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ABSTRACT

The curriculum extension program (CEP) of the Shell Science Centre provided group tutoring to small groups of secondary school pupils using qualified teachers. This evaluation report presents articles discussing various aspects of the program and its effectiveness. The first article by A. Ziervogel provides a review of the program. The following three articles discuss the tutoring activities in the three subject areas: physical science (P. Hobden), mathematics (P. Ntenza), and English (A. Ziervogel). A second cluster of six articles summarizes: (1) results of a mathematics test administered to program participants and non-participants (P. Ntenza); (2) results of a review test in the physical sciences to improve program quality (P. Hobden); (3) school based curriculum development using pupil writing as a starting point (A. Ziervogel); (4) findings of a statistical analysis of attendance records to examine attrition, absenteeism, and early dropouts (A. Lewy, A. Ziervogel, and P. Botha); (5) profiles of tutors and students in the program (C. Scott); and (6) matriculation results of CEP participants in comparison with non-participants (A. Lewy and P. Hobden). The final article by P. Botha looks ahead to the possibility that the Centre will continue to offer the program to secondary school students in the future. (MHD)

THE SHELL SCIENCE CENTRE

CURRICULUM EXTENSION PROGRAMME 1987-1989

Compiled by
A. Ziervogel

Individual articles in this collection have been edited by A. Lewy

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Contents

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I wish to extend thanks to Iona Laing and Sylvie D'Alton for their help in producing this volume and to Ulla Bulteel and Peter Grieves for doing the computer analysis of data used in the articles. Thanks also to all staff members of the Centre, tutors and technical workers who participated in the running of the programme.

Finally, we are indebted to all tutors and participants who answered questionnaires, and some of whom wrote examinations which served as input for the data examined in the report.

P M C BOTHA

Shell Science and Mathematics
Resource Centre Educational Trust

Preface

A Lewy

The curriculum extension programme (CEP) of the Shell Science Centre provided group tutoring to secondary school pupils. Tutoring is frequently employed to help weak students cope with the intellectual demands of school, a task traditionally considered the responsibility of parents. Parents used to hire tutors and they financed the expenses of tuition. The tutors were frequently students of higher level, and usually inferior in intellect and attainment to the classroom teachers. Nevertheless, the tutoring could give considerable support to the pupil, due to the individual tuition and the intensive personal interaction between tutor and pupil.

Tutoring

Tutoring has also been employed as a compensatory technique for raising the achievement level of disadvantaged groups of students who, as a result of impoverished home conditions, failed to acquire a standard of knowledge sufficient for functioning successfully in school. Such compensatory tutoring programmes continued to be individualised, but due to financial and organisational constraints the tutoring was done not on a one-to-one basis but in small groups. Working with a small group of 10-15 students could satisfy the needs of the individual. Furthermore within the framework of compensatory programmes it was possible to recruit teachers of higher qualification than those who served as home tutors in traditional settings.

The Centre's CEP was a compensatory tutoring programme carried out in small groups, which enabled attention to be given to the needs of individuals. The Centre was able to recruit highly qualified staff, who worked together as tutors with regular classroom teachers from the programme's catchment area. More than a hundred high school pupils received tuition in English, mathematics and physical science during a period of three years, after which most of them sat for the matriculation examination.

The report opens with a review of the programme by A Ziervogel, which is followed by a brief description of tutoring activities in the three subject areas. P Hobden summarises the programme in physical science, P Ntenza in mathematics, and A Ziervogel in English.

Revision Test

In a second cluster of articles P Ntenza summarises a mathematics test administered to programme participants and their classmates who did not participate in the programme, and compares the attainments of these two groups. P Hobden presents the summary of a revision test in the physical sciences and demonstrates how a revision test can serve the purpose of improving the quality of the programme. A Ziervogel's article on written composition serves two purposes. It provides information on participants' personal attitudes to their science tuition, and represents school-based curriculum development using pupil writing as a starting point. The article by A Lewy, A Ziervogel and P Botha is based on statistical analysis of the attendance records. The findings are conceptualised in terms of attrition, absenteeism, and educational wastage. As well as giving information about the CEP course, it may serve as an exemplar in summarising attendance records in a non formal educational setting, that is where attendance is not compulsory. C Scott's profiles of a tutor and some participants flesh out the personalities of individuals who might otherwise have remained as statistics or names only. P Hobden and A Lewy examine the matriculation results of CEP participants and compare them with those of their fellows who did not participate in the programme. The final article is a retrospective view of the programme expressed by the Centre's director and also a look ahead to the possibility that the Centre will one day resume it's programmes for secondary school pupils.

The Curriculum Extension Programme CEP

A Ziervogel

The Shell Science and Mathematics Resource Centre maintained a 3-year group-tutoring course for high school pupils in the years 1987-9. Standard 8 pupils were admitted to the course which was designed to continue providing tutoring till they reached standard 10. The original plan of the Centre was to launch new courses for a single cohort starting at standard 9 and finishing when they reached standard 10. Later the period of studies was extended to a 3-year cycle for standards 8-10. Unfortunately, financial constraints forced the Centre to discontinue the programme and after completing a single cycle of a 3-year course, the whole programme was suspended. This report provides a schematic review of major features of the programme.

Previous Group Tutoring of High School Pupils

Some high school tutoring programmes were carried out in South Africa before the Shell Science Centre's curriculum extension programme (CEP).

In 1983 the United States Agency for International Development (USAID) designed a programme for assisting black matriculants in South Africa called the University Preparation Programme (UPP). As implemented by the Urban Foundation, instructional materials developed by American educationists formed the basis of the tuition programme. The materials were based on the Joint Matriculation Board's syllabus and methodology on PSI (Personalised system of instruction).

This top-down attempt to introduce educational change in the classroom has not been very successful. Teachers were not sufficiently responsive to the methodology and did not feel at ease in using the materials given to them in the prescribed way. Consequently, the Urban Foundation established tuition centres for students interested in obtaining supplementary tuition to what they received in their regular classes. Attendance was irregular and problems of organisation and administration affected the success of this endeavour.

In 1985 a curriculum extension programme was initiated by the Shell Science Centre aimed, like the project of the Urban Foundation, at assisting pupils from disadvantaged educational and social backgrounds to obtain a good pass in the matriculation examination. The operational philosophy of the Centre differed from that of the Urban Foundation in adopting an approach of shared responsibility. Rather than operating an open programme, it established criteria for selecting pupils for the programme. Pupils were requested to register and attend on a regular basis. The programme required a commitment on the part of pupils to:

- persevere in their studies while the project committed itself to providing services for the pupils. The teacher-to-pupil ratio was also reduced to an average of 1:12. To a large extent, tutors and pupils enjoyed a person-to-person relationship, which deepened with time due to the small size of the study group.
- The second difference is that the Shell programme did not operate in a top-down manner. The Centre's permanent staff designed a course and prepared instructional materials, discussed various aspects of using these materials with the tutors, and encouraged tutors to adapt these materials to the unique needs of their pupils and also to supplement the materials. The tutors were not only users of materials handed over to them but also partners in deciding what should be taught in the course.
- Thirdly, the content of the course was not strictly syllabus-oriented. Centre staff and tutors felt free to depart from the formal school syllabus by introducing topics of enrichment, and sought to increase participants' interest in the subjects of their studies.
- Fourthly, a tutorial approach rather than an expository one was encouraged in teaching and syllabus-based work was often replaced by activities specially designed by subject coordinators. Active participation by pupils was strongly encouraged.

The first curriculum extension programme was planned as a 2-year course. It was started in 1985 with standard 9 pupils from three schools in Umlazi, three in KwaMashu, three schools in Phoenix and four schools in Sydenham. It continued in 1986 in the participants' final matriculation year in standard 10.

The 1987-9 CEP

The first 3-year course of the Centre was launched in 1987. Concerned with the fact that very few black candidates were leaving high school to follow careers in science and technology, the Centre decided to extend the duration of the curriculum extension programme to a 3-year cycle, admitting pupils in their standard 8 year in 1987.

Table 1. The 1987 CEP centres

Centre Durban area	Pupils	Groups	No. of tutors	No. of schools
Umlazi	37	3	9	4
Swinton	36	3	9	3
V N Naik	56	4	12	5
Toncoro	20	2	6	2
Newcastle	45	3	9	4
Greytown	20	1	3	1
All	214	16	48	19

At Greytown no courses were run in physical science. Instead technical drawing and biology were offered.

The pupils would remain in the programme for 3 years, leaving at the end of their standard 10 year in 1989. This longer period of study would enable tutors to deal more closely with learning problems encountered by participants and to provide more enrichment.

The programme focused on three subjects, mathematics, physical science and English for communication in mathematics and science. Tuition was offered for 2 hours per subject each week on three afternoons of the week.

Selection of Participants

At the time the programme started, entrance was limited to ten pupils from each school who were studying mathematics and physical science.

The selection of the ten pupils was left to the principal, staff, and parents of the school. Some schools selected the top ten science and mathematics pupils, others those whom they felt needed supplementary tuition, and others allowed interested pupils to volunteer for the programme.

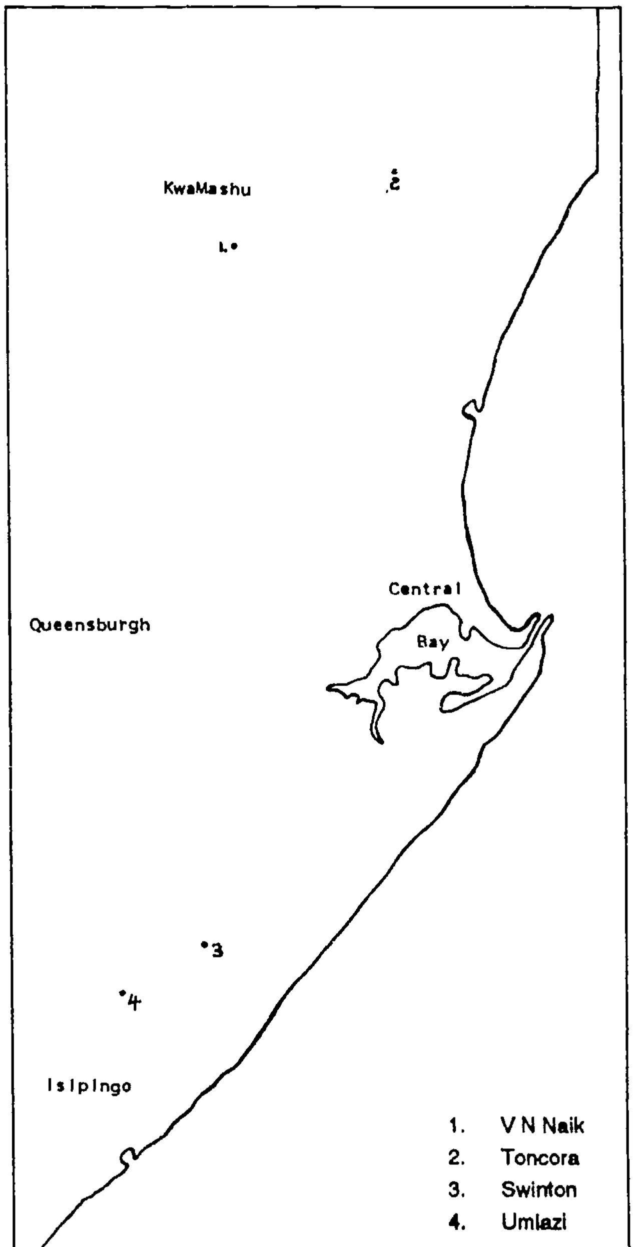
Several schools were approached and fourteen schools in the Durban area agreed to enter the programme in 1987. Later schools in Newcastle and Greytown also joined the project.

Table 1 shows the scope of the 1987 CEP

Four study centres operated in the Durban area and two additional centres were established at Newcastle and Greytown. Map 1 shows the location of the four Durban venues.

Participants were bussed to the centres from their schools in an effort to ensure punctuality and regular attendance. They were returned to central points in their townships after each afternoon session.

Map 1. Location of Durban Study Centres



Some Characteristics of the Schools

The participating schools were all coeducational high schools offering (with the exception of the Greytown school) mathematics and physical science to standard 10.

The schools in the Durban area were controlled by four different departments of education, namely:

Department of Education and Culture, KwaZulu:	9 schools
Department of Education and Training, House of Assembly:	2 schools
Department of Education and Culture, House of Representatives:	2 schools
Department of Education and Culture, House of Delegates:	1 school

The programme was designed to cater for pupils from various backgrounds and education departments. The pupils at four of the study centres had an English second-language background while those at the other two study centres were of English first or second-language backgrounds. At the time it was felt that this mixing of language backgrounds would be of benefit to all participants.

Communication and Cooperation with Schools

Various channels of communication and cooperation were established.

- Personal visits were made to principals of the schools before the start of the programme to explain the aims and win approval.
- Letters were written to the principals of the six schools which remained in the programme at the beginning of 1988 and 1989. A working document was drawn up by Centre coordinators outlining the aims of the programme. Exhibit 1 shows extracts from this document explaining how the curriculum was determined and the advantages of the programme offered to participating schools.

Curriculum

- ☆ *The curriculum will be determined by the Centre personnel together with the subject teachers from the participating schools.*
- ☆ *The curriculum extension programme aims to provide pupils with basic skills in English language, physical science, and mathematics and to extend their knowledge and experience by exposing them to materials not normally provided in the school curriculum.*
- ☆ *The programme will in no way supplant the subject teacher nor repeat what is covered at school as it is a curriculum extension programme.*

Advantages to the Participating Schools

- ☆ *The subject teachers will have participated in drawing up the curriculum and in the activities. The experiences they share and skills they gain will enable them to use these with their own pupils.*
- ☆ *The Centre will provide the teachers with the resources to use on the programme activities in their own schools by making available on loan videos, books, materials, science equipment, etc.*
- ☆ *The pupils will be enriched in all three subjects and their leadership qualities developed.*

Exhibit 1. Extracts from the working document

- A meeting was held for teachers of the pupils, principals, and tutors at the beginning of 1987 and 1988 to explain the aims of the programme and for principals, teachers, tutors, and Centre subject coordinators to meet.
- A report on each pupil was compiled by the subject tutors and a copy given to the pupils and the schools. The report did not reflect marks in any of the subjects but general progress and attitude.

Problems

On reviewing the programme at the end of 1987, three problem areas were identified: unrest, mixing of pupils from different language backgrounds, and selection of tutors.

Unrest in KwaMashu schools and the financial cost

Schools in KwaMashu were subjected to considerable unrest during 1987 and this disrupted the programme at the Toncoro and V N Naik venues on many occasions until it collapsed at the beginning of September, whereas the programme ran the full 18 weeks at Swinton Road and Umlazi. Financial losses were incurred in the hiring of buses to fetch pupils and payment of tutors and supervisors who arrived for sessions which had to be cancelled at the last minute.

The student representative councils of schools in KwaMashu felt that the curriculum extension programme was elitist in that it offered tuition to only a few pupils and they stated that the programme should cater for either all KwaMashu high school pupils in all subjects or none at all. While the Centre sympathised with these sentiments and would have liked to accommodate all interested pupils, financial constraints made it impossible to do so. The decision was taken reluctantly to discontinue the curriculum extension programme at the V N Naik and Toncoro venues.

Mixing of English first language and English second language pupils.

The majority of the pupils participating in the programme came from Zulu home language backgrounds. English was the medium of instruction at school but was seldom spoken outside school and was regarded as a second language. These pupils were mixed at two of the venues with pupils whose home language was English. It was thought that this would benefit both sets of pupils. However, English first language (EFL) pupils, although always ready to help their English second language (ESL) fellows, soon became bored and preferred to work on their own at their own pace. We found that, particularly in English sessions, we were producing two sets of materials. It was decided, after much deliberation, to discontinue the programme with EFL pupils and offer it to ESL pupils only 1988 and 1989.

In 1988 and 1989 we continued to offer the programme only at the Umlazi venue, that is to pupils from the original four schools which had participated at the venue and to the two groups of ESL pupils who transferred from the Swinton Road venue. These six schools were asked to increase their participating pupils to fifteen. Some of the new pupils entered the programme in 1988 in their standard 9 year and others in 1989 in their standard 10 year. Other pupils dropped out of the programme during 1987, 1988, and 1989 (see article on "Attrition, Absenteeism, and Wastage").

Choice of tutors and curriculum.

