " mathematics is the construction of knowledge..... Innovative work that has been done in mathematics education for the past decade has been based on constructivism and clearly its exemplification is in cooperative groupwork.

2.7 Cooperative groupwork and achievement in mathematics

Reviews on cooperative group work in mathematics by Davidson (1985, 1989), and by Webb (1985;1989) have shown positive effects in other areas as well as in academic achievement. Davidson (1989) reviewed more than 70 studies in mathematics comparing achievement in cooperative learning versus whole class traditional instruction. In more than forty percent of these studies, students in the small groups significantly outscored the control students on the individual mathematical performance measures. Terwel (1990) claims that as a result of cooperative groupwork learners offered and received explanation from one another and these

were often useful in providing insight and in reaching higher levels of understanding. Test results showed significant progress from pre-test to post-tests.

What is also of interest are other gains in mathematics learning which are promoted by cooperative groupwork. Schoenfeld (1987) found that cooperative groups engage in behaviour that is similar to those exhibited by expert mathematicians when they solve problems. They begin to monitor their own thoughts, the thoughts of their teammates and the status of the problem.

Artzt (1990) also claims that cooperative groupwork has been credited with the promotion of critical thinking, higher-level thinking, and improved problem solving abilities of students.

3 RESEARCH DESIGN AND METHODS

3.1 Research questions

As stated under the aims and objectives, the purpose of this study was to investigate the role of cooperative groupwork in mathematics learner achievement within the context of the OBE informed Curriculum 2005. Two questions were guiding the study:

- (a) What do mathematics educators and learners perceive as cooperative groupwork within the context of OBE-Curriculum 2005?
- (b) What is the impact of cooperative groupwork on learner achievement in mathematics?

3.2 Research design

The overall design of the study was experimental where achievement in mathematics is a dependant variable on the approach of teaching and learning mathematics. The baseline study, which included surveys, would serve to inform the nature of the intervention programme necessary. Statistical analysis would then be compare the achievements of the control and experimental groups.

3.3 Selection of participants

3.3.1 Criteria

Four high schools and one college of education in East Rand were selected to participate in the study. The experimental group came from two schools and the control group came from other two schools in the same area. Participants in schools were involved with grade eleven mathematics content. Whereas college participants were involved with the methodology of teaching high school mathematics.

Participation by institutions (schools and college) was voluntary. But certain criteria had to be met in selecting the final participating institutions from a list of visited prospective participating institutions. Criteria were:

1. With the exception of the college, participating schools should not be involved with any other mathematics intervention programme.
2. Participating institutions had to be in the Johannesburg area for easy access and the reduction of travel costs.
3. Participating institutions had to have been under the control of the ex-DET.
4. Participating institutions had to be committed to the project for the duration of the project.
5. Schools had to be in the vicinity of the college .

3.3.2 Selection procedure

Meetings to solicit participation of colleges and schools in the project, were organised. In preparation for this, a full explanation and motivation of the PEI pilot research project was prepared. Copies of the original PEI advert, the recent document as well as the research design were made available to the educators and these were discussed.

According to the experimental design, the experimental schools had to be in the area of the college. Four colleges in Gauteng have been earmarked to continue operating as initial teacher education providers, these are Pretoria, Johannesburg, Sebokeng and East Rand colleges of

education. Pretoria College of Education and Johannesburg College of Education are not ex-DET colleges. Thus either Sebokeng College or East Rand College could participate in the project.

The initial meetings were held in May with Sebokeng College and three primary schools in its neighbourhood. All three schools were involved with staff development programmes provided by some NGO, for example, COUNT or MCPT. A list of primary schools which had links with NGO's was requested from all the NGO's that operated in that region. The few that were not directly involved with some intervention programme had been Curriculum 2005 pilot schools. Even though Sebokeng College agreed to participate in the project and in fact some lecturers were enthusiastic about the project, the management expressed scepticism about the project. It was decided that including sceptics in the project might compromise its objectives. Sebokeng schools as well as Sebokeng college were therefore ruled out as possible participant in the project. This added another complication on the existing time constraint for the project.