In 1987 experienced school teachers or ex-teachers of high repute were invited to tutor on the programme. In all, 12 tutors were employed per subject, that is 36 in all. The curriculum for the course was drawn up by the Centre coordinator responsible for the subject concerned. Discussions with tutors and staff of the schools led to the realisation that failure to involve the pupils' own teachers as tutors reinforced the feeling that the pupils were considered to be receiving an inferior education in their schools. This led to resentment and lack of support for the programme on the part of the teachers.

In 1988 and 1989 tutors were accordingly appointed on a different basis. Pupils from the six schools which remained in the programme were divided into five groups and each group was tutored by two people in each subject, a subject teacher from one of the participating schools together with an experienced outside tutor. This innovation was seen as a means to involve the schools in the programme and as a form of INSET for the school teachers. Thirty tutors in all were employed during 1988 and 1989 at the Umlazi venue.

This system of paired tutors worked far better than the previous one and led to far greater support for the programme from school subject teachers. It also provided feedback on the pupils' opinions of and problems with the course.

At the end of 1988 discussions with the tutors revealed that they were dissatisfied with the way materials for the course were prepared. The materials had been prepared by Centre subject coordinators and discussed with the tutors. While the individual tutors were allowed latitude in adapting the materials to the needs of their groups and in introducing additional material of their own choice, they nevertheless felt that they would like to be involved in the actual preparation of the materials rather than receiving them in what they considered a top-down approach.

Workshops were held at the beginning of 1989 where tutors drew up the curriculum instead of being instructed on how to implement prepared curricula. Details of the individual subject curricula follow in separate articles.

Pupils and Tutors participating in the Curriculum Extension Programme.

Table 2 contains information about the number of pupils and tutors involved in the programme.

The number of participants decreased in 1988 as a result of closing the KwaMashu area centres. Also sites were reduced in number during 1988-9 and situated in the Durban area where studies were conducted in four schools, and in Newcastle.

Table 2. Durban-based programme 1987-9

Year	Pupils	Centres	Tutors
1987 (3-year cycle)	149	4	36
1988	97	1	30
1989	93	1	30

Table 3. Financial costs of the programme

Year	Direct costs	Direct + indirect costs	No. of pupils	No. of weeks/ (sessions)	Direct cost per pupil per session
1987	R137 913,13	R230 942,00	214	18 (54)	R11,93
1988	R 80 400,02	R256 141,00	117	18 (54)	R12,70
1989	R 84 165,75	R351 353,00	110	11 (45) including a 5-day winter school	R17,00

Cost of the Programme

Information about the expenses of the course is presented in table 3.

Direct costs include payment of tutors; materials; venue; payment of supervisor; payment of caretaker and cleaner; transport of pupils to and from venue; refreshments for pupils.

Indirect costs include percentage of Centre staff salaries; percentage of Centre staff overheads; percentage of Centre staff time and travelling expenses.

These costs included in (1988 and 1989) a smaller programme operating in Newcastle with a maximum of 20 pupils.

Comments on the 3-year programme

At the end of 1989, Centre personnel reviewed the experience of the past 3 years with a view to initiating a new cycle. It was found that the programme had proved time-consuming to run. Both the development of materials and the organisation of studies required a heavy outlay. Since the focus of the Centre's activities had moved to teacher INSET, the subject coordinators regretfully decided to suspend the programme. Additional reasons for this decision were that the Centre had expanded in developing networks of teachers in six regions of Natal and subject coordinators were required to spend more time working with teachers.

The programme had been expensive to run costing R838 436,00 over a 3-year period. To continue would have committed the Centre to a financial outlay over a further 3 years with ever-increasing costs.

For the reasons mentioned above the Centre discontinued the curriculum extension at the end of 1989. The team involved in running the programme considers it a useful experience, which caused great satisfaction to the Centre's coordinating team and the teachers and pupils who participated in this venture, and expresses the hope that the Centre may reopen courses of this type in the future.

The English Component

A Ziervogel

Many of the problems experienced by high school pupils in mathematics and physical science are directly or indirectly related to their inability to fully comprehend, and express themselves in English, the language in which they are assessed in their final matriculation examination.

When the curriculum extension programme was initiated in 1987, it was decided to include an English for communication in mathematics and science component in addition to mathematics and physical science.

English for special purposes (ESP) is regarded by applied linguists as a difficult area to work in and there is little published material in the fields of science and mathematics. None was available in South Africa for pupils in standards 8-10 at the time the programme started.

Material was thus developed on a trial-and-error basis at the beginning. Inquiry into different language projects and discussions with people working in the English second language field, for example the English Language Education Trust, provided helpful orientation.

THE 1987 COURSE

Content and Methodology

After discussions with the ESP tutors and the mathematics and physical science coordinators, it was decided to concentrate on providing basic tuition in the four skills of listening, speaking, reading, and writing.

Each 2-hour session with pupils had:

- ☆ Dictation of a piece of text from a standard 8 science or general mathematics textbook. This was done to improve listening skills, spelling and punctuation and to introduce English second language (ESL) pupils to English as spoken by a English first language (EFL) speaker.
- ☆ Group oral work, for example role play; debates on science issues to encourage pupils to acquire vocabulary; interviews and information gap tasks which can only be completed if participants communicate with one another.

Exhibit 1 contains listening exercises used in the course.

- ❑ **Reading** from source materials, namely Read Well. This material was specially prepared for ESL pupils in a southern African setting. Reading skills included:
  - ☆ finding the main ideas in a paragraph by asking the questions who, what, when, where, how and why
  - ☆ extension of finding main ideas to more difficult text
  - ☆ organisation of ideas by making lists and paragraphs of similar ideas
  - ☆ writing headings for a piece of text, as an approach to identifying the main idea in a piece of writing
- ❑ **Writing**, using source material from Write Well, also specially written. Basic writing skills included
  - ☆ joining words with who, which, what, when, where, before, after, while, until, as soon as
  - ☆ combining sentences to form paragraphs
  - ☆ writing definitions
  - ☆ summarising

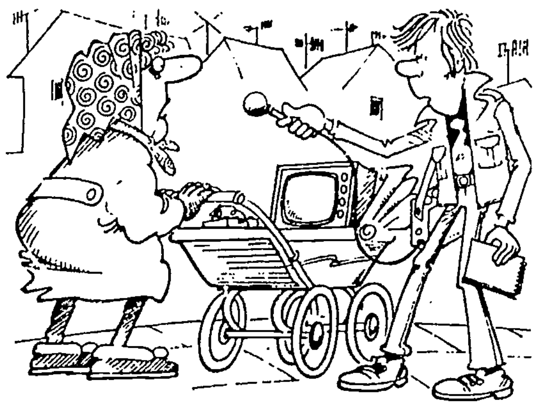
Additional reading was supplied in the form of short articles taken from New Scientist and Science in a Social Context. Pupils were also each given a copy of Upbeat, a magazine aimed at South African teenagers which contain articles, quizzes, and stories.

Tutors were given the freedom to introduce oral activities of their own choice to stimulate interaction. Tutors were asked to write a short report on each session describing what they and their pupils had done.

Tutors were requested to allow for pair and group work tutoring as much as possible to encourage group problem solving and interaction and to actively teach as little as possible. This method would allow pupils to work at their own pace and the more able to help the less able (peer tutoring).

Student A

Market research – television or radio programmes



You work for a Market Research Bureau. You are doing research into the types of television or radio programmes people watch or listen to. You stop people in the street to ask them questions and write down their answers in pencil on the sheet below. Student B is a passer-by.

MARKET RESEARCH — TELEVISION/RADIO QUESTIONNAIRE

1 How many hours a week do you spend watching television or listening to the radio?

- less than 5 hours
- 5–10 hours
- 10–15 hours
- 15–20 hours
- more than 20 hours

2 What sort of programmes do you like watching or listening to?

3 Are there any sorts of programmes you don't like?

	Like	Dislike
the news		
films or discussion programmes		
quiz shows		
pop music programmes		
comedy programmes		
documentaries		
classical music programmes		
serials		
plays		
detective series		
chat shows		
children's programmes		
variety shows		
sports programmes		
(others)....................		

4 What is your favourite programme?

5 Are there any sorts of programmes you would like (a) more of? ....

(b) less of? ....

You can begin like this:

Excuse me, can I ask you some questions about television/radio?

And finish:

'Thank you very much for answering my questions.

Student B

Market research – television or radio programmes

Student A works for a Market Research Bureau. He/she is going to ask you questions about the types of television or radio programmes you watch or listen to. Answer his/her questions.

Before starting, here are some of the most common types of programmes on television or radio:

the news	serials
films or discussion programmes	plays
quiz shows	detective series
pop music programmes	chat shows
comedy programmes	children's programmes
documentaries	variety shows
classical music programmes	sports programmes

Exhibit 1. Listening exercise

Problems

Tutoring: Although the tutors invited to work on the course had all been selected because they were experienced, highly regarded teachers, some found it difficult to adapt their traditional teaching styles to tutoring, where they were required to act as facilitators to pupils working in pairs or groups.

Difference in language ability between ESL and EFL pupils

At two of the centres, pupils whose home language and background was Zulu were mixed with others whose home language was English. The pupils in these centres were mixed for group work. This mixing, although well intentioned, failed because the EFL pupils became bored and had to be provided with advanced materials, which were beyond the ability of the ESL pupils. The ESL pupils withdrew in oral discussions and interactions as they felt inadequate.

Eventually EFL pupils asked to be separated from the ESL pupils and be given more challenging materials. Tutors found it difficult to work with two such disparate groups unless they separated them, which defeated the whole object of mixing them.

This was the main reason for dropping the EFL pupils from the programme at the end of 1987.

Vocabulary: Pupils experienced difficulty with technical and non-technical vocabulary in mathematics and physical science. Technical vocabulary, once acquired, is not difficult as the words have a specific meaning, for example arc, bisect, ion; non-technical vocabulary causes problems as the words change in meaning depending on the context in which they are used. Dictionaries were supplied and pupils were encouraged to compile their own from words they came across in difficult sessions. The mathematics and science tutors were asked to help pupils by defining new or difficult words.

Apprehensions of tutors on taking on ESP: The tutors employed were all experienced English first or second language teachers but not physical science or mathematics specialists. They all expressed anxiety at becoming involved in a specialised type of English tutoring. One dropped out during the year and another at the end as both felt they could not cope with the demands of the subject.

THE 1988 COURSE

The course content was planned by one of the tutors after consultation with the other tutors at the end of 1987 and the beginning of 1988. Materials were compiled and tutors discussed implementation during a workshop.

The content was once again developed around the basic skills of listening, speaking, reading, and writing.

Listening: Dictations were taken from a standard 9 physical science textbook, Successful Science, by Broster and James. The extracts were selected to tie in with the section of work being covered during physical science sessions.

For example:

Force as a vector quantity (lines indicate pause breaks) The method / of representing displacement / as an arrow / drawn to scale / and determining / the resultant / of successive displacements / by the tail-to-head / or parallelogram method / may be applied / to all vector quantities./ Since force /is a vector quantity / we shall apply these methods / to a number of forces / acting on one object.

This type of dictation was alternated with one in which pupils were asked to draw a mathematics figure from precise instructions or to write the instructions for drawing a figure.

For example, half the pupils were to provide instructions for drawing the figure shown in exhibit 2. Following a classmate's instructions, the rest of the pupils were to draw the figure on the blackboard.

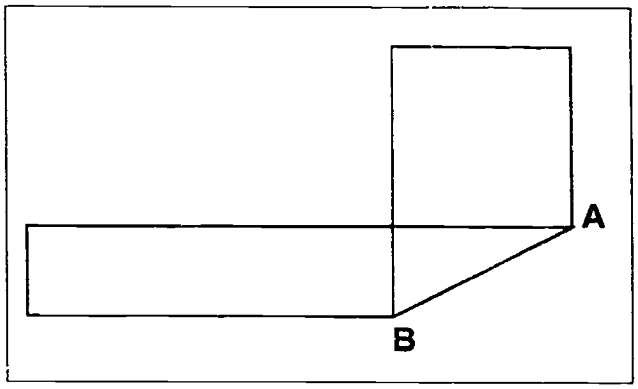


Exhibit 2. Listening exercise: Figure drawn from instructions

The work was marked by the tutors, who reported an improvement in recognition and spelling of vocabulary as time passed. Pupils enjoyed writing precise instructions for drawing maths figures and became more skilled in choosing the correct terminology.

Speaking: Group interaction was encouraged through games, interviews, debates, etc. An example of a tape recorded interview is given in exhibit 3.

> *Group 1 are scientists. You must work out a discovery which will improve the world in some way. You must decide on the discovery (e.g. a machine that tidies up bedrooms!) and how the discovery will work (structured purpose, method, conclusion).*
>
> *Group 2 are interviewers from Radio 2. You must work out about 8 appropriate questions to ask the scientists in approximately 5 minutes. The questions must be relevant and structured, that is one question leading into another.*
>
> *Each group will choose a spokesperson, and the interviews will be recorded and played to other groups in a lesson.*
>
> *NB: Pupils who speak into the tape recorder must give their names before the interview starts.*

Exhibit 3. Speaking exercise: tape recorded interview

Reading: Read Well was used as source materials for developing basic reading skills and this was applied to more relevant material, for example comprehension of tables and diagrams, summarising text.

Supplementary reading was encouraged from Upbeat magazine and library books (largely simplified and graded readers) available from the Umlazi centre.

Writing: Pupils continued to use material in Write Well, for example on writing instructions for a task, writing reports, and writing up their experiments under the standard headings of aim of experiment, apparatus used, method, and conclusion.

Work was done on the use of logical connectives involving sequence, for example before which, following wh'ch, subsequently, all important in scientific discourse.

Evaluation: At the evaluation of the 1988 course at the end of the year, the tutors indicated that they wished to have a part in the preparation of the curriculum; on the basis of their pupils also having expressed a preference for materials to be taken directly from their science and mathematics textbooks. This would help them in dealing with the language used in the textbooks.

THE 1989 COURSE

Tutors met before the course started and drew up a work programme in the four basic skills.

Listening: Pupils were read extracts from physical science textbooks and were asked to answer questions on the text to encourage their listening skills and comprehension. They drew mathematics figures from instructions and were required to write precise instructions for drawing more complex figures.

Speaking: Use was made of close exercises in which students were asked to fill in missing words in a text (exhibit 4). This encouraged comprehension, interaction, and group problem solving.

Read the following passage and provide a suitable word for each blank space. Work in groups and discuss possible words until you have decided, as a group, on the most suitable words:

Galileos's ideas were built on by Newton in stating his First Law of Motion:

Every body remains at rest or continues in a state of uniform motion in a straight line unless an unbalanced force acts on it.

There is a lot we can learn from this _______ . Think of a cyclist riding along a level road. _______ the force from her pedalling exactly balances the friction _______ on the bicycle, she will ride at a constant _________. She will not speed up or slow down, ncr ______ she suddenly change direction. If the cyclist stops pedalling, _____ friction forces are not balanced by the pedalling force. _______ friction is in the opposite direction to the motion _____ the bicycle, the bicycle slows down (decelerates).

If _____ cyclist pedals harder, the extra force causes the bicycle __ accelerate. If the cyclist turns the handlebar, the forces ________ the tyre and the road make the bicycle turn. _____ bicycle will not turn unless there is an unbalanced ________ to make it do so. Even if the bicycle ______ not change speed when it turns, it is accelerating. _______ is because accleration is a vector having both size ________ direction - and the bicycle is changing the direction of ___________ movement.

Exhibit 4. A close exercise

Reading and writing: Greater use was made of science texts as source material. The extracts gave practice in comprehension, paraphrasing, changing verb forms, for example active to passive, and contraction of clauses to single words.

The language exercise focused on the rhetoric of science discourse to give pupils experience in manipulating this type of language.

Practice was also given in interpreting tables and graphical data and constructing flow charts (Exhibit 6).

Answer these questions in groups. The three graphs drawn overleaf compare and contrast an ideal gas with a real gas.

Look at the graphs and answer the questions below:

1) What can you say about:

   (a) the pressure and

   (b) the volume of a real gas contrasted with an ideal gas at low temperature?

2) Why is the graph of the ideal gas in figure 3 a straight line and not a curve?

Hint: It shows the relationship between the pressure and volume for a fixed temperature i.e. Boyle's Law.

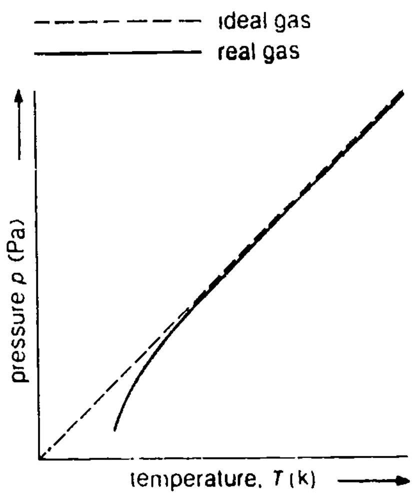


Figure 5a A graph of p vs T (volume constant)

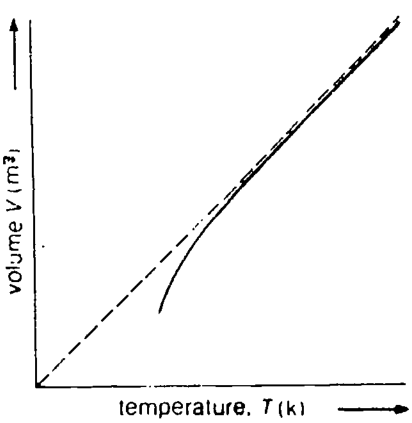


Figure 5b A graph of V vs T (pressure constant)

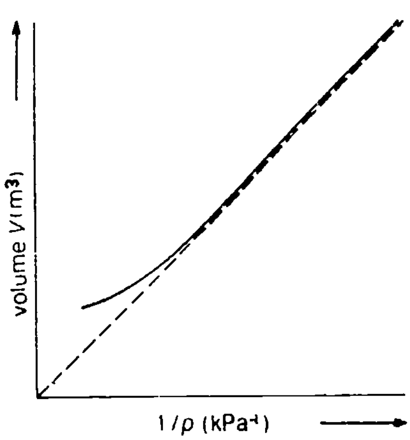
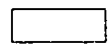


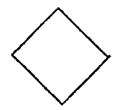
Figure 6 A graph of V vs $\frac{1}{p}$ (temperature constant)

Exhibit 5. Interpreting data from graphs

Construction of a Flow Chart

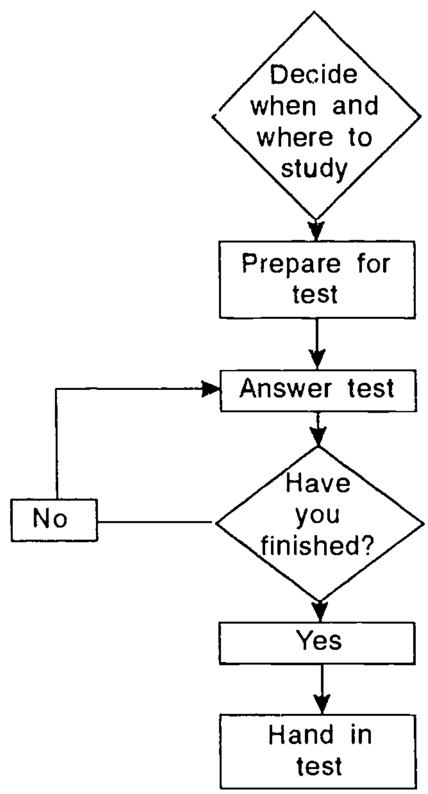
Read the instructions for Joule's Experiment below. Draw a flow chart to show the different steps and any decisions you have to make.

Use an oblong  to indicate a step

and a  to indicate a decision.

Example: Your teacher tells you that you will write a test on Acids and Bases at the end of next week. You prepare for the test, write it and hand in your paper.

Illustrate the process by way of a flow chart.



Joule's Experiment

Aim: To investigate the relationship between the amount of work done in a resistor and the time taken for the current to flow.

1. Set up the apparatus as shown in the figure overleaf.

   Dip the 1 resistance coil into the beaker of cold water, close the switch and adjust the rheostat so that a current of 5A is obtained.

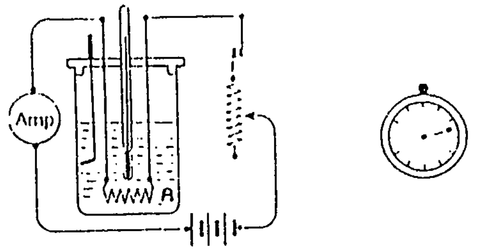


FIGURE : Apparatus for investigating the heating effect of an electric current.

2. Measure off 100cm3 of cold water into the calorimeter and pass a current through the circuit. Stir the water regularly and read its temperature every minute for, say, 4 minutes.

3. Tabulate as follows:

INITIAL TEMPERATURE ^{O}C

Elapsed time (t)	Final temp (^{o}C)	Rise in temp (^{o}C)
1 minute		
2 minutes		
3 minutes		
4 minutes		

Draw a graph of rise in temperature against time.

Exhibit 6. Construction of a flow chart

From writing up, under guidance, the experiments they did in physical science sessions, pupils progressed to observing the experiment and writing it up on their own under aim of experiment, apparatus used, method, and conclusion (exhibit 7). Much of this was done in group or pair work to encourage verbal communication, practice in using scientific and mathematical vocabulary, and peer tutoring.

Fountain Experiment

Aim: To observe the solubility of Cl_2 gas in water.

Apparatus:
i) Bromothymol
ii) Beaker
iii) Flask
iv) Bunsen burner
v) kCl or kBr & HCl acids
vi) H_2O
vii) Stopper with a tube

Method:
Firstly they dye the water and then they mix kCl with HCl in a flask. They light on the bunsen burner and heat these two substances. As they heat these substances they make sure that the tube of the stopper is inside the water. The flask is turned upside down and water get inside the flask by means of a tube of the stopper and the water which was inside the beaker was absorbed by the pressure.

Conclusion:
Then the observer saw that the Cl^2 is soluble in water.

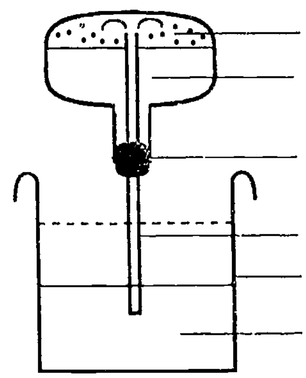


Exhibit 7. An experiment written up

Much of this was done in group or pair work to encourage verbal communication, practice in using scientific and mathematical vocabulary and peer tutoring.

Supplementary reading was encouraged from Upbeat magazine and the library of graded and ungraded readers. Most pupils preferred simplified or graded readers.

Summing Up

Over the 3-year period, pupils were exposed to the unique features of the course:

- ☆ English as spoken by mother-tongue speakers
- ☆ variety of materials
- ☆ pair and group work
- ☆ group problem solving
- ☆ debate on science in society
- ☆ library books and magazines
- ☆ encouragement by tutors in questioning ideas and taking a stand on issues.

The advantages gained were skills which will enable the pupils to participate more fully in a changing South Africa through improved vocabulary and speaking skills, increased confidence, and a greater ability to work together in identifying and solving problems.

The Mathematics Component: CEP 1987-1989

P Ntenza

The mathematics component of the CEP aimed to teach students how to approach mathematics problems, how to utilise analytical skills and take advantage of intuitive grasps for solving mathematics problems. In this way the mathematical thinking of pupils would hopefully be improved, and it is then that such an achievement would to some extent have an effect on the end-of-year matriculation results on mathematics. Consequently it did not strictly follow the mathematics matriculation syllabus as this was dealt with by the teachers in their respective schools. The developers of the worksheets did not aim to directly improve the matriculation results of the CEP group.

Although initially some mathematics teachers from the schools participating in the CEP complained that their students were doing "things that are not in the prescribed syllabus" and therefore the students were being confused, when they (teachers) became involved in the tutoring, during 1988 and 1989, their perceptions of the whole programme changed as they themselves contributed ideas towards the development of instructional materials. Further input was also obtained from students at the end of 1988 when the CEP was evaluated. Some tutors and students had indicated that towards the end of each year consideration should be given to doing revision of certain topics in mathematics so that the students would be better prepared for their examinations. Subsequently a winter school, five days long, was organised in June 1989 for all students who had participated in the CEP.

The instructional materials used in the CEP consisted of worksheets developed at the Shell Science Centre by the coordinator of the mathematics programmes. These worksheets covered various topics specified in the school syllabus and also topics of enrichment. Great emphasis was put on including in the worksheets, assignments and exercises which might raise learners' interest in the subject and which might increase their liking of mathematics. Within each topic, exercises which had the potential of promoting mathematical thinking, were designed and developed for the relevant level of instruction.

Most worksheets used by the students were in the form of self-guided learning activities and in the form of cooperative small group learning activities. The tutors's role, in such context, was to monitor the learning activities, helping those individuals, or groups, who encountered problems and providing feedback as to whether the solutions were correct. Accordingly the classroom setting was informal, students were seated in a way that enabled interaction among themselves.

Initially the developers of instruction materials frequently encountered disappointment in finding out that the students had difficulties in coping with the instructional materials presented to them. It was therefore decided to closely observe how the worksheets were used in class in a particular instance, so as to answer questions such as: were students able to solve problems presented in the worksheets? Was sufficient time allocated for working on the mathematical problems? Did students enjoy the work?

A typical assignment in Algebra

The following assignment presented in exhibit 1 is an example of a series of assignments which aimed to sharpen the students' awareness of number patterns which might constitute a basis for solving a problem in algebra. The ability to see something mathematically significant in a situation, state it mathematically and prove it true in general, is probably the most important skill a pupil can learn in mathematics.

Study the following pattern and complete. Check your answers by factorisation and by direct calculation.

$$2^2 - 0^2 = 4 \times 1 = 4$$
$$3^2 - 1^2 = 4 \times 2 = 8$$
$$4^2 - 2^2 = 4 \times 3 = 12$$
$$5^2 - 3^2 = 4 \times 4 = 16$$
$$17^2 - 15^2 = 4 \times \ldots = \ldots$$

(i) Now find $101^2 - 99^2$

(ii) Also calculate a and b if $a^2 - b^2 = 4 \times 979$

(iii) Can you give an explanation why this works?

Exhibit 1. An assignment in algebra

While most students were able to continue the lines of the computation exercises, and were also able to verify the correctness of the calculation, the observation of their working pattern suggested that the goal aimed at by setting this exercise was not attained. Little awareness of the pattern was observable, rather the students operated by carrying out the full calculations of the results. Alternatively they followed the pattern as suggested in the second column of exhibit 1 increasing by 1 the second factor of multiplication without really understanding the reasons why this pattern worked. It was important that they learnt to extract from the situation what really mattered and dealt with it mathematically. In this way they would be able to see the generality and power of mathematics. Consequently they would learn what a proof is really for - to verify a guess. But the motivation for all that came from seeing the pattern.

No wonder they could not answer question (iii) above which is a step requiring the students to work in algebraic language as opposed to the manipulation of numbers. The students were expected to show that:

$$(x + 1)^2 - (x - 1)^2 = 4x$$

which is the general equation for explaining the results.

These observations suggested that there was a need to provide more explanation about the purpose of the exercise, and probably to put such an exercise into a series of other exercises, which had a common goal, viz. to create awareness of the patterns, to look for a specific kind of pattern and to know what to do after they have seen the pattern.

A typical assignment in Geometry

One of the worksheets (Std 8:1987) contained an assignment in Geometry as presented in exhibit 2.

Observing the classroom occurrences it was found that the students encountered quite a number of difficulties.

Firstly there were psychomotoric difficulties. Most students had difficulties in using the compasses for drawing circles correctly. The implication of this finding was that exercises had to be given to students on how to use the compass.

Secondly there were linguistic difficulties which were of two types: vocabulary and the structure of the paragraph. Students did not understand the word "bold" in the sentence and consequently they could not carry out this instruction. Difficulties also emerged in memorising the defined terms: CARDOID and CUSP. It became quite useful to refer to better known deviates of the Latin translation of "heart" and "cardiology" respectively for the two terms.

The paragraph structure was also difficult. The instructions appeared in a very concise language which is quite common in mathematics textbooks, nevertheless for the particular group of learners who were in the CEP there was a need to use a simpler language structure. Thirdly there were logical difficulties as the task assigned to the students required a very meticulous execution of sequentially ordered steps.

Failure to carry out one step in this sequence made it impossible to correctly execute all subsequent steps. To overcome this difficulty it was necessary to break down (for the students) the assignment into subsequent steps, and to build a feedback mechanism, which would help to check the correctness of each step and to enable the student to correct flaws before proceeding to the following steps.

The specification of the following steps reduced the severity of the logical difficulties encountered by the students in the problem shown as exhibit 2.

Draw any circle of radius not longer than 3cm. Make the outline of this circle bold, by retracing the circumference, if necessary. Choose any point A on this circle. By choosing different circles on the circumference of this circle and adjusting radii so that each circle passes through A, draw many circles.

The envelope of these circles is called CARDOID. Cardoid means 'heart-shaped.' The point A is called the CUSP of the cardoid, and the circle with which we start is called the base circle.

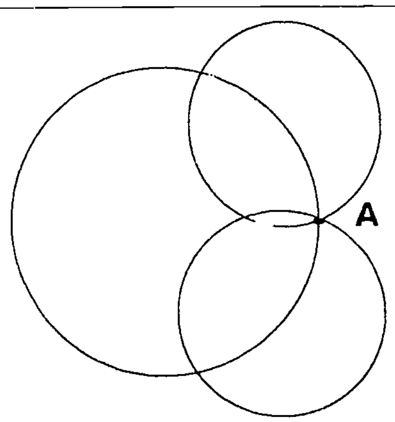


Exhibit 2. An assignment in geometry

1. Draw any circle of radius not longer than 3cm. Check, by measurement, whether the radius is really less than 3cm. What is the exact length of the radius?
2. Make the outline of the circle bold (i.e. thick line). Retrace th circumference, by using your compasses and pencil.
3. Mark a point A on the circle. Choose another point on the circumference of the circle and draw a circle which passes through point A.

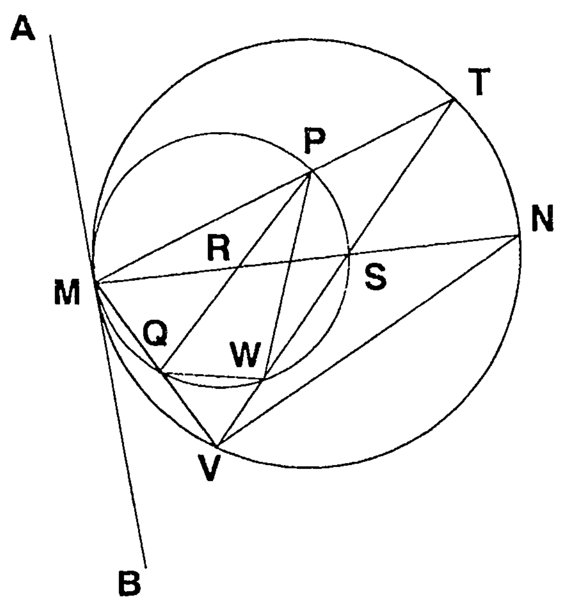
   Now you should have two circles on your page. One is drawn in a bold (thick) line, the other one is drawn in a lighter line.
4. Select another point on the circumference of the bold circle (the first one which you drew) and make another circle, which cuts point A.

   Make sure that the last circle you draw has its centre on the bold circle.

These were the first steps of the assignment. The subsequent assignment components also had to be handled in such a manner. There had also to be a clear indication that there was a need to draw approximately 15-20 circles before the CARDOID pattern was observable.

An assignment in Geometry (Std 10:1989)

Two circles touch internally in M. Chord MN of the large circle intersects the other circle in S. TSV is any chord of the large circle. MT and MV intersect the small circle in P and Q respectively. PQ intersects MN in R.



(i) Find as many facts as you can about the figure

(ii) Hence, formulate a rider.

Exhibit 3. An assignment in geometry

Using the given information students had to discover on their own as many facts as they could, giving reasons in each case. In many mathematics textbooks the questions on geometry are formulated as riders such as "prove that PQ //TSWV", and there might be two or three other similar questions. In other words, there is a tendency to focus the students' attention on these questions, and in the process quite a lot of mathematics is not exposed to the students. In such an exercise a student who as one of his/her facts wrote "angle MSW = angle TSN, vertically opposite angles" would be awarded with a correct tick for his/her answer, and this might boost the students' confidence in geometry.

Having collected this mass of data, students were expected to sift out irrelevant data and remain with that data that would, for example, assist them in proving that PQ//TSWV, and hence be able to formulate riders thereafter.

A number of problems were encountered at first with this type of exercise. Students tended to write down a minimum amount of information which would not be of any help towards formulating riders. But as they attempted more similar problems, they found the exercises quite interesting and informative as they discovered techniques and tricks of making riders as difficult as possible. Students were encouraged to formulate riders on the same geometry problem and then challenge their peers to solve those riders. Students (and even their tutors) seemed to enjoy this innovative approach to learning problem-solving in geometry.