3.3.3 Description of participating institutions East Rand College

East Rand College is one of the black colleges which was under the control of the old Department of Education and Training. About eighty percent of the mathematics teachers in the East Rand high schools graduated from East Rand College. It offers the Secondary Teachers' Diploma (STD) and the Primary Teachers' Diploma (PTD).

Lethulwazi (School A)

The average matric pass rate for mathematics was 13% in 1997. All four grade 11 and 12 mathematics teachers graduated with an STD from East Rand College. The school building is part of the old Putco hostel. One could easily mistake the noise from the hostel as coming from a school! Clearly, the school does not have the necessary infrastructure. For example, the principal, the HODs and the school clerk all share the same room which also serve as a store room. Most classrooms have leaking roofs. On rainy days students are sent home. This happened during the course of the project.

Thuto Lesedi (School B)

The average matric pass rate for mathematics in 1997 was 27%. Grade 11 & 12 mathematics teachers graduated with an STD from East Rand college and Soweto College.

Control Schools

Masithwalisane Senior Secondary and Vosloorus Comprehensive School are control schools. Masithxvalisane had a matric pass rate of 21% in mathematics in 1997, while Vosloorus comprehensive had a 22% pass rate.

3.4 Data Gathering Methods.

A biographical instrument eliciting information such as qualifications and experience in teaching mathematics of the participants as well as the preferred topic for the intervention programme was developed.

A questionnaire which included open ended questions was developed to establish the understanding of cooperative learning and the frequency of its use by educators.

An attitude Likert scale on cooperative learning would be administered to the educators' experimental and the control groups. An attitude scale with ten items was adapted from the Powerless scale by Neal and Seeman (1962).

To confirm responses from the questionnaire and the attitude Likert scale, observations of cooperative groupwork in classrooms would be conducted . A questionnaire which sought to establish the perception of cooperative groupwork held by school and college learners was developed.

3.5 Instrument testing

Testing was done to determine whether the developed instruments for the baseline study would provide the desired data; these were questionnaires for college teacher educators and school teachers as well as the Likert scales. Instruments were tested on five high school mathematics teachers who teach in Soweto and three college teacher educators from two colleges, namely Promat and SACTE colleges. The original scoring table in the Likert scale was removed since it could influence the respondents. Some editing was also done for easier comprehension of the instruments.

3.6 Intervention/Treatment

The intervention took the form of a series of workshops on cooperative groupwork, the knowledge of theory on cooperative learning was established by the results from the base line study, especially on classroom observation. The topic to be covered as an exemplification of cooperative group work was chosen by the participating school teachers to be linear programming.

Whilst the control group is taught linear programming by the traditional whole class approach; the experimental group would be taught the same topic in a cooperative groupwork approach. Despite the cases of documented improvement in mathematics achievement for learners who were taught mathematics in a cooperative mode, compared to those who were taught in a whole class mode, specific cooperative group activities are not readily available in South Africa. Finding cooperative groupwork activities on linear programming was not easy since most standard textbooks were not designed to cater for cooperative group work. Therefore cooperative groupwork activities had to be developed.

3.7 Measuring Achievement

Two of the criteria for cooperative groupwork by Lazar, namely, individual learning and higher order thinking skills, explicitly relates to increased learner performance and thus achievement. Definition of achievement in the reviews by Davidson (1989) included mathematics tests scores obtained by learners.

This study' recognises that any change in achievement is not a short term process and cannot be measured by just one test or one form of assessment! However, it is hoped that this pilot study would provide lessons for further investigation on the impact of cooperative groupwork on achievement in mathematics.

Participants chose linear programming as a topic to exemplify cooperative group work because they claimed, "students always do badly in linear programming problems, let it improve performance of learners in linear programming!" It was agreed that , a linear programming test based on the past IEB examination question paper would suffice to measure the performance of learners in this topic.

IEB examination are considered to be of high duality in the country! –

4 PRESENTATION OF DATA

Field Work

Field work was divided into a baseline study, an intervention programme and implementation. Data collected from the baseline study sought to find the perceptions held on cooperative groupwork and practices on cooperative groupwork. Interpretation thereof informed the planning and the nature of the intervention programme. However, implementation did not proceed as planned. It was discovered that all grade 11 students in the experimental group had never been taught functions, relations and graphs of linear functions or any other graphs. But these are concepts which were supposed to have been dealt with at grades 9 and 10, moreover they formulate the prerequisite knowledge for linear programming. This had serious repercussions on the intended design of the project which was experimental. In the light of all the preparations that had been made implementation was adjusted to provide the pre-knowledge on linear functions and their graphs. The data collected could only contribute towards one of the two questions which were guiding the study, namely, what do mathematics educators and learners perceive as cooperative groupwork within the context of OBE-Curriculum 2005?

4.1 Educators' Data

A total of ten educators were the respondents to the questionnaire and the Likert scale (two mathematics college teacher educators and eight mathematics school educators).

Questionnaires

- Responses from educators in the college and schools indicated familiarity with cooperative groupwork in a mathematics class. All agreed that cooperative groupwork is an approach that is line with Curriculum 2005 and OBE and that cooperative groupwork develop social skills. Even though a connection between a cooperative groupwork approach and the new curriculum was implied, no further elaboration was made by the respondents, as expected. It may well be that item 3 should have required respondents to give reasons for their agreement with the statement. When this was followed up in interviews, respondents indicated their limited knowledge of OBE,

C2005 and its implications on the classroom practices.

- The actualised potential of cooperative groupwork in enhancing teaching and learning mathematics in the classroom was also not mentioned. Even though ninety percent of the respondents claimed that preparing for a cooperative groupwork lesson is not the same as preparing for a lesson in a whole class approach there was no further elaboration for the claim.
- They perceived supervision as the most important role they have to play during groupwork, for example, they stated that "cooperative groupwork requires constant supervision" and "the teacher must supervise groupwork". This was further confirmed during the observation of lessons conducted in a cooperative groupwork mode.

Likert Scale: The scores for responses were assigned as follows:

- 2 (SA) Strongly Agree
- 1 (A) Agree
- 0 (?) Uncertain
- 1 (D) Disagree
- 2 (SD) Strongly Disagree

The lowest mean score (-2) indicates the strongest positive disposition towards cooperative groupwork and the highest score (2) indicates the weakest disposition towards cooperative groupwork. Mean scores for each item were calculated and these are shown in Table 2.

The average mean scores for all the items' responses are negative, thus indicating a positive disposition towards cooperative groupwork in mathematics teaching. The lowest mean score was -1,6, that is, they strongly disagree that: "Controlling the learners who are engaged in cooperative groupwork is difficult" (item 9). This corresponds to their perceived supervision role expressed in the questionnaire. The other lowest mean scores came from items 8 & 10. Item 8: "I do not think that cooperative groupwork can improve mathematics learning." A strong disagreement with this statement (-1,4) shows that educators believe that cooperative learning can improve mathematics learning. Similar responses should be expected from item 1: "There is little that cooperative learning can do to improve achievement in mathematics for my

students.". The difference between the responses for items 1 & 8 (-0.6), simply means that whilst cooperative learning can generally improve mathematics learning, it can not improve achievement for their students. Positive disposition for cooperative groupwork is also shown by the general strong disagreement with Item 10 (-1.4): "There are more disadvantages in cooperative groupwork than advantages".

However, the highest mean score (an indication of an agreement) from item 2:

Item	Mean
1	-0,8
2	-0,2
3	-1
4	-1,2
5	-1
6	-1
7	-0,8
8	-1,4
9	-1,6
10	-1,4

Table 2: Mean Values for Responses of Likert Scale Items

4.2 Learners' Data

Two questionnaires were administered to twenty college and fifty school learners. Except for items 7 & 8, all the first six items were similar in both questionnaires.

Items 7 & 8 for college learners:

7. Is there a difference between groupwork and cooperative groupwork Yes/ No Give reason (s) for your answer.

8. Will you use groupwork as a teacher'? Explain.

Items 7 & 8 for school learners:

7. Do you learn new things in maths when your class is divided in smaller groups? Yes/ No (If yes is your answer, briefly describe the new things you learn in groups.)

8. Do you only solve given maths problems when your class is divided in smaller groups? Yes/ No If no is your answer, describe other activities that are not only focused on solving the given problems. Twenty school learners did not complete the questionnaire claiming unfamiliarity with groupwork in mathematics learning.