Concluding Remarks

Unfortunately some ideas mentioned could not be implemented fully as the 1989 CEP had to be stopped during the middle of the year. Nevertheless it is hoped that teachers who were involved in the programme will use these ideas back at school when teaching geometry.

Finally, programmes such as the CEP, which involve students are very sensitive in the sense that some teachers might feel threatened especially when the content of the programme overlaps with the teachers' work in the class. It is recommended that teachers, students and parents to a certain extent, should always be involved in the design of a programme so as to ensure its success. Whether the mathematics component of the CEP really achieved its goals is difficult to say, as there were other factors such as unrest in schools which also played a role and affected the smooth continuity of the programme.

The Physical Science Component

P Hobden

Overview

The programme was initiated in response to a perceived deficiency in the science education of local schools. The examination results from pupils in these schools had been poor in previous years. The few pupils entering tertiary education institutions to :udy science were criticised for lack of labora' › kills.

Although the programme was referred to as the curriculum extension programme, the science component had little extension associated with it. Previous experience had shown that many (especially practical) activities that were part of the published school curriculum were not taking place in the target schools. Consequently the programme concentrated on making up this deficit.

From the initial stages the main idea was to provide pupils with a variety of practical experiences (experiments) which would enable them to deal effectively with examination problems.

It could be seen from senior certificate examination papers that more and more questions were being based on knowledge of practical phenomena. Without seeing or experiencing the phenomena, pupils would be at a distinct disadvantage when writing this examination.

Activities

The topics dealt with in the Centre's programme followed the scheduled work programme in the schools by about two weeks. This was done so that activities in the Centre's programme could be planned on the assumption that participants had acquired some basic knowledge after dealing with the topic at school. Thus time could be spent on the development and broadening of concepts through practical activities, discussion and problem solving, with direct teaching kept to a minimum.

This is well reflected in an extract from the course outline as presented in exhibit 1.

SESSION 5	Properties of waves interference diffraction polarization Activity: ripple tank
SESSION 6	Light Diffraction and interference Activity: single and double slits observations
SESSION 7	Wave/particle nature of light Photo electric effect Activity: irradiation of zinc plate and photodiode
SESSION 8	Radioactivity Alpha beta gamma radiation Activity: Geiger counter

Exhibit 1. Extract from programme for the first half of 1988

Consider the activity for session 7. Pupils had dealt with the theoretical aspects of the photoelectric effect at school during the previous week. During the session they participated in a demonstration of the phenomenon and then discussed their observations in small groups. After a report-back pupils attempted problems based on the phenomenon.

Activities tended to be problem-based. A question from a past examination paper was chosen and the practical activities planned around it, emphasising the close link between the practical and the examination. Previous experience had indicated that pupils were often uninterested in activities unless their relevance to the examination could be shown. An example of this "linking" is presented in exhibit 2. This shows the first page of a handout for participants. The practical activity for this session was chosen because of its close relation to the question selected from a past examination paper. The table of data presented in the question is very similar to the data that pupils would obtain when carrying out the investigation.

Tutoring

The science tutors worked in pairs, with an English second language (ESL) tutor (in most cases from participants' school area) paired with an English first language (EFL) tutor (in most instances from another education department).

THE SHELL SCIENCE AND MATHEMATICS RESOURCE CENTRE EDUCATIONAL TRUST

CURRICULUM EXTENSION PROGRAMME : PHYSICAL SCIENCE

WEEK 2 BODIES IN MOTION NEWTONS 2ND LAW

Below is an examination question from the November 1988 paper. Read it carefully and you should recognize that it is concerned with Newtons 2nd Law.

The table of results below is obtained from an investigation into the relationship between force 'F' acting on an object and the resulting acceleration 'a', of the object.

.1 What type of relationship is suggested by these readings? (2)

.2 Show the relationship in the form of a graph. Use a scale of 1 mm : 0,1 unit for both axes. Record acceleration on the horizontal axis. (5)

F (N)	a (ms^{-2})
1	0,5
2	1,0
3	1,5
4	2,0

.3 What quantity is measured by the ratio F:a? (2)

.4 From the graph determine the value of the ratio F:a. (3)

NEWTONS 2ND LAW

The resultant force acting on a body with constant mass is equal to the product of the mass and the acceleration of the body.

In symbols: $\vec{F} = m\vec{a}$

where $\vec{F}$ = resultant force (a vector)

m = mass of body (a scalar) and

$\vec{a}$ = acceleration of body caused by the resultant force (a vector).

In order to obtain a better understanding of this law, we are going to do a practical to verify the relationship between the force applied and acceleration produced. This should help you to deal with examination questions such as the one above.

Exhibit 2. First page of an activity handout for pupils

This appeared to be an efficient pairing with the tutors complementing each other. Often the instructions or demonstrations would be carried out by the EFL tutor and the ESL tutor would be more effective encouraging and helping small groups and managing report-backs.

The tutors from the participants' schools and outside schools were given an opportunity to be involved in the development of the materials used. At the beginning of each year, approaches were discussed and outlines of possible activities chosen. The week before materials were to be used tutors were given the chance to discuss the next week's session and to suggest changes before printing.

With a view to having a common approach to tutoring a number of training sessions were held, some with tutors from the other disciplines. One workshop focused on using constructivist strategies to develop understanding in science.

This strategy is based on the assumption that pupils firmly hold descriptive and explanatory systems for scientific phenomena. These belief systems are resistant to change through traditional instruction. Consequently alternative teaching strategies, taking these existing conceptions into account, have to be used such as probing, concept mapping, and discrepant events. Another workshop dealt with the importance of language and the development of activities to promote understanding by second language learners.

If during the year it was felt that some aspect was being neglected, then the topic was discussed at a meeting and a written reminder was given to all after discussion, for example a note explaining the value of pupil writing and steps to be followed in encouraging it. This is illustrated by exhibit 3. Unfortunately there was a turnover in tutors for a variety of reasons, resulting in some who had missed earlier workshops not having the same teaching strategies or sense of direction as their colleagues.

Practical Activities in Physical Science

When we involve pupils in practical work our goal is to change the pupils' understanding of phenomena. We are presenting the pupil with a new experience. The new experience is not in itself learning. The pupils must have the opportunity to think about what they have done and build a relationship between the new experience and their old understanding. The most powerful tool in making sense of experience is language.

Small group discussion

The tutors must provide guidance to the group. Do not just leave the group to talk about what they have experienced. A clear understanding of what they were asked to do is essential.

Writing

Please encourage as much writing as possible.

1. Before the activity: pupil must sketch out a plan in the form of a flow chart - single words, phrases, diagrams.
2. During the activity: rough notes of observation and actions carried out.
3. After the activity: expressive writing in which the pupil writes for himself using language which has real meaning. Should include a personal description of events and speculation about ideas for explaining things.
4. Formal report. This demands that the pupil set out the main points of information for someone else to read. It demands more selection and organising of ideas with greater structure. It is then available for future reference.

Exhibit 3. Note to tutors on pupil writing and small group discussion

Continuous assessment

A characteristic of the science component was the continuous assessment. Before each session started tutors discussed the strategy to be followed and at the conclusion tutors filled in written reports asking for details of pupil activity, pupil responses, and comments. An example of typical comments by tutors is presented in exhibit 4.

At the end of each semester meetings were held to discuss the past semester. Focus questions were used to promote discussion on issues that had arisen during the semester, for example "What are the implications of the test results for us as tutors? Some of the school teachers of the pupils do not participate in the programme. How can we encourage contact and communication with them?"

The pupils participating in the programme appeared to enjoy their science sessions. Observation of the sessions and tutor reports showed pupils who were involved in and enjoying the activities, especially practical work. When asked to write an essay on the lesson they enjoyed most from the whole programme, many described a science lesson offering positive comments such as those illustrated in exhibit 5.

As a consequence of the good classroom environment created by tutors and the non-threatening relationships developed between tutors and pupils, many questions were raised by pupils and little was left unchallenged. Unfortunately the pupils were often not willing to put their ideas in writing possibly because of their lack of command of written English.

Despite emphasising this aspect of learning to both pupils and tutors, little success was achieved. Pupils' practical reports and session summaries were more often than not very sketchy. With the increasing number of examination questions requiring qualitative as opposed to quantitative responses, this lack of perseverance was regrettable.

Conclusions

Did the programme achieve what it set out to do? If the success is measured in terms of scores in the senior certificate examinations, one might be tempted to evaluate the programme as effective but not cost-effective. The pupils chosen to participate were selected by school principals. In most cases they were chosen because they were recognised as achievers. A look at the final results showed that they continued to achieve better than average with final examination results considerably above the national average (Refer to chapter "Matriculation Results" Lewy & Hobden). However, the full extent of the success of the programme cannot be measured by looking at test scores alone.

PHSC

THE SHELL SCIENCE AND MATHEMATICS RESOURCE CENTRE EDUCATIONAL TRUST

LESSON REPORT

TUTOR NAME : [redacted] DATE : 9/5/89

CENTRE : [redacted]

TOPIC COVERED: JOULE'S ~~CHEER~~ EXPERIMENT $W \propto I^2$

ADDITIONAL MATERIAL INTRODUCED : Heating Effect

TUTOR ACTIVITY: ① Explanation of Theory of heating effect ② Explain prac. procedure ③ Helped with questions on pracs and worksheet questions

PUPIL ACTIVITY: Practical investigation

PUPIL RESPONSE: Good. Could set up circuit with min help knew how to take readings and graph same only after a scale was chosen for them.

TUTOR COMMENTS ON LESSON

Successful lessons. Pupils showing increasing ability to handle apparatus and record results.

Problem solving still presenting problems – pupils experiencing difficulties with analysis of question. Pupils need more practice with drawing of graphs.

TUTOR COMMENTS ON LESSON

Successful lessons. Pupils showing increasing ability to handle apparatus and record results.

Problem solving still presenting problems – pupils experiencing difficulties with analysis of question. Pupils need more practice with drawing of graphs.

Exhibit 4. Extract from tutor lesson report for the activity on Joule's law

> *"In this first experiment I found it difficult between the polar and non-polar but now that is not my problem because I know that polar is a molecule that can be divided into positive and negative atoms. Non-polar is the opposite of the above. This lesson was very interesting and enjoyable, I think if you can do it you will be very happy to see it."*

Exhibit 5. Extract from a pupil essay titled *"The lesson I really enjoyed this year"*

There is no doubt that pupils benefited from participation in the programme. Firstly, they were exposed to a variety of experiences in a different learning environment. This must have influenced their attitude to science and broadened their conceptual frameworks. Secondly, the exposure to practical work had a number of valuable results. Among the more important were that pupils had experience of handling apparatus and chemicals themselves. Girls, normally relegated to observers in practical sessions at schools, were fully involved. Thirdly, pupils were exposed to EFL tutors for more than a hundred sessions over three years. This would make the transition to tertiary institution, where lecturing by EFL speakers is the norm, less threatening. Fourthly, pupils encountered their peers from different schools in their groups, making it easier to effect more realistic assessments of their own potential. Overall pupils were enriched by their experiences over the three years.

There were also a number of other benefits from the programme. The pairing of tutors meant that teachers were exposed to different models of teaching and to team teaching and small-group work with pupils. They were also able to practise the practical activities and other lesson activities, for example problem solving, with an experienced teacher. The apparatus was made available by the Centre on a loan basis. They could then perform the practicals, assisted by pupils who had participated in the programme, in their own classrooms so passing on the benefit to a wider group of pupils.

When the programme was initiated, it was intended to provide another mechanism whereby the benefits of the programme could be spread to a wider group of pupils. The idea of peer tutoring was adopted. In essence pupils participating in the programme had to work through the activities with four or five of their peers at school. It was assumed that this would occur just by verbally encouraging participants to do this. After evaluating the programme in the first year it was seen that this peer tutoring did not occur to any significant extent. The idea was then dropped as requiring far too much effort and time to implement than staff could reasonably be expected to spend given other demands and priorities. As it was, peer tutoring only took place on a non-formal basis and was not monitored. Looking back this decision was unfortunate as with a little investment of time and training in one or two schools, the benefits could have been spread to a wider audience or at least valuable data could have been gathered for future programmes.

Another disappointing aspect of the programme was the lack of commitment by some of the school teacher tutors. Their participation was a vital component guaranteeing the success of the programme. When some withdrew for study or other reasons they should have been persuaded more strongly that their participation was indispensable. Often their withdrawal was accepted and little done to persuade them to return. Looking back this was a strategic mistake.

With hindsight some other revisions of the programme may be suggested. Tutors often reported that they had difficulty working with pupils in the same group who had such widely differing abilities. Any future programme must face this difficulty either by streaming or by investing more time and effort in training tutors in the techniques and skills used in mixed ability classes. Another change would be to limit the breadth of work covered even more than was done. Often the programme dictated that tutors proceed even though they could see pupils were not confident. The rationalisation that as many topics as possible needed to be "covered", must be resisted in future programmes.

Finally more attention should be paid to training tutors. Many tutors when faced with the frustrating lack of basic knowledge of pupils reverted to direct teaching (more of the same) so that more content could be covered rather than trying other strategies such as those suggested in the training workshops. This on occasion subverted the whole purpose of the programme and would not have occurred with more thorough training sessions dealing with the philosophy and aims of the programme. Unfortunately it was felt that requesting tutors to give more time was unreasonable given the turmoil within education during that period.

Attrition, Absenteeism and Wastage

in the Curriculum Extension Programme of the Shell Science and Mathematics Centre during 1987-1989

A Lewy, A Zlervogel and PMC Botha

Background

The curriculum extension programme (CEP) provided tutoring in physical science, mathematics and English for three years to pupils of standards 8-10. The pupils were bussed to a centre in Umlazi three afternoons a week, and each day received tutoring in one of the three subjects listed above.

According to the plan, pupils from standard 8 were invited to join the programme for a period of three years, i.e. until they finished their studies in standard 10 and sat for the matriculation examinations.

The studies were scheduled for 18 weeks each year i.e. for 54 days of tutoring, but due to holidays and scheduled days of vacation in 1987 the studies ran for 48 days only. In 1988 only one study day was cancelled and the number of actual study days was 53. In 1989 there were 29 scheduled days and, at the end of April the programme was terminated.

Pupils who attended the programme were invited to attend other study frameworks offered by the Centre. In June 1989 they were invited to attend a 5-day Winter School which provided tutoring in matriculation subjects and from the 6th day of May they were invited to attend the matriculation examination preparation programme (MEPP), scheduled to run until the matriculation examinations took place in October 1989.

The participating pupils were from six schools: Chesterville, Igagasi, KwaShaka, Lamontville, Ogwini and Zwelibanzi.

In an attempt to evaluate CEP activities a series of small scale focused studies were initiated by the Centre. This study reports on the attendance of the course by examining the three interrelated aspects of attrition, absenteeism, and educational wastage. It is based on data summaries derived from the attendance records of CEP for 1987-9 (April). The findings of the study will be used for making recommendations which may contribute to the improvement of the programme.

Attrition, Wastage and Absenteeism in an Educational Context

The term attrition is used to mean leaving educational courses before their formal termination. It is viewed as "the negative complement to student retention". Attrition has been systematically studied mainly in tertiary education (Cope and Elkins 1985), but in Third World educational systems attrition is a major problem in primary and secondary education, and much attention has been given to it here also (see e.g. Fuller 1986).

Where education is not accompanied by extrinsic rewards, such as adult education programmes (which do not lead to a diploma) and in compensatory education programmes (which do not require compulsory attendance) the rate of attrition may serve as a measure of programme effectiveness. High attrition may be a symptom of programme-based problems. It may mean that the system is not working well and that the learners' needs are not being met.

Research on attrition has been aimed at reducing it (Astin 1975). In evaluation research the lack of attrition, i.e. the retentivity of a programme, is frequently used as a measure of quality (see e.g. Lewy 1987). In this study the attrition rate is used primarily as a measure of the programme's quality. The findings may also assist programme planners to identify students who are disposed to drop out of the programmes and reduce the rate of attrition.

The term educational wastage has been used in various ways: in follow-up studies of vocational education trainees it may connote the pursuit of a career other than what they were trained for (Bardouille 1981); economists define the term more precisely as "the total number of pupil-years spent by repeaters and dropouts" (Loxley 1985). In this study the term means leaving the programme after a short period of attendance. Dropping out of a course does not necessarily mean educational wastage, since one may still have benefited from it in acquiring knowledge which one might use later in a career or which might enable one to function better in a variety of social roles. Indeed, the idea of recurrent education is based on the assumption that active participation in any learning activity whatsoever has a functional value (Bengston 1985); but superficial participation of a few hours in a structured course of study planned over a whole school year seems to have very little functional or educational value i.e. it is educational wastage.

The words absenteeism and truancy are frequently used as synonyms for absence from school. Truancy is a legal term defined as "absence from school for unexcused reasons" (Kaesar 1985), while absenteeism connotes both unexcused and excused absence. Clearly absenteeism is the term appropriate to non-formal educational programmes, where participants are not legally bound to attend lessons.

In this study absenteeism refers to lack of attendance of any type without regard to whether it is excusable or not. Our concern with absenteeism is the problem that absentees pose, as they not only miss out on the benefit of particular lessons, but also the "continuity of course content which is crucial for learning" (Moos and Moos 1978). In empirical research absenteeism is treated as either a dependent or an independent variable. In the first category are studies which examine factors causing absenteeism, namely those that lie with the pupil (including the family), those that lie with the school, and those that lie with society (Kaesar 1985). Absenteeism appears as an independent variable where the dependent variable is the pupil's school grade or level of achievement. In the present study absenteeism is treated as both an independent and a dependent variable.

Operational definitions

Attrition occurred when pupils left the course after having participated in the programme continuously for at least 10 study days. A distinction is made between attrition during the school year and attrition in transition from one year to the next. Absenteeism refers to missing a study day or study days, by pupils regularly participating in the programme. Pupils were considered absent from studies only if after the day/days of non-attendance, they returned to the programme and attended classes for at least 2 consecutive days. Wastage refers to exploratory attendance by pupils, participating for less than 10 study days, and then relinquishing the course and never returning to it.

Attrition rate

While the programme was planned as a 3-year course, it turned out that relatively few pupils participated in the programme for the full three years. Some of the pupils joined the programme in mid-course, for example, pupils from Chesterville and Lamontville joined only in 1988.

The total number of pupils participating in the programme during the three years was 117.

Table 1 lists number of students entering and leaving the course.

Table 1 shows that the programme started in 1987 with a moderate number of students: 36 pupils entered the programme and 28 of these continued to the second year - 8 of this intake did not go into the second year since 4 did not complete a full year in the programme and another 4 did not return to the programme in 1988. Thus the retentivity of the programme in 1988 in relation to those who stayed in the programme till the end of 1987 is relatively high (28 out of 32 i.e. 87%). Of these students 19 stayed for 1989 too, giving a 3-year retentivity index of 19 out of 32, i.e. 60% which can be considered high for a programme in which attendance is not compulsory.

The attractiveness of the programme is reflected in the fact that it had 64 new admissions in 1988. Of these new entrants 15 did not stay to the end of the year but 5 of them were only casual visitors to the programme, attending fewer than 10

Table 1. Pupils in the programme

Year of entrance	Admitted during 1987	Left during 1987	Admitted during 1988	Left during 1988	Admitted during 1989	Left during 1989
1987	36	4	28	-	19	1
1988	x	x	64	15	42	9
1989	x	x	x	x	17	5
Total	36	4	92	15	78	15

Table 2. Percentage of attendance
(Number of registered students in parenthesis)

Pupil Group	Term							
	87/1	87/2	87/3	88/1	88/2	88/3	89/1	89/2
Chesterville				77 (15)	50 (12)	34 (10)	63 (12)	76 (9)
Ingagasi	92 (10)	86 (10)	84 (10)	85 (15)	77 (15)	74 (15)	68 (14)	39 (11)
Kwa Shaka	92 (8)	70 (10)	76 (6)	73 (15)	48 (14)	85 (14)	72 (14)	55 (6)
Lamontville				65 (15)	65 (8)	67 (5)	64 (9)	62 (6)
Ogwini	93 (9)	72 (8)	84 (9)	88 (15)	82 (15)	71 (13)	87 (13)	74 (13)
Zwelibanzi	90 (9)	80 (9)	89 (7)	87 (17)	90 (17)	71 (17)	78 (16)	40 (16)
All	91 (36)	78 (37)	84 (32)	79 (92)	70 (81)	70 (74)	73 (78)	56 (61)

consecutive lessons, and therefore their quitting the programme should not be considered as attrition since they never acquired the status of regular participants. Nevertheless they are included in the statistics appearing in table 1. Of the 49 new entrants who completed the 1988 year, 42 continued in 1989 giving a retentivity ratio of 86%.

In summary it can be said that the retentivity ratio between years was higher than 80% and the 3 year retentivity ratio was around 60%.

Absenteeism

Absenteeism was examined by considering the proportion of attendance of pupils. Information about attendance during the various parts of the school year was obtained by dividing the school year into three terms of equal duration. This division is a technical one only and has no bearing on the running of the programme.

The proportion of attendance for the six schools during the eight terms of the whole study period is presented in table 2. The attendance percentages are given in relation to the total of possible attendance i.e. number of pupils multiplied by number of days.

Two observations: firstly, attendance is highest in the first term of the year. To some extent this is a computational artifact since pupils who leave in the middle of the term reduce the proportion of attendance, and this occurred more frequently in the middle of the second and third terms than of the first term. Nevertheless, in numerous cases where the number of persons was stable from term to term, attendance rates were higher in the first term. The second point of interest is the difference among schools both in regard to the ratio of attendance and the ratio of drop-out.

Finally, it should be noted that the overall

Table 3. Pattern of absence

a. Block Pattern	Total days of absence
1 1 1 1 1 1 1 1 1 2 2 1 0 1 1 2 1 2 2 2 2 2 2 2 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1	13
1 1 1 1 1 1 1 1 1 1 2 1 0 1 1 2 1 2 2 2 2 2 2 2 2 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 1 1 1 1 1	13
1 1 1 2 1 1 1 1 1 1 1 0 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 1 1 2 1 2 2 1 2 2 2 2 2 2 2 2 2 1 2 2	18
b. Dispersed Pattern	
2 2 1 1 1 1 1 1 1 1 1 2 0 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 2 1 1 1 2 1 1 1 1 2 1 2 1 2 1 1 2 1 1 1 1 2 1 2	12
1 2 1 1 1 1 1 1 2 1 1 1 0 1 1 1 2 1 1 1 1 1 2 1 1 2 1 2 1 2 1 1 1 1 1 1 1 2 2 1 1 1 1 2 1 1 2 1 1 2 1 1 2	13
1 1 1 2 1 1 1 1 1 1 1 1 0 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 1 2 1 2 2 1 1 2 1 2 2 1 1 1 1 1 1 1 2	11

Each digit represents a given date. Presence is coded 1; absence is coded 2; 0 refers to a holiday.
There are three terms, each consisting of 18 study days.

Table 4. Number of study days by percentage of attendance

Percentage of attendance	By Year 1987	1988	1989	By Subject Maths	Phys	Eng	All
91 - 100	23	9	3	10	14	11	35
81 - 90	9	14	5	8	13	7	28
71 - 80	4	16	7	10	8	9	27
61 - 70	8	4	10	8	6	8	22
51 - 60	2	7	x	5	1	3	9
41 - 50	1	2	2	3	x	2	5
All	48	53	29	44	43	43	130

attendance ratio of 70-80% can be considered an indication of interest in the programme.

Patterns of Absenteeism

Educators pay attention not only to the number of days missed by pupils, but also to the pattern of a pupil's absenteeism. A continuous absence of several consecutive days may interfere more seriously with studies than short absences spread over a long period of time. The first pattern is referred to as "block absence", defined operationally as an absence of at least 5 consecutive days. The second pattern, in which no period of absence has a duration of 5 consecutive days, is termed "dispersed absence".

Attention was focused on pupils who during the 1988 year attended until the end of the year, and in that year missed more than 10 days. There were 25 persons in this category. Table 3 contains illustrative examples of the two absence patterns.

Analysis of the data revealed that only 14 of these 25 pupils showed a "block absence" pattern. In relation to those who finished the 1988 year in CEP (61 persons), the proportion of persons with a "block absence" pattern is only 23%.

In summary, it can be said that the majority of absences among those who stayed in the programme for the whole year were occasional absences of short (less than 5 consecutive study days) duration.

Variations across years and subjects

During 1987-9 the programme ran for 130 days. Clearly during this time there were days with high attendance and days with lower attendance.

Table 4 analyses the extent of variation in attendance during the 130 days of the programme, and the bearing of programme year and subject on attendance.

Table 4 reveals a very high attendance (more than 90%) during 35 days. Most of these days were in 1987 (23 days). In the same year there was only one day with less than 50% attendance.

As already observed in the summaries of previous tables the attendance rate was highest in 1987 and tapered off in the second and third years. No substantial differences were found in the attendance patterns of the pupils according to the three subjects taught in the course.

The Extent of Attendance

As already indicated, 19 persons exhibited a high level of perseverance and participated in the programme for three years. Most of these students attended more than 100 days at the CEP programme during this time. The distribution of the attendance days of these students is presented in table 5. Looking at the figures in table 5, one gets an additional indication of the potential effect of the programme.

Table 5. Days of attendance

Days	Number of Pupils
81-90	2
91-100	5
101-110	7
111-120	4
121-	1
All	19

Absenteeism and Scholastic Achievement

Evidence has accumulated a positive relation between the attendance of pupils and their achievement levels. Those who have a good achievement record tend also to have a higher attendance record. As indicated by Kaesar (1985) it is impossible to determine cause and effect between these two variables. It is logical to assume that attendance in class contributes to achievement. But it is equally true that high-achieving students have a stronger motivation to attend than low-achieving students. It is quite likely that there is an interactive relation between attendance and achievement.

Empirical studies of the relation between these two variables have used data on compulsory school attendance. It interested us to examine whether attendance in non formal educational frameworks such as CEP was also related to achievement. For this purpose we considered the attendance records of the programme in 1989 and the standardized achievement scores of pupils in Zulu, Afrikaans, and English.

The Pearson correlations among the variables suggested that in the case of our programme there was no clearly distinguishable relation between attendance and achievement. The Pearson correlation coefficients between the days of attendance in the course and the scores in Zulu, Afrikaans and English were 0.04, 0.10, and 0.08 respectively. Indeed, it was the observation of CEP tutors that some of the very weak participants exhibited a high level of perseverance in their studies, a fact which may explain the lack of correlation.

Educational Wastage

In a compensatory educational setting such as the CEP it is difficult to define the concept of educational wastage. A very demanding definition refer to resources invested in tutoring students of three types:

- ☆ those who did not stay in the programme till its termination
- ☆ those who did not pass the matriculation examinations
- ☆ those who would pass matriculation examinations even without participating in the CEP studies

Such a definition of wastage has been rejected for both pragmatic and conceptual reasons. It is impossible to produce a good estimate of the third component of wastage specified above. One cannot say how many pupils would pass the matriculation examinations without participating in the programme. But the main reasons for rejecting this definition are conceptual. A basic assumption of the planners of the programme is that tutoring would benefit even the above-mentioned categories of students. The first two categories might acquire partial knowledge from the courses. Those who would pass the matriculation examinations anyway might raise their examination marks or acquire knowledge of use to them in their careers.

For these reasons, it was decided to employ a less demanding definition of wastage, namely participation in the programme for 10 study days, since this would be insufficient for acquiring knowledge of lasting value.

It may well be that this definition of wastage yields a lower estimate than other definitions, but the planners considered this approach a fair representation of the rationale of the programme. Examining the attendance data revealed that in 1987, when only 36 pupils registered in the programme, there were no instances of educational wastage. In 1988 1 pupil left the course after seven days' attendance, and in 1989 5 pupils left the course before their attendance reached ten days.

In summary it can be said that only 6 out of 117 persons acted as occasional visitors of the course and left it without making an effort to adjust to it. Although a small number, it would be useful to know why they quit the course.

Summary

In 1987 the Shell Science and Mathematics Resource Centre launched the curriculum extension programme (CEP) for senior high school pupils. Standard 8 pupils from six Zulu high schools were invited to participate in a tutoring programme scheduled to run for three years, i.e. until they sat for matriculation examinations. Tutoring was offered in science, mathematics and English and was carried out three afternoons per week, one day for each subject.

At the beginning of 1988 and 1989 additional standard 9 and 10 pupils respectively were admitted to the programme from each school. During the three years 117 pupils participated in the programme, but at any particular time no more than 92 pupils attended. The Centre adopted an open admission policy, pupils occasionally dropping out and new ones being admitted to the programme.

This study represents an attempt to describe programme attendance in terms of attrition, absenteeism and educational wastage. Information about these aspects of the Programme was sought:

- ☆ to inform programme planners whether the attendance met reasonable expectations
- ☆ to identify any problems of attendance
- ☆ to suggest ways of increasing attendance

It was assumed that attendance was a measure of the appeal of the programme; and thus that the findings would indirectly provide evaluative information about it.

Attrition

A distinction was made between attrition during the school year and that in the transition from one school year to the next. The attrition during 1987 and 1988 was approximately 15% and during 1989 was slightly higher reaching 20% while the attrition in transition from 1987 to 1988 was 13% and from 1988 to 1989 approximately 20%. This level of retentivity in a programme of voluntary attendance seems to argue for the attractiveness of the programme.

Absenteeism

The level of attendance reached an average of 90% in the first term of the programme, in subsequent terms tapering off, towards an average of 70-80%.

Attendance became especially low in the last term reaching a level of 56%. Despite this decreasing attendance, it should be noted that some pupils attended more than 100 study sessions during three years (one of them more than 120 sessions).

No substantial differences have been found in course attendance in the three subjects (mathematics, physical science and English). Although there were several days in which the attendance was below the level of 50%, in 63 days (out of the total of 130 days) the attendance was higher than 80%.

Wastage

In this study wastage was defined as resources invested in pupils who attended the programme for less than 10 days. It was assumed that such pupils did not gain any benefit from coming to the course, both the pupils' investment in the course and the Centre's investment in them being wastage. There were only six pupils in this category. (Such wastage is a negligible proportion of the total investment amounting to 40 in 6000 study days.)

Attendance as an indicator of the quality of the programme

An attrition level of 15-20% during a school year, a similar level of attrition from one school year to the next, and an average attendance level of 70-90% during the eight terms of the programme speak for the attractiveness of the programme to its participants. One should remember that the programme operated on an open entrance basis, with no penalties imposed upon pupils for absence. Under such circumstances the fact that some of the pupils accumulated more than 120 days of attendance in a programme of 130 days duration says much for the attractiveness and value of the course - more perhaps than the figure on attrition, absence, and wastage.

Recommendations

Despite the satisfactory level of attendance and the intrinsic value of the programme, it is desirable to have a support mechanism to ensure a high attendance level:

- The programme coordinators should impress on the pupils the need for regular attendance if they are to get the most out of the programme.
- It may be counter-productive to require pupils to justify every occasion of absence, but it may be useful to make some award for high attendance.
- Class committees should be organised with the aim of reducing absenteeism.
- Members of the committee should find out the reason for absence and, if necessary assist people in avoiding absenteeism. They should help pupils to overcome difficulties in their studies due to absence (especially in longer period of absence). They should submit a written report to the project coordinator about their activities.
- There should be a list of rules on handling cases of absence, which should be distributed among the programme participants. These measures might reduce occasional absences, but not the more frequent ones. Such cases require more intensive treatment.
- Programmes which provide tutoring to pupils, and possibly those that deal with adults, should employ a social worker to visit frequent absentees, to query their absence, and to provide assistance thereby leading to better attendance.
- These recommendations are aimed at the causes of participant absenteeism, but the following may be necessary in dealing with absenteeism from organisational or pedagogical causes.
- A short report should be done by the social worker and submitted to the Programme manager (or the person who is in charge of this task) stating the reasons for absence or departure from the programme.

- The content of such absence reports should be used by the programme team in making decisions about the organisational and pedagogical aspects of the programme which may increase attendance.

Notes

According to the data in table 2, in the 3rd term of 1988 74 pupils were registered. 13 of them discontinued their studies in the third term, hence in this calculation 61 is regarded at 100%. Some of these pupils returned to the CEP in 1989.

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Mathematics Achievement:

Comparison of CEP Pupils and their Classmates

P Ntenza

Participants in the curriculum extension programme came from six schools for black pupils in the Durban area. The tutoring lessons were attended by 36 pupils at the beginning of 1987, and by 92 and 78 pupils at the beginning of 1988 and 1989 respectively. The number of pupils from a single school attending the CEP ranged from 6 to 17.

In 1989 towards the end of the programme a mathematics test was administered to the whole class of standard 10 pupils in the parent-schools from which the CEP students were recruited, irrespective of whether they had participated in the CEP or not. Altogether 224 pupils were tested, among them 63 pupils who participated in the CEP.