All responses from college learners indicated that they are not often engaged in groupwork but they may have been given a definition of groupwork in their didactics course. They all gave one definition for groupwork, namely, "groupwork is teamwork where all pupils contribute". School learners who have experienced groupwork had different definition or explanation of groupwork for item 2. The numbers in brackets indicate the frequency of the response.

Item 2: Explaining groupwork to a friend by school learners

"Helping each other when we do not understand" (7)

"When the teacher is not in class we discuss" (5)

"When we discuss and practice mathematics."(4)

"We work in groups and a representative of each group then explain to the rest of the class what the group has been doing."(3)

"The teacher gives a topic and we all contribute ideas on the topic."(2)

"The teacher allows the pupil who understands the lesson better to explain to the class." (2)

"The whole class participate in a lesson" (2)

Clearly, school learners gave an explanation based on their experience of groupwork and student teachers seemed to have been given a definition of groupwork and memorised it. This does not auger well with the spirit of independent thinking which is promoted by the new policy on education and training.

Item 3 What makes them happy during groupwork

With a few exceptions both school and college learners gave similar responses to this item. Exceptions came from the student teachers who claimed that, " all their learners will gain from the lesson,` 1 will not have a problem on the slow learners", " I can grab more than one method of teaching".

Other responses could be classified as follows:

“Understanding maths" (6 school learners, 3 college learners)

“We are all free to talk and ask questions” (6 school learners, 5 college learners)

“We learn more from each other than from a teacher”(5 school learners, 3 college learners) “

We use different methods”(3 school learners, 2 college learners)

“ We help each other”(3 school learners, 5 college learners)

“Even if you do not know anything you have a chance to participate”(2 school learners)

Having an opportunity to help one another and the freedom to communicate during groupwork is enjoyed most by both college and school learners. Understanding maths and learning from one another seems to be enjoyed most by school learners. It is interesting to note the emphasis placed on enhanced learning as a result of groupwork by school learners, in particular. This is in line with one of Lazear's principles, i.e. cooperate groupwork must ensure individual learning.

Item 4 What they hate about cooperative groupwork

Most college learners did not respond to this item. The few that responded claimed that there's nothing they hate about groupwork. This response leads one to suspect that what they are saying about groupwork is mainly based on what they have been told rather than what they have experienced! If they had enough experience with groupwork as prospective teachers or as learners they would have noted some disadvantages with groupwork, for example , the time constraint or lack of participation by other members of the group.

On the contrary, only a few school learners did not respond to this item. Those who responded had the following to say about what they hate about groupwork:

“Groupwork where some member(s) do not contribute because of selfishness or laziness.”(7) “

“Ridiculing others when they make mistakes”(6)

“When groupwork creates disorder and too much noise”(5)

“ When you do not have any ideas and yet you are called upon to present on the chalk board or, to be a group leader”(4)

“When you ask a member of the group and they refer you to the teacher”(4)

“Working with girls”(1)”

Item 5 Is maths easier when you learn in cooperate groups.

Ten college learners responded with a yes without giving any reasons. The reasons given by school and college learners varied so much that they could not be classified under the same categories.

School Learners:

" I am free to ask anything"(7)

" It is difficult to understand teachers"(6)

" We do not always have to listen to the teachers we only go to them if we need to"(5)

"Some teachers become angry when you keep on asking questions" (4)

" Students come up with different methods that are easier to understand" (3)

"We do better in tests"(3)

"We have a chance of showing that we can understand maths"(2)

College Learners:

"The teacher can explain and be understood in different ways" (4)

" We can not concentrate as one big class group"(3)

" I get a chance to prepare my lessons"(3)

" We understand better than if we are alone"(3)

" Sharing the ideas of solving problems makes maths easier"(2)

" We discover our mistakes immediately"(1)

Item 6 Is maths fun when cooperative groupwork is used during a maths class

All respondents agreed that maths is fun when cooperative groupwork is used during a maths class. Some reasons given were common for college and school learners.