The reason for administering the test to all pupils in the parent schools was threefold:

1. To obtain general information about the achievement level of standard 10 pupils in the schools of the CEP catchment area.
2. To ascertain in which areas of mathematics knowledge the pupils had attained a satisfactory level of knowledge.
3. Since the mathematics test was biased towards the content taught in the CEP course, it was of interest to find out whether the CEP students attained higher scores on the test than their classmates.

During the three years of the curriculum extension programme 44 afternoon study sessions had been devoted to tutoring in mathematics.

The Rationale of Mathematics Tutoring

Mathematics tutoring in the CEP attempted to strengthen mathematical thinking. It did not strictly follow the mathematics syllabus prescribed for senior high school classes, focusing rather on topics with the potential of promoting mathematical thinking (Ben Peretz 1985). Pupils were taught how to approach a mathematical problem, use analytical skills, and take advantage of intuitive grasp for solving mathematics problems. One of the aims was to train pupils to look at a set of mathematical expressions (in algebra) and to identify a certain pattern in terms of which they could describe what they saw. The course emphasised the relation of mathematics to real life problems. It discouraged mechanical computations of high level of complexity and encouraged short cuts and "elegant" solutions.

The Mathematics Test

The mathematics test consisted of 8 problems on arithmetical and geometric series, using algebraic expressions for solving numerical problems, and geometry. The 8 problems were divided into 45 items. Correct solutions of any item earned 1-15 points according to the level of complexity of the item. Altogether 166 points could be earned for perfect solution of the test.

Examples of assignments in series and in geometry are presented in exhibit 1.

QUESTION 4

Study the following:

$3^3 - 2^3 = 3x6 + 1$

$4^3 - 3^3 = 3x12 + 1$

$5^3 - 4^3 = 3x20 + 1$

4.1 Investigate further by writing down three more rows.

4.2 Now predict and check:

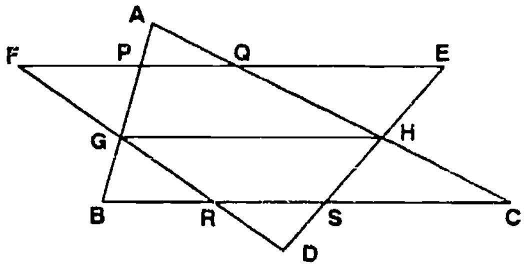
$20^3 - 19^3 =$ ....

4.3 Find a and b if

$a^3 - b^3 = 3x156 + 1$

4.4 Can you explain algebraically just what this pattern is based on?

QUESTION 6



6.1 Study the above sketch and determine the number of triangles in it. Use the letters indicated to name these triangles.

6.2 If FE//GH//BC; FD//AC and AB//ED, name all parallelograms in the sketch.

Exhibit 1. Sample items from the test

Results

Results are presented for the test as a whole, for the 8 problems, and for the 45 items. The results are given in percentage scores except when stated otherwise.

Group Scores

Table 1. Group scores for the 8 problems and the whole test

Problem	Mean	Std Dev	N
1	35,0	22,3	
2	42,8	17,9	
3	23,6	19,2	
4	45,4	13,4	
5	15,1	15,7	
6	54,6	23,4	
7	23,2	13,5	
8	4,8	15,2	
Whole test	29,0	10,8	224

Table 1 shows that the results were quite low. The best results were obtained in problem 6, which required sharp visual discrimination and very careful and systematic counting.

Very poor results were obtained in problem 8, which was difficult. Also, candidates may not have had sufficient time to deal with it as the last item of the test. Problem 8 required a high level of mathematical ability for proving the stipulated relationship. Problem 5 was also difficult.

Additional information on performance in the test is presented in table 2, which contains the frequency distribution of the percentage scores for the 8 problems on the whole test.

Table 2. Distribution of percentage scores

Interval	Problem								
	1	2	3	4	5	6	7	8	All
95 - 100	2		2					1	
90 - 94	1		-			6		1	
85 - 89	-		-			11		-	
80 - 84	1		1		2	10		-	
75 - 79	13		-		-	17	1	-	
70 - 74	-	1	-		-	13	-	2	1
65 - 69	12	8	-	15	1	20	1	-	-
60 - 64	-	21	8	5		23	2	1	-
55 - 59	5	-	-	68	2	39	1	-	4
50 - 54	47	41	15	21	6	14	3	2	5
45 - 49	-	101	-	-	1	-	7	-	12
40 - 44	20	-	29	58	4	31	12	11	13
35 - 39	-	7	-	19	9	6	11	-	30
30 - 34	22	11	60	13	7	4	28	1	41
25 - 29	30	-	-	4	23	-	31	-	43
20 - 24	-	7	30	7	15	6	35	6	32
15 - 19	41	2	-	2	31	3	33	-	24
10 - 14	-	-	22	4	18	4	29	-	14
5 - 9	6	1	-	3	32	2	19	-	4
- 4	24	24	57	5	73	15	11	199	1
All	224	224	224	224	224	224	224	224	224

It can been seen that for problems 1, 3, and 8 there are cases of perfect scores, and that in problem 4 all scores were below 70%.

Scores in Individual Schools

The results obtained in each of the six schools are presented in table 3.

Table 3. Total test scores in individual schools

School	Mean	SD	N
1	20,6	7,7	29
2	31,7	11,0	25
3	26,4	8,8	66
4	26,3	8,4	18
5	36,5	13,3	33
6	31,8	9,5	53
All	29,0	10,8	224

The range of the school means was 20,6 - 36,5 percentage points. Even the highest school average was far from satisfactory. Nevertheless in interpreting the test results one has to consider the fact that the test came to examine proficiency in a certain type of exercise, which quite likely had not been systematically taught in the schools.

More detailed information about the differences across schools is available in table 4, which gives the frequency distribution of the scores obtained in two problems (the easiest and an average one) in two schools, one relatively high-achieving and the other low.

Table 4. Results in two schools

Interval of % scores	Q2		Q6		Total	
	S1	S5	S1	S5	S1	S5
95 - 100						
90 - 94						
85 - 89				3		
80 - 84			1	1		
75 - 79			-	5		
70 - 74			2	2		1
65 - 69		4	3	4		-
60 - 64		6	-	4		-
55 - 59		-	4	2		1
50 - 54	1	10	2	2		4
45 - 49	15	8	-	-		5
40 - 44	-	-	1	6	1	3
35 - 39	1	2	2	1	1	5
30 - 34	3	-	2	-	1	3
25 - 29	-	-	-	-	6	4
20 - 24	1	1	4	-	4	4
15 - 19	-	-	1	-	11	2
10 - 14	-	-	2	-	4	1
5 - 9	-	-	-	1	1	-
- 4	8	1	5	2	-	-
All	29	33	29		29	
Mean	30,9	50,6	37,7	50,8	20,6	36,5
SD	20,4	15,1	24,4	23,2	7,7	13,3

On the easy problem (Q 6) some candidates in school 5 achieved a score of approximately 90%. There was a high dispersion of scores in all schools. This is especially true of easy problems (like no. 6 where the range covers intervals from 0 to 90).

Scores on the Test Items

As already indicated, the 8 problems were made up of 45 items. The total test score of each pupil was the sum of 45 part-scores.

The frequency distribution of each item score is presented in table 5. In this table the frequencies refer to raw scores. Nevertheless to provide comparative data, the means and standard deviations are expressed in percentage scores, where the maximum score obtainable for a particular item is coded as 100.

The column of means provides a convenient comparison of item difficulties. This information is complemented by the column of 0 raw score, which indicates how many pupils (out of a total of 224) had a score of 0 on any item.

The 45 items can be divided into three groups. In one group are 9 items for which average scores were above 70%. It can be said that these items represent the common knowledge of the whole group, since they were mastered by 70-90% of all learners (Block 1971). So, for example, students were able to carry out the assignments in exhibit 2.

Study the following:

$3^3 - 2^3 = 3x6 + 1$

$4^3 - 3^3 = 3x12 + 1$

$5^3 - 4^3 = 3x20 + 1$

4.1 Investigate further by writing down three more rows.

Study the following:

1=1
1+3=4
1+3+5=9
1+3+5+7=16

2.1 Investigate further by writing down three more rows.

Exhibit 2. Assignments carried out

Table 5. Scores on 45 items
N = 224

Problem	Item	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean	SD
1	1	34	5	185														83	36
	2	121	103															45	49
	3	86	36	102														53	45
	4	126	98															43	49
	5	196	4	24														11	31
	6	210	14															6	24
	7	203	-	21														9	29
	8	207	17															7	26
2	1	25	6	193														87	32
	2	26	12	186														85	33
	3	48	7	169														77	41
	4	158	46	20														19	32
	5	213	10	1														2	12
	6	205	11	6	2													4	15
3	1	66	27	46	85													55	41
	2	148	45	21	10													17	20
	3	197	21	3	1	2												4	13
4	1	15	9	200														91	26
	2	15	10	199														91	26
	3	21	14	189	-													87	20
	4	23	38	132	11	20												46	24
	5	115	2	107														48	49
	6	222	-	2	-	-	-	-										0	3
5	1	162	20	26	14	2												13	24
	2	122	6	96														44	49
	3	195	12	9	8	-												6	17
	4	122	7	95														43	48
	5	197	9	7	11	-												6	18
	6	170	9	45														22	40
	7	217	1	2	4	-												2	11
	8	190	2	32														14	35
6	1	19	1	4	3	5	1	6	12	59	23	91						78	27
	2	95	27	18	22	23	16	17	6									28	31
7	1	37	33	154														76	38
	2	188	36															16	39
	3	37	30	47	42	43	16	7	2	-								31	21
	4	115	29	38	26	14	2											22	27
	5	118	18	6	12													9	25
	6	56	13	16	19	29	21	25	19	11	7	8	-	-				31	25
	7	136	32	32	15	7	2											15	23
	8	42	34	50	50	30	18											44	30
	9	158	14	8	8	7	7	5	2	6	4	1	-	2	2	-	-	9	18
	10	210	8	6														4	18
	11	147	65	8	4													13	21
8	1	199	6	1	11	2	1	2	-	1	1	-						5	15

In the second group are another 9 items, with scores averaging 40 - 69%. These items were answered by pupils with a relatively high achievement level in their class. An example of such items appear in part b of exhibit 3.

Study the following sequences. For each sequence answer the following questions:

a) Find the next two terms; and

b) State the rule you have used for obtaining these terms.

1.1. -17; -15; -13;...............

1.2. 27; 9; 3; ....

Exhibit 3: Assignments carried out by higer achievers

The remaining 27 items were answered correctly by very few pupils - even among the top achievers in the group. An example of question 8 is presented in exhibit 4. Since this problem contained a single item, the distribution of persons earning a particular number of points for the question can be found in table 5.

> Draw any quadrilateral ABCD. By construction bisect angles A and B. Let these bisectors meet at E. Using your construction find, by measurement, the relationship between angle AEB and the sum of angles C and D.
>
> Now show that this relationship is always true.

Exhibit 4. Problem 8 of the test

As revealed in table 5 the majority of candidates (199 out of 224) got a score of zero on this item, and none a perfect score of 10 points.

Achievements of the CEP Pupils and their Classmates

Since the CEP participants had gained experience in solving problems of the type represented in the examination and their classmates had not, it was of interest to compare the results obtained by these two groups. It can be seen that for all 8 problems and also on the total test, the CEP groups obtained significantly higher scores that the other.

Summary

The results revealed that the majority of pupils could not cope with 27 of the 45 items of the test. Only 9 items turned out to be well known to the pupils, these items being mostly those serving as an opening to more complex questions, and not meant as a challenge for the testees. A further 9 items showed up the high-achievers in the group.

No differences were found in the performance of pupils in answering questions on algebra and geometry. In both areas they did quite well on very simple problems which could be solved by observing number or geometrical patterns and did not require complex mathematical thinking.

The test covered topics taught in the CEP programme. Usually these topics were not well covered in regular classes, mainly because they were not included in the mathematics syllabus. The organisers of the CEP programme considered these topics suitable for developing mathematical thinking.

The CEP pupils attained higher scores than their classmates on all problems. Nevertheless one cannot impute this to their participation in the curriculum extension programme, since it may well be that mostly only high achieving pupils responded to the invitation to join the programme.

References

Block, J (ed.), 1971, Mastery Learning: Theory and Practice, Holt, Rhinehart and Winston.

Ben Peretz, M, 1985, Learning Potential, in T Husen and T N Postlethwaite (eds.), International Encyclopedia of Education, Oxford: Pergamon Press.

Table 6. Comparison of the CEP group and their classmates

Problem	CEP group N = 63 Mean	SD	Classmates N =161 Mean	SD	*t value
1	51	22	28	18	7.1
2	50	13	39	18	5.0
3	30	22	20	17	3.3
4	49	10	43	14	3.6
5	25	20	10	10	5.7
6	67	17	49	23	6.3
7	31	14	20	11	5.6
8	13	22	1	8	4.0
Total	38	10	25	8	9.7

*significant at ,01 level

Revision Questions in Physical Science

P Hobden & A Lewy

In May 1989 a test in physical science was administered to the participants of the curriculum extension programme (CEP) of the Shell Science Centre.

The purpose of the test was

- to provide examination practice by using a test modelled on the matriculation examination
- to assess participants' prospects of passing the matriculation examinations
- to improve instructional procedures for the topics reviewed in the test
- to assess the extent to which practical activities carried out within the framework of the CEP helped the students to deal with matriculation examination questions.

The Test

The test consisted of six questions, five of which were taken from past senior certificate examination papers. The test items dealt with topics which had been taught in the CEP course. Pupils had an opportunity of carrying out practical work that could equip them with knowledge and skills needed in answering these test questions.

The questions

The six questions dealt with the topics of Newton's Laws and motion (3 questions); momentum and energy (1 question); and electricity (2 questions). In answering the questions the candidates were required to carry out routine calculations, use diagrams, and interpret data (see appendix).

A key for scoring was prepared by the coordinator of the physical sciences project together with two tutors. The 6 questions were divided into 21 component tasks carrying a maximum of 83 points.

The points assigned per question varied between 7 and 21. Scores were reported as percentage scores (i.e. a raw score of 83 was coded as 100). In the summary of the results percentage scores were used.

Administration of the test

The test was administered in one of the regular meetings of the course. No time restriction was imposed, and candidates completed the test in approximately one and a half hours. No special problems were encountered during the administration of the test.

Attendance was relatively low. Approximately 50% of the pupils registered for the course took the test. One may assume that weak students got "cold feet" although it should be noted that a small group of very weak students exhibited a high level of perseverance in attending the course, and also undertook the test.

The tested population

The test candidates were standard 10 pupils from Igagazi, Ogwini, Zwelibanzi, KwaShaka, Chesterville and Lamontville secondary schools. They were divided into five study groups, each having a roughly equal mix of boys and girls from different schools.

Results

The results present the distribution of the test scores (separately for boys and girls); the means and standard deviations of the scores for the whole group, for boys and girls separately, and for the various study groups; and the scores on each of the six questions and for the components of which the questions were made up.

Distribution of the Scores

Table 1 shows that only 2% of the candidates had a score higher than 80% of correct responses. In a programme of this nature a mastery level of at least 60% would not be an unreasonable aim. However, if we set 60% of correct responses as a passing score, then only 23% of candidates passed the examination.

Employing a lower standard of 50% correct responses increases the percentage of persons passing the examination to approximately 40% (this figure is obtained by dividing the percentage of pupils in the 41-60% interval into equal parts).

Table 1. Distribution of scores

Percentage score	Boys (%)	Girls (%)	All (%)
81 - 100	0	5	2
61 - 80	18	24	21
41 - 60	45	19	33
21 - 40	32	28	30
0 - 20	5	24	14
Total	100	100	100
Number tested	22	21	43

Figure 1 charts the information contained in Table 1. This shows that the distribution of scores differs for boys and girls. Most of the boys had a score clustered around the group average, while the girls tended to have either very low or very high scores rather than average ones.

Means and Standard Deviations

The information contained in Table 1 and figure 1 is complemented by Table 2.
Table 2 shows that the average score of the boys was slightly higher than that of the girls, despite the fact that the highest score was obtained by one of the girls.

Table 3 provides statistics for the five study groups participating in the CEP course.
It can be observed that there are substantial differences in the results obtained by the various study groups each of which had different tutor pairs.

It would be of interest to summarise the results for pupils from each school separately. Unfortunately the way data were recorded did not permit this.

Table 2. Means and standard deviations

Group	Mean	SD	Number tested	Range	Reliability
Boys	45	16	22	16 -73	
Girls	40	24	21	6 - 81	
All	43	20	43	6 -81	0,689

Table 3. Achievement in the five study groups

Group	Mean	SD	Number
1	58	6	8
2	33	25	9
3	39	16	7
4	38	18	11
5	49	21	8
All	43	20	43

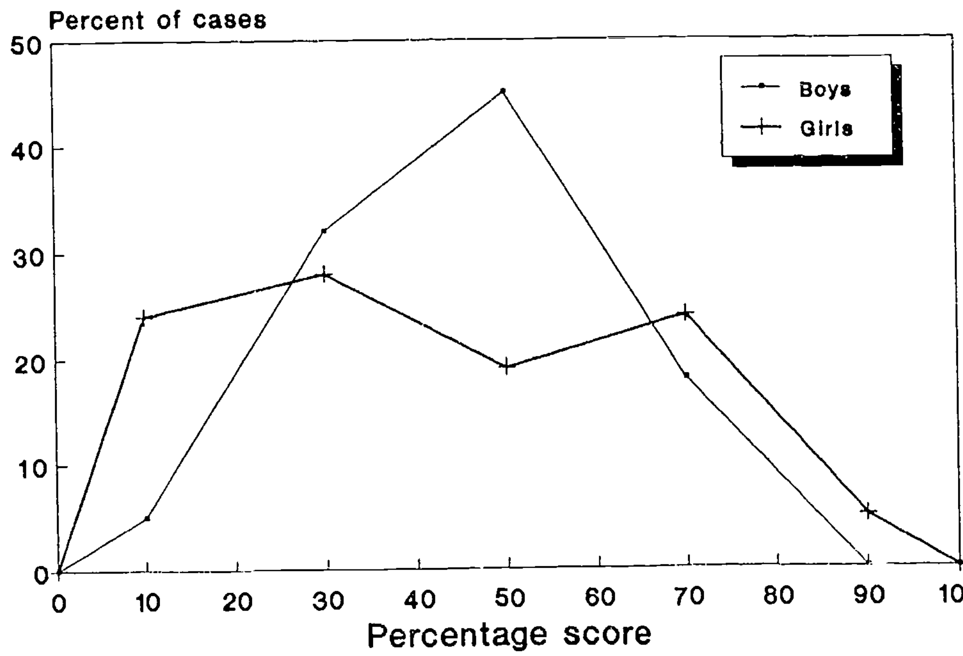


Figure 1. Distribution of percentage scores for boys and girls

Item Statistics

Table 4 contains information about the relative difficulty of the six questions for the 43 participants.

Table 4. Item statistics
(*Scores are percentages of maximum possible score)*

Question	Mean	SD	Maximum raw score
1	41	29	20
2	33	20	8
3	43	21	12
4	39	29	15
5	52	32	27
6	40	31	7

The easiest item was question 5. The mean score on this question was 52. The most difficult was question 2 (with a mean score of 33). The standard deviations especially for items 5 and 6 are relatively high, suggesting that a few candidates obtained extreme scores (high and low).

Question Components

As already indicated, each of the six test questions was divided into several components and each component was scored separately. The smallest number of components was two (questions 2 and 6) and the highest number, five for question one. The maximum score attainable per component varied from 2 to 7. The results for question components appear in Table 5.

A mean score in the region of 80% was obtained in only two question components Q1:1 and Q3:4; on four other components, the mean scores were between 60 and 79%; and in 15 components the mean scores obtained were below 60% and therefore substandard.

Table 5. Question component scores

Question	Component	Mean pct sc	Mean raw sc	SD	Maximum score value	Number of persons receiving a particular score							
						0	1	2	3	4	5	6	7
1													
	1	88	2,63	0,79	3	02	2	6	33				
	2	38	1,14	1,44	3	26	0	2	15				
	3	36	2,19	2,19	6	18	6	3	4	1	0	11	
	4	30	1,21	1,61	4	23	7	3	1	9			
	5	23	0,95	1,36	4	27	0	11	1	4			
2													
	1	32	1,95	1,29	6	7	6	19	6	3	2	0	
	2	27	0,54	0,88	2	31	1	11					
3													
	1	30	1,79	1,77	6	13	6	16	1	2	2	3	
	2	65	1,30	0,94	2	14	2	27					
	3	23	0,47	0,86	2	33	0	10					
	4	79	1,58	0,79	2	8	2	33					
4													
	1	47	2,81	2,71	6	15	6	2	2	1	1	16	
	1	71	2,12	1,22	3	8	5	4	26				
	3	36	1,09	1,34	3	23	6	1	13				
	4	7	0,21	0,71	3	39	1	1	2				
5													
	1	76	3,05	1,54	4	7	2	1	5	28			
	2	32	1,63	1,24	5	12	0	28	0	1	2		
	3	58	2,88	2,40	5	16	1	2	0	1	23		
	4	43	3,02	3,19	7	19	2	2	2	2	1	0	15
6													
	1	67	2,02	1,21	3	9	3	9	22				
	2	18	0,72	1,35	4	32	1	4	2	4			

Number tested = 43

In Q4:4 the great majority (39 persons out of 43) gained a score of 0 and only two persons gained the maximum possible score: the mean score was only 7%. In only a single component (Q2:1) did no one obtain the maximum possible score.

An interesting U-shaped score distribution appeared in several components, namely Q1:2; Q2:2; Q3:2, 3; Q4:1, 3 and Q5:3, 4. The U-shaped distribution means that respondents either could not deal with the item at all and received a score of 0 or dealt with the item well and received the maximum score; few obtained an average score. This means that partial knowledge was little help, the component requiring full understanding and ability to carry out the task.

Due to the observed U-shaped distribution of the question component scores, it was of interest to examine the distribution of the scores for the questions themselves (Table 6).

As evident from Table 6, the pattern of U-shaped distribution does not repeat itself in the question scores. Instead we encounter other distribution patterns e.g. bimodal. This means that a graphical representation of the scores has two peaks. This pattern is clearly observable in question 3 and 6. In questions 1 and 5 one may observe three peaks.

The pattern of peaks in this case would also appear to be a consequence of success on components of the question. A examination of the locality of peaks in the data shows that they occur at points related to the accumulative component scores. eg Q1 has peaks at 3,6,13 related to the component scores of 3,3 and 6

This reinforces the previous conclusion that partial knowledge in answering many components was of little value. The patterns showing once again that many of the components required full knowledge to succeed with few partial marks being allocated.

Table 6. Percentage of pupils with a particular score in each question

Score value for question	Questions 1	2	3	4	5	6
0	2	7	2	14	14	21
1	7	12	5	2	5	7
2	9	40	7	5	2	19
3	14	14	9	16	2	26
4	2	16	19	14	0	5
5	7	7	9	7	0	7
6	12	2	26	2	12	7
7	2	0	9	2	0	9
8	0	2	5	0	2	
9	2		5	12	2	
10	0		0	7	0	
11	7		2	2	7	
12	2		2	12	5	
13	12			2	2	
14	5			0	5	
15	5			2	2	
16	2				5	
17	0				9	
18	7				21	
19	0				5	
20	2				0	
21	-				0	
All	100	100	100	100	100	100
Maximum score value	20	8	12	15	21	7

Summary and Recommendations

The *first* purpose of the test was to provide examination practice, and this was achieved merely by administering the tests. The *second* purpose was to assess the examination prospects of the candidates. If one assumes that a score of 40% in this test corresponds to a pass in the matriculation examination, then it seems that approximately 50% of the group have a chance of passing. This result may be considered satisfactory in the light of the low pass rate (approx. 30%) in the schools from which students came to the CEP.

As to the *third* purpose, namely improvement of instructional procedures, the results may serve as a basis for three recommendations:

Firstly, if one wants to assess the ability of students to interpret data, it is necessary to build this properly into the questions which are supposed to deal with interpretation of data. Inspecting the results of the tests revealed that candidates were able to answer such questions (taken from past examination papers) without referring to actual data. We encounter here a situation, as frequently happens in testing, in which the actual taxonomic value of an item is much lower than that which the item writer attributes to it.

Secondly, the U-shaped distribution of question component scores is among others an indication of different ability levels in the tested group. This heterogeneity is strongly reflected in the total test score distribution for girls. Figure 1 shows that the score has a bimodal frequency distribution. This distribution pattern indicates that adjustments in teaching strategy are called for.

The expository teaching approach which addresses all students as a single group was only used minimally. Pupils worked for the most part in mixed ability small groups which was not as successful as expected. Perhaps the pupils need to be placed in homogeneous ability groups with different activities planned for each ability group.

Thirdly, the test results revealed that certain basic items of knowledge which are a prerequisite for more advanced topics have not been satisfactorily acquired by the majority of pupils. Thus, for example, the distinction between internal and external resistance is an item of basic knowledge, and pupils who have not mastered this item of knowledge cannot understand more advanced topics in electricity. Teachers do not spend enough time ensuring that all their students have mastered this topic and thus they are to blame if a substantial proportion of students do not benefit from the teaching of the advanced topics. It seems necessary to emphasise that before starting to teach more advanced topics, teachers have to ensure that all students possess the basic knowledge.

As to the *fourth* purpose stated in the introduction, it was found that despite intensive practical work in the area of simple circuits, students could not apply the experience thus gained to solving theoretical questions. This implies either that more effective methods should be used to help students make the links between practical work and problem solving, or that practical work does not help pupils in the solving of quantitative problems.

Appendix 1. The Revision Test

THE SHELL SCIENCE AND MATHEMATICS RESOURCE CENTRE EDUCATIONAL TRUST

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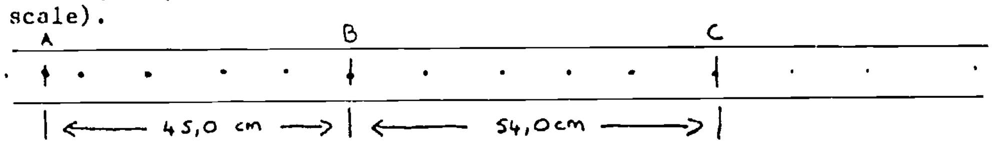
PHYSICAL SCIENCE — CEP — MAY 1989

REVISION QUESTIONS

QUESTION 1

A lead sinker tied to a paper tape was dropped from the first floor of a building. The paper tape was pulled by the sinker through a ticker timer of frequency 50 Hz. The sketch shows a portion of the tape (not drawn to scale).



1. What is the period of the ticker timer in seconds? (3)

2. What are the time intervals from A to B and from B to C? (3)

3. Calculate the average speed (in m/s) of the sinker as represented by AB and BC on the tape above. (6)

4. Calculate the value of g according to this experiment (in m/s^2). (4)

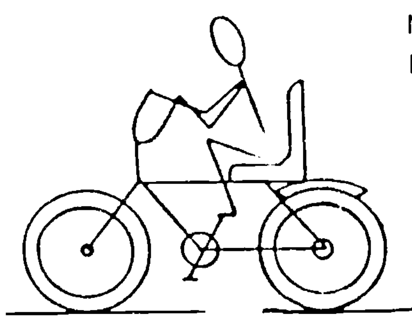
5. State two possible reasons why this value of g (in 4.) is lower than 10 m/s^2. (4)

(20)

QUESTION 2

i) By means of a sketch diagram indicate all the forces acting on the bicycle.
Be as accurate as possible. Indicate the relative size of the force by the length of arrow. (6)

ii) State the direction of the resultant force acting on the bicycle or indicate if it is in equilibrium. (2)



No brakes
No pedalling
Slowing down

(8)

QUESTION 3

During a trolley experiment a constant force is used to accelerate trolleys of different mass.

The results were as follows:

Mass (m) in kg	40	20	10	6,7	5
Acceleration (a) in m/s^2	0,5	1	2	3	4

1. Draw a graph of a vs $\frac{1}{m}$ on graph paper. 6
2. What conclusion can be drawn from the graph? 2
3. What is represented by the gradient of the graph? 2
4. Calculate the magnitude of the resultant force which accelerated the trolleys. 2

(12)

QUESTION 4

Body A, with a mass of 10 kg, moves with a speed of 5 $m.s^{-1}$ and then collides with body B, initially at rest, and with a mass of 15 kg. The two bodies unite on impact to move off together in the direction A had moved before the collision.

1 Calculate the speed of the bodies after the collision. (6)

2 Calculate the total kinetic energy of the bodies before the collision. (3)

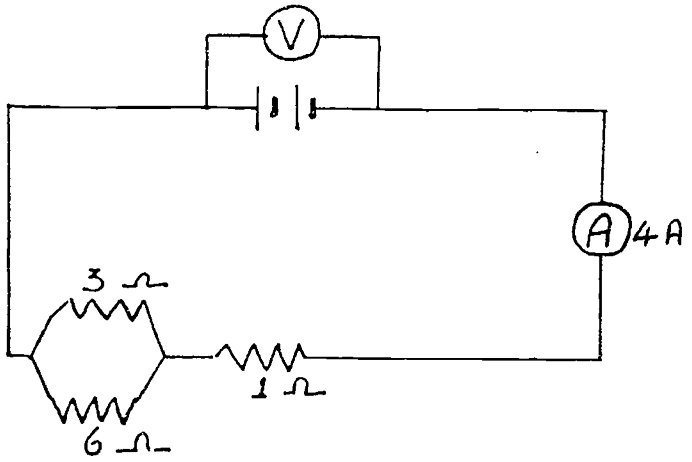
3 Calculate the total kinetic energy of the united bodies after the collision. (3)

4 Suggest ONE possible reason for the difference in the values obtained in 2 and 3 above. (3)

(15)

QUESTION 5

Study the following electrical circuit:



The internal resistance of EACH cell in the battery is 0.25 Ω .

Calculate:

1 the effective resistance of the two parallel resistors.

2 the total resistance of the circuit.

3 the reading on the voltmeter.

4 the EMF of the battery.

QUESTION 6

An electric heater was bought at a second-hand shop. The label on the heater however is damaged so that only the following information is visible:

AC ; 200 Ω ; 0,25 kW.

1 Calculate the current in the heater should it be connected to a 220 V supply (3)

2 Determine whether the heater will 'burn out' if it should be connected to a 220 V supply. (4)

46

Curriculum Adaptation Assisted by Analysing Students' Written Compositions

A Ziervogel

The autonomy of teachers in making decisions about the curriculum

The demand for granting autonomy to teachers in curriculum-related matters has been greatly increased in the 1980's. Curriculum experts express the view that teachers know the learning needs of their students best and therefore should have the right to determine what is taught in their classes (Skilbeck 1984). Opposed to this is the centralist trend of prescribing a compulsory core curriculum across all schools within a particular educational system. Sabar et al. (1987) propose as a solution a partnership in decision making between school-based and extra-school educational authorities.

Informal educational programmes are usually less exposed than schools to external control in curricular matters and teachers in informal programmes enjoy a relatively high autonomy in making decisions about what to teach and how. However, informal programmes which intend to tutor students for passing examinations set and administered by external authorities have little freedom in making curricular decisions, since programme leaders are under obligation to select curricular contents which will help students pass the examinations.

But by examining actual teaching and learning situations, one may realise that a third factor in addition to an externally set syllabus and teachers' predilection for one or another instructional topic may determine the parameters of the curriculum. This is the textbook used in the class. Research has demonstrated that the textbook is one of the most influential factors determining what is taught in the class (e.g. Stake and Easley 1978; Squire 1985). The influence of the textbook is strong both in formal and informal educational settings.

Since the Shell Science Centre operates a tutoring programme to help students pass external examinations, it faces the problem of establishing an acceptable balance between these three factors. It is well known that the examination syllabus is set by an external authority, whose decisions cannot be affected by preferences and wishes of extra-school tutoring programmes. In selecting textbooks the teaching staff may have full autonomy, but they operate under the constraint of the availability of textbooks. However, the teaching staff can exercise a high level of autonomy in deciding what units to select from available textbooks, for teaching and in preparing supplementary instructional materials for their classes.

Indeed the practice of bringing supplementary instructional materials to the class is quite common and in educational systems of developed countries most teachers distribute hand-outs to their students.

Handouts, however, may be of variable quality. Some teachers assemble exercises from various textbooks, improvise exercises, or take worksheets from the repertoire of the school without thoroughly examining whether these offer useful material to students. It is quite seldom that a number of teachers work together and try jointly to develop supplementary instructional materials on the basis of a thorough examination of students' performance.

This article intends to describe an example of developing supplementary instructional materials on the basis of systematic assessment of the educational needs of the student population. We shall report here only of the first phase of the development activity, which followed the established pattern of needs assessment (Provus 1977; Suarez 1985). In operational terms we examined the discrepancy between the actual level of students' performance and the ideal level, as judged by the teachers, needed for passing the matriculation examination. This was done by analysing the students' work.