" We understand maths"(6 school learners, 2 college learners)

"We share ideas and methods"(4 school learners, 5 college learners)

" We help each other"(school learners, 4 college learners)

"We participate in the class"(3 school learners, 2 college learners)

"We have a chance to express ourselves"(3 school learners)

"We have a chance to do maths on our own"(3 school learners)

"In a group we are more relaxed and the goal is to understand"(3 school learners)

" If you explain something to your classmates you know you never forget it."(1 school learners)

" We enjoy one another's company" (3 college learners)

" It helps students to pass at the end of the year"(4 college learners)

" I will have more time to evaluate my learners and investigate their problems"(4 college learners)

Responses from college learners were clearly more focused on the advantages of using cooperative groupwork as in a classroom, whereas responses from school learners were more or less a repetition of what they had already said in items 3 & 5.

School learners' responses on items 7 & 8.

Item 7 On whether they learn new things during groupwork

" I understand what I would not have understood from a teacher"(7)

" You can not rely on the teacher's information " (6)

" We learn to speak out"(5)

" We learn to help one another"(5)

" Some of our peers have new ideas about maths"(4)

" We learn to know each other"(2)

Item 8 On the advantages of learning mathematics through cooperative groupwork

The responses were similar to those given in items 3, 5, 6 & 7 , for example,

" We help one another other"

" You can not rely on the information given by the teacher only"

" I understand what I would not understand from a teacher"

"I am free to ask anything"

College learners' responses on items 7 & 8.

Only three out of twenty said there was a difference between cooperative groupwork and groupwork. The reasons given were: " In groupwork some do not participate but in cooperative groupwork everybody must participate", " In groupwork we write down without discussion whereas in cooperative groupwork we discuss and prepare our work", " In groupwork you just work in pairs whereas in the cooperative groupwork you bring your opinion to the group". In all

three responses there is a notion of cooperative groupwork being more than just working in groups! However, it is disturbing that the rest do not seem to see any difference between the two.

Item 8 : They all stated that they will use cooperative groupwork for the following reasons:

" slow learners would get a chance to understand mathematics " (3)

“it gives more time for all students to understand”(3)

“students' pass rates in maths will increase”(3)

“It gives introvert learners a chance to express their thinking”(2)

“It will help me to identify learners who do not understand”(2)

“It encourages the learners to work" (2)

" Sometimes children are afraid to ask the teacher" (2)

" learners are able to assess themselves"(2)

“ It will give me more time to finish scheme work because students work independently”(I)

Generally, the spontaneity found in school learners' responses is missing in college learners. School respondents seem to be talking from experience whereas college respondents' seem to be repeating what they may have heard in their didactic classes. This is evident in responses on item 8. They all had excellent reasons why they are going to use groupwork. However, it is highly unlikely that they have witnessed the passing of students at the end of the year as a result of cooperative groupwork which was claimed in item . On the other hand school learners who never had a cooperative group experience did not bother to complete the questionnaire because they claimed they have nothing to say about groupwork.

4.3 Classroom observations

The purpose of these observation was to investigate whether cooperative groupwork was implemented in accordance with the principles for cooperative learning. Judging by responses from the questionnaires and the Likert scale, all educators claimed familiarity and strong support of cooperative groupwork. Invariably, they agreed to have their cooperative classes observed. Lessons in cooperative groupwork mode were observed in four classes, two classes from the experimental group, one from the control group and one from the college of education.

College class

The class was given an exercise which was based on differential calculus which had been done in previous lessons. Students worked in groups of four or five. The lecturer walked around making sure that students were doing what they were supposed to do. Help where necessary was given. At the end of the period, the lecturer said, "Most of you have solved the problems and therefore the class is dismissed" Groups did not share their solutions with the rest of the class. This could have been an ordinary revision lesson where students were free to work in groups, the teacher did not seem to have taken any measures to ensure that individual learning or positive interdependence does take place.

School classes

In one experimental class, the teacher had prepared worksheets on circle geometry for groupwork. This was a consolidation of theorems in circle geometry which had been taught the previous week. The class was divided into six groups, each group had five students. The teacher went around the class checking whether progress was made by students. Students did work together but the questions asked did not require higher cognitive abilities but only recall of knowledge or coping of this from the textbook. All members contributed in completing the given worksheet.

In the second class of the experimental group, the teacher instructed the class to work in pairs. Her lesson plan indicated that her intention was to give students a chance to work inductively. Students were required to draw a circle with radii of their choice. Using the diameter as a base, they had to draw any angle and measure its magnitude. This would have led them to the theorem of the angle in a semi-circle. Despite the teacher's efforts to involve the students in the activity, the class was very passive as a result the teacher ended up stating the theorem. Groupwork in this case was only a seating arrangement, otherwise the lesson was conducted in a whole class approach.

In the control group class, the teacher gave students an exercise based on solving trigonometric equations. Seemingly this had been taught in previous lessons. The class worked in groups of five or six. In most groups some students dominated the discussion and did all the work and some were passive. The teacher noted the active students and these were called to share their

solutions with the class towards the end of the period. Even though this was termed cooperative groupwork, it was ordinary groupwork where cooperation was not an issue and the teacher seem to overlook this!

4.4 Interviews

College educators and school teachers claimed to use groupwork in their classes. However, at the mention of cooperative groupwork they seemed unsure. College teacher educators stated that groupwork should be used to introduce variety in teaching and learning. Even though teachers agreed on some possible merits of groupwork mentioned in the questionnaire, they all echoed the time constraints as one of their biggest problem. Due to courses organised for teachers by GDE , class boycotts and other disturbances , they asserted that they only have about fifteen weeks of classroom teaching in a year. Groupwork forces the speed of teaching to be controlled by students whereas the lecture method puts teachers in the driver's seat.

5 Intervention Programme

Six teachers from two schools were involved in the intervention programme which consisted of workshops on cooperative groupwork in mathematics within the context of OBE. The two schools that participated in the intervention programme had not attended any OBE orientation programme. Workshops were, classified into three categories, namely: OBE orientation, Principles of cooperative learning; Application of these in teaching linear programming in a cooperative groupwork approach.

limitations

- Teachers were involved in provincial initiatives such as management courses and COLTS (Culture of Learning and Teaching Services). COLTS required high schools in the same districts to write common tests at the same time and these took a week. Regular classes were cancelled during the week of test writing. Afternoons were set aside for marking.
- The intervention programme was planned for at least three weeks, three days per week, however, only two days of the week during the afternoons were available. The

intervention programme was completed just before the short break in September.

4. 6 Implementation

Schools reopened on the 5th of October and negotiations for implementation were made. Teachers were not prepared to implement during the school hours since not much had been done and only three weeks remained to complete the curriculum for the year. The whole class approach was viewed as an ideal approach to speed up teaching and therefore there was no place for cooperative groupwork approach.

Implementation in the afternoons was then negotiated. The number of students who volunteered to stay after school hours was seventeen students out of a possible thirty. Only one teacher was prepared to work with the group. Refreshments and taxifares were given as incentives to keep the remaining group of students throughout the implementation which started on the 8th of October and finished by at the end of the first week of November.

Constant support was given to the teacher during the implementation period. In normal teaching, a textbook is sufficient for a lesson but in cooperative groupwork, textbooks are used as reference material. The first lesson was dedicated on learning to work cooperatively in groups. Other lessons were on linear programming through cooperative groupwork.

4.6. 1 Learning to work cooperatively.

The lesson was meant to inculcate the social skills and positive interdependence among members of the cooperative groups. Students were divided into four groups . In keeping with the learner centred approach, each group had to give itself a name and develop the rules for its group members. Most of these rules corresponded with what teachers teaching in a cooperative groupwork would have developed for their groups and these are given in Table 3.

4.6.2 Linear programming through cooperative groupwork.

Linear programming is a method of solving practical problems using graphs of linear functions (equations) together with linear inequalities. Each group represented a company which had to maximise productivity and profit or minimise the cost of production taking into consideration a given a set of financial, manpower, time, materials constraints etc. One or two members of the group had to model each constraint by a graph of linear inequality and these were intended to

obtain the feasible region which encompasses all the constraints.

It turned out that students had never done graphs for straight lines, function and relations. This brought about the abortion of the design of the project as there were no plans to provide the lessons on linear graphs as this was never mentioned by teachers at the interviews. However, for ethical reasons and the time spent in developing the implementation plan, activities that had been developed for this phase were conducted. This necessitated a few cooperative lesson on the introduction of linear functions and graphs. At the end of which, an assessment form (see appendix) was given to students. The comments are given in Table 4

<i>NAME OF THE GROUP</i>	<i>RULES</i>
GETWISE	<ol style="list-style-type: none"> 1. No parasites 2. Give others a chance to talk 3. We must agree on one answer 4. One person at a time 5. Outside information is allowed 6. No one is wrong or right 7. Take everything seriously
IMPACT	<ol style="list-style-type: none"> 1. Teamwork 2. Respect other members' opinion 3. Listen and pay attention to one another 4. No one is wrong
TAKE FIVE	<ol style="list-style-type: none"> 1. We are all giving our opinions 2. We help each other 3. No one is wrong because we are all learning 4. We must respect each other
NEW HORIZON	<ol style="list-style-type: none"> 1. Punctuality 2. Teamwork 3. Respect 4. Patience 5. Seriousness 6. Discussion 7. One person at the time

TABLE 3: Rules Developed by the Groups of Students.

<p>What went well</p>	<p>I enjoyed the lesson. Everyone came with an idea. We understood very well most of the things we did. At last we gained something from a maths lesson. We enjoyed the lessons. Everyone was thinking. We learned about linear functions and graphs. When we work as a group things become easy. We always found a possible and a correct answer. Discussion improved my understanding of mathematics. We now understand linear graphs. I understand things I would not have understood if the teacher taught me. I understand linear equations and functions Mathematics became very good. Sharing the task makes things easier. We all learned and the teacher was good to us We understood linear functions and their graphs Most of the things we did we understand</p>
<p>all the members of the group</p>	<p>listened to each other cooperated encouraged one another learned some mathematics from the task</p>
<p>Comments</p>	<p>If we can keep on working like this in mathematics classes, we could pass. If we continue helping each other and sharing our problems Working together and encourage one another we will pass. We must continue this groupwork. Working in groups would make us pass mathematics, the school must help us to work in groups. Understanding more by working together. Things will be better in our lives. If we had started earlier in the year. If this project had started earlier we could have had better results in mathematics at the end of the year. We must work in groups in our class. Everyone would pass mathematics with flying colours. If we can continue to work learn mathematics like this. What could be better is that this mathematics programme must go next year. The programme must be done by other classes</p>

TABLE 4: Students Self Assessment Data

5 INTERPRETATION OF DATA

5.1 Findings

- Classroom observations and interviews revealed that both school and college educators use cooperative groupwork in a very limited manner for mathematics teaching.

It is used for consolidating the work that has been done in the previous lessons. There was no indication during interviews of any other use of cooperative groupwork.

This was a clear discrepancy between what educators profess to know and believe about cooperative groupwork and the way they implemented that in their classes. Could it be that the improvement in mathematics learning and achievement would be achieved through revising what has been done through groupwork?

- School learners' experiences of cooperative groupwork revealed by their responses on the questionnaire, were very close to what is expected from teaching mathematics in a cooperative groupwork approach in an OBE context. For example, "understanding and expressing this understanding..." is part of the OBE definition of mathematics. Understanding maths and being free to express themselves are reiterated throughout the questionnaire. These two were the main reasons why school learners are happy when working in cooperative groups (item 3, p4); why maths is easier when cooperative groupwork is used as a method of learning (item 5, p5), why maths is fun when they work in groups (item 6, p6). Understanding was also cited as one of the " new things" they gain in cooperative groupwork and it is also an advantage of working in groups (items 7 & 8, p7).
- Citing freedom to talk and helping one another as advantages of cooperative groupwork, indicates that school learners have a chance to practice cooperative and communication skills during groupwork. Communication and cooperative skills are at the core of two critical outcomes in OBE (see p Table 1, p7)

- What school learners hate about groupwork (item 4), are typical of inappropriate groupwork. For example, non-participation of other members in the group, ridiculing others and lack of order during groupwork.
- With college learners freedom to communicate, understanding maths, sharing of ideas and methods were also among the main reasons why maths is fun when cooperative groupwork is employed as a method of learning. However, college learners seemed to base their responses on what they may have been taught about cooperative groupwork in their didactics course. This is clearly shown from the uniform definition of cooperative groupwork given by all learners and responses on items 1, 7 & 8. A disturbing finding which indicates a lack of integration between theory and practice.
- The finding which was not part of the research questions, but which had an adverse effect on the project was that cooperative groupwork, being a vehicle for facilitating a lesson, cannot compensate for the lack of assumed knowledge necessary for the content in a lesson. To be more specific, the level of mathematical knowledge held by grade 11 students was not consistent with the grade 11 curriculum. Important basic concepts that should have been acquired in grades 9 & 10 were missing; making it impossible to continue smoothly with the planned implementation!
- An interesting finding, was when school learners repeatedly stated the difficulty they have in understanding their teachers (items 5,7,8) as a way of justifying their preference for cooperative groupwork. Three learners went on to say that some teachers become angry when persistent questions are asked (item 5)!
- During the intervention it became clear that high school maths teachers lacked knowledge and appreciation of cooperative groupwork within the context of OBE-C2005. They did not know the OBE definition of mathematics which has implications its teaching.
- The data gathered on self assessment form emphasised the learners' claims and added some recommendations on the implementation of cooperative groupwork. For

example, " We understood", " discussion improved my understanding of mathematics", "when we work as a group things become easy", " if we can continue to work like this, we will pass maths" and " the programme must go on next year and it must be done by other classes"

5.2 Recommendations

- It was not possible to meaningfully research the impact of cooperative groupwork on achievement as was originally intended. However, perception held by learners and educators on cooperative groupwork in mathematics teaching and learning was determined. The outcome of the study could be used as a spring board for the completion of the intended research.
- Research aimed to investigate more reasons (other than time constraint) for the observed discrepancy between what educators profess to know and believe about cooperative groupwork and their cooperative groupwork, is recommended.
- Teachers need to make an effort to listen and begin to know their students and adjust their teaching methods accordingly! Teacher-centred methods does not emphasize this but if OBE learner-centred methods are to be implemented, teachers have to pay attention to what makes their learners learn. This study revealed that cooperative groupwork enhances mathematics learning. Further research on what makes students learn
- Since OBE is the basis of the new curriculum, the department should take the initiative to inform secondary classroom practitioners about its implication in teaching mathematics. INSET programmes are justifiable focusing on primary teachers who are in the process of implementing OBE.

- Cooperative groupwork should be used as a vehicle to exemplify the principles and implications of OBE in the classroom situation. This could take rhetoric from OBE and set the much needed foundation for improved mathematics learning.
- The lack of tolerance by teachers for persistent questions asked by learners is an outcome of an authoritarian approach and the poor quality of PRESET which characterised teacher training in ex-DET colleges. (National Teacher Education Audit, Synthesis Report, p 63 & 91). Integration of theory and practice of cooperative groupwork as a way to improve classroom mathematics practices at the PRESET level needs to be done.
- The absence of the assumed knowledge for the intervention raises a question about the curriculum level at which grade 11 learners are operating in some schools! The department of education needs to investigate this.
- Investigation needs to be made as a matter of urgency on the time spent in learning mathematics in black high schools. It may well be one of the factors contributing towards the low performance of students in mathematics is insufficient time spent on the subject.
- The potential held by cooperative groupwork to improve mathematics classroom practices, should be further investigated.

5.3 Conclusion

The study revealed that students preferred cooperative groupwork because among other reasons, they have difficulty communicating and understanding their teachers. Through the use of cooperative groupwork teachers can save the unproductive time spent on teaching without any learning taking place. This would solve the problem of the time constraint prevalent in schools. Even though the study did not research the impact of cooperative groupwork on achievement, it did reveal the merits attributed to cooperative groupwork by learners from their experiences. Merits like understanding, freedom to ask questions and express themselves are the best

foundations for improving achievement in mathematics.

Lastly, if all had gone well i.e. if all black high schools were functioning well, researching the impact of cooperative groupwork in six months is almost an impossible task, especially if the researcher intended to do a baseline study! Terwel (1990) reiterated that it took Netherlands twenty years to observe an improvement in mathematics achievement because of cooperative groupwork! A study investigating achievement should have taken at least a year.

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