The development activity described here was carried out by the Shell Science Centre's English as a Second Language team within the framework of the curriculum extension programme (CEP) operated by the Centre. We will first describe the nature of the English course of CEP and then provide details about the development activities.

English as a component of the Curriculum Extension Programme

English for Special Purposes

The curriculum extension programme was designed to increase the competence in science subjects of high school students from the black population. Admission to this programme was reserved for those who studied physical sciences and mathematics and intended to sit for the matriculation examination in these subjects. The aim of the programme was to help students pass the matriculation examination, and accordingly studying mathematics and physical sciences was considered to be the most important component of the programme. Nevertheless, at a very early stage in determining curricula for CEP it was decided to include English in the programme and to treat it as a subject of equal importance with the science subjects.

This decision was supported by several considerations. Firstly, it was noticed that the target population of the programme passed the matriculation examination in English with difficulty. English is not their mother language and in their family setting is only partly used, if at all, for routine communication. Thus, English as a school subject and as a mandatory subject for the matriculation examination was considered as a legitimate object of compensatory teaching. Secondly, English is used as the medium of instruction. An adequate mastery of the language is a prerequisite for the effective study of school subjects including science. English (or in more general terms the language of instruction) across the curriculum is a central concern of curriculum planners, and experts recommend that within the framework of teaching any particular subject it is necessary to systematically treat language problems unique to that particular subject; the subject-related vocabulary should be taught directly, and the characteristic language patterns and conventional modes of expressing ideas or describing phenomena should be given systematic treatment. This applies no less to native speakers of the language. Also, the target population of the programme writes the matriculation examination in science and mathematics in English and its ability to handle English adequately in answering the questions would improve its chances of passing the examinations.

From the above it will be clear that the English programme of CEP is largely governed by the principles established for teaching a foreign language for special purposes. Linguists have developed unique curricula for those who wish to learn something of a foreign language for special purpose, such as getting along as a tourist in a foreign country, serving as a business correspondent, reading instructions on how to operate mechanical equipment, and mastering the characteristic prose of a particular subject.

While the English curriculum of CEP reflects the conception of language teaching for special purposes (Hutchinson and Waters 1987), there is nevertheless a lack of clarity about the special purpose it comes to serve. In some instances this is defined narrowly as the ability to cope with the requirements for studying science; in other instances a more comprehensive definition is preferred, namely that of coping with the demands of studying in a high school in general.

CEP's English Curriculum

The English team operating the CEP adopted the broader definition of English for Special Purposes and accordingly decided to implement a curriculum for fostering the mastery of all language skills but at the same time narrowed down towards skills needed for successfully functioning in science studies. The English curriculum provides learning experiences in the four major areas of communication: reading, listening, writing, and speaking, with special emphasis on using these skills in a broad variety of school-related situations. It is biased towards dealing with language skills needed to succeed in studying science and mathematics. Nevertheless, it proceeds on the assumption that studying science and mathematics is one aspect of adjusting to school and life, and that therefore this should be dealt with integrally with all other components of the learners' language studies.

The content of the course is largely determined by the textbooks used by the learners; the teaching staff, however, prepare hand-outs which focus studies on deficiencies observed in the performance of the students.

In the following section we will describe the steps taken by the team to assess students' assignments for the purpose of setting educational objectives in studying *writing*, and for providing supplementary instructional materials for such courses.

The Assignment

Students participating in the CEP studies were given a test or exercise in English in four parts: vocabulary, reading comprehension, dictation, and free composition. The theme of the free composition was: "Describe *one* maths or one physical science lesson you really enjoyed this year. Explain why you enjoyed it and, if you found any difficulties, explain these as well." In this article we will deal with one component of the test only: the compositions.

Criteria for analysing the compositions

An attempt was made to go beyond assigning a mark to the compositions, and to examine their characteristics in a way which might provide useful ideas for curriculum planning. The analysis could help the course-based curriculum planners in two ways. Firstly, it could point out flaws in the writing of the students and thus serve as a basis for deciding what needed to be taught. Secondly, the compositions together with critical comments might be used in future as supplementary study materials in courses of writing. Such study materials might fit the needs of the target population better than exercises appearing in commercially distributed textbooks, due to similarity of their cultural and linguistic background to that of those who would use them.

Guidelines for analysing the compositions were developed on the basis of models and checklists reported in the relevant professional literature. No particular model was adopted for carrying out the analysis. The guidelines represent an eclectic collection of criteria which seemed to be useful for curriculum planning. Intensive use was made of criteria listed by Raimes (1983) and by the University of Lancaster Institute for English Language Education (1988), and the work of Perera (1984).

In exhibits 1 and 2 we present a concise version of two of the models mentioned above.

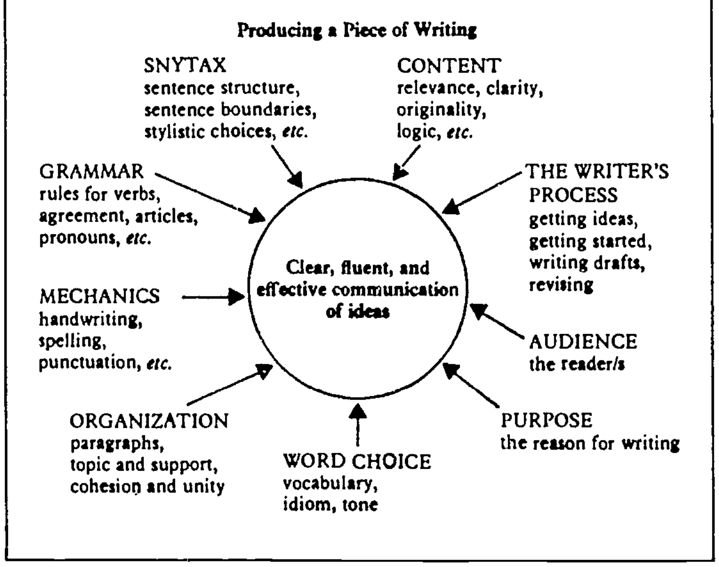


Exhibit 1. Producing a piece of writing

Discourse level:	Overall theme
	Relevance
	Organisation
	Reader awareness
	Register
	Avoidance of plagiarism
Intra-paragraph level:	Cohesion
	Syntax
	Vocabulary
	Redundancy
Word level:	Spelling
	Number/Concord
	Articles
	Prepositions
	Tense
	Word form
	Punctuation

Exhibit 2. University of Lancaster model

Quite arbitrarily we selected a set of criteria from these models, and redefined them in a way which fitted local circumstances. We divided the criteria into two groups: descriptive criteria and evaluative criteria.

Descriptive Criteria

Criteria contained in this group are primarily descriptive and do not necessarily have an evaluative connotation. They characterise the writing along dimensions of style without giving preference to one or another category of the dimensions dealt with.

The structuring principle: chronological versus logical. Narrative compositions are structured by chronological arrangement of the events described. In contrast, expository writing is structured on the basis of logical analysis of the phenomenon dealt with.

The particular assignment which constituted the topic of our analysis was a composition with the title "A lesson in science or maths which I really enjoyed". This assignment can be carried out by using either a chronological or a logical structure for organising its content. In the first instance one may describe the sequence of events as they occurred in the class. In the second instance one may focus on types of events or on particular traits of the events which the writer especially liked.

As already stated, preference should not be given to any one of these structures for organising a composition of this type. Nevertheless, it should be noted that writing about topics in science usually relies on logical structures rather than chronological ones.

The personal-impersonal dimension. Another descriptive dimension is the personal-impersonal contrast. The title of the composition, in our case, invited writers to describe their feelings and thus one may expect that the writers would prefer to use a personal style. Some writers again in dealing with the traits of a good lesson might go beyond describing personal feelings and express ideas in impersonal style about qualities of good lessons in general. Again, both styles are acceptable for this particular composition, though in writing about topics in science an impersonal style is frequently given preference.

Evaluative Criteria

As to the evaluative criteria we shall list here those which can be applied at the paragraph and discourse levels. This does not mean that we disregarded the importance of more conventional criteria which apply at sentence and word level, but we felt that dealing with paragraph and discourse levels criteria presents a challenge for the teaching staff and mainly for those teachers who represent the schools of our target population, and therefore we decided to focus on them.

Self-sufficiency. This criterion is emphasised in the writings of Perera. She states (1984: 259):

> *A major way in which a piece of writing differs from most speech is by having its own autonomous existence separate both from the person who produced it and from the physical situation in which it was created.*

In compositions written in a school setting writers frequently do not specify details of the situations dealt with in their writing because they assume that these details are familiar to the reader. This assumption is correct when the only reader of the composition is the teacher, but the writer should consider the needs of a reader who has not attended the lesson described or who is not familiar with the conditions prevailing in the school.

Organisation. In dealing with organisation we adopted some items listed in the University of Lancaster IELE (1988) document:

- ❑ Are the paragraphs well linked to each other?
- ❑ Does the composition have a thematic cohesion or does the writer deviate from the topic and elaborate on unnecessary details?
- ❑ Is the length of the introduction appropriate to the text as a whole?
- ❑ Is the end of the composition an appropriate finish of the theme dealt with? Is it a recognisable ending or does the reader have a feeling that the writing has been ended in the middle of dealing with the theme?

Specifying reasons. This criterion was arrived at by examining the unique features of the particular composition which the students were requested to write. Have they stated the reasons why they liked the particular lesson? Have they elaborated on the reasons or only stated them in very vague terms, such as "because it was interesting" or "because we learned a lot"? Are the reasons relevant?

Variation of conjunctions. Does the writer use a rich variety of conjunctions or have only a limited repertoire of the most common ones, such as "and", "but", etc.?

Comments on the compositions

From the seventy-three compositions which were graded we selected a sample of six representing a whole range of scores assigned to the compositions. Evaluative comments were written by an English Language teacher on each of these six compositions. The comments touched on each evaluative criterion separately. In the subsequent sections reference will be made frequently to these comments.

Four compositions are reproduced verbatim in exhibits 3-6. These are the composition which gained the highest score, two compositions which gained mediocre scores, and one which had a very low score. We have not reproduced here the composition which had the lowest score, since it was characterised by very bad spelling and a very weak sentence structure, which made it difficult to focus on the whole composition. We shall examine these four compositions by reference to the criteria described above.

One Tuesday morning, when we were returning from the assembly, we went to our classroom. The first two periods were for Physics. Our Science teacher, Mr Dlamini came into the classroom with an old bag, a plastic container full of match-sticks and four bigg balls of coloured dough.

He then told us that we were going to make models of different molecules from the dought. We were then divided into groups. We had to make models of Diatomic molecules i.e. H_2, N_2, 0_2, Cl_2, and also those of Ammonia, hydrochloric acid, methane, Diamond and Graphite. The group which will make the best models will receive a new model kit for all elements.

My group and I were very keen to win the prize, so we did our best to impress the teacher. We even reserved explanations for each model. Even the angles between the bonded atoms were made to be exact. We also made the atoms t in their correct sizes. Everybody in the group was active, noe of us were standing and talking. Everybody was busy and we were having a lot of fun and on our way to success! We were all steady but sure on what we were doing.

Eventually the teacher came by to check and award marks for the models made by each group. The teacher then turned horses in midstream, he just tole us about the history of the Periodic Tavle. The pupils wanted the results, but the teacher just ignored us. I could see that he was doing this on purpose.

For a moment terror seized me, the teacher went straight out of the door! At last he announced us as the 1988 Winners of the Molecular models competition! We were very happy about this.

Exhibit 3. Composition 1

I like mathematics because of my work that I like to take it, is engineering. In engeneering we needs mathematics you cannot take this work without mathematics subject in you certificate.

But in Mathematics they is one lesson that I am enjoying than the otherone. That lesson is called "The absolute value graphs". The subject in my school that I like is mathematics and physical science But the subject that I enjoyed more than the otherone is maths. In Maths the lesson that I am enjoying more than the otherone is an "absolute value graphs"

This lesson teach you, how to calculate and already hoe to drawn a graph. In many things in the world you can see that they is many things that is needed graphs If you can make some bridges the graph need, you cannot make a bridge or a house without a graph of that particular that you needs, that why the graph are very important in our life

In making the formular of that thing that you want to now the maths formular need to help you. You can see that thing must be there and how, all that you can see. If you are going you can take a box and pay, there fore you need to now a maths or you are going to the shop the maths subject need. Therefore maths subject is the general subject that you can must now you life.

Exhibit 4. Composition 2

The one Physical Science lesson that I enjoyed this was was Molecular Geometry. This lesson was about figures and angles as the word Geometry state it. Here we were dealing with figures and angles of molecules like the types of bonds when two atoms or molecules react. We were devided into groups of three and issued each group a kit. These kits were loaded with round like structures of different sizes and different colours representing different kind of atoms, like while for hydrogen and black for carbon. There were also rods which represented bonds as the oxygen atom is diatomic and has two bonds and each nitrogen atom has three bonds.

I enjoyed this lesson because I like doing expriements and I like doing things by myself. I also liked it because it was some sort of a game, the atoms seemed to be like toys to me and I would form whatever the structure I like to. We also watched a video about this lesson to enrich us with more knowledge about bond formation.

The only problem I came across was that it was the first time I ever did that, we had not done it at school. As a result I had a problem on what type of bonds exist between these elements. With the exception of that the whole lesson was wonderful.

Exhibit 5. Composition 3

As we all know that now is the time to look after each and every event that occurs, that is why I would like to describe a physics lesson as the one I enjoyed. Chemistry is the part that interests me the most due to the following points.

In Chemistry we find that the fact that we are alive is because of Carbonic Acid ($C0_2$) which I know that many of us does not know it. This describes fully that the elements that are responsible for our lives are Carbon and Oxygen. Since we know that Carbon and Oxygen would not be present if the other Diatomic gases molecules were not *there and the diatomic gases molecules would not be there if these two basic gases were not there, because gases are going hand in hand with others to form one another.*

In Chemistry I also learnt about Bohr's assumptions which say: The elements can jump from their probably region of movement to other energy levels because of the excited state and when they jump, they jump according to the equation $E = E_1 - E^2 = E = hf$ or $E = h\ 1/2$. He said the electrons sharing movement in the same orbital posses the same quantity of energy which is in packet called Quante. I have also learnt that in his assumptions there possibly occurred short-comings.

In Chemistry I have learnt about the models of different scientists such as Isaac Newton, John Dalton, John Thomson, Rutherford, Bohr and De Brogle. A scientist by the name of De Brogle identified an orgital as the most probable region of movement of electrons without emitting energy. He also says it can be viewed as a region which delimits the standing wave pattern of an electron. That is where a lesson which interest me is.

Exhibit 6. Composition 4

How are the Compositions Structured?

We find a good example of narrative structure in composition 1 while in the other three compositions the structure is quite weak, and in so far as one can uncover a structural principle in them, it is logical rather than chronological.

It seems that the pupils can handle the narrative structure better that the logical one. Those who selected the logical structure deviated from the topic of the assignment. Instead of writing about a particular lesson in science, they wrote about a topic in science which they liked (like absolute value, graphs, or molecular geometry), which quite likely was taught not in a single lesson but in a series of lessons. Nothing in these compositions points out a particular idea which is linked to a lesson. Deviation from the assigned topic is even more salient in composition 4, in which the writer explains why she likes chemistry, instead of dealing with a single lesson.

It may well be that wandering off the topic was a necessity for many writers because they could not remember a lesson in science or mathematics which they really enjoyed. Thus the lapse or deviation was not a mistake caused by lack of attention or misinterpretation of the title of the assignment, but rather a purposeful device for coping with a difficult assignment. Even the author of the composition which employed a chronological structure in a way deviated from the topic of a science or mathematics lesson by writing about a competition which took place in a science lesson. The writer took advantage of the broad meaning which may be attributed to the title of the composition and interpreted it in a way which is entirely legitimate, even if it does not fit the original intention of those who defined the assignment.

In general, it can be said that disposing of the chronological structure turned out to be a disadvantage for the writers, as their skill in logical ordering is inferior to that in chronological ordering.

Does impersonal style of writing appear in the compositions?

The title of the composition contains the personal pronoun "I", which in itself introduced a personal bias into the writing. The writers were asked to deal with a science or maths lesson from a personal point of view rather than present an impersonal exposition of scientific ideas. Disregarding the personal dimension, refraining from using the pronoun "I", would be an unjustified deviation from the task they were asked to perform. Nevertheless, some paragraphs of the compositions come very close to an impersonal exposition of scientific ideas. An example may be the following section from composition 4.

> *In Chemistry we find that the fact that we are alive is because of Carbonic Acid (CO_2) which I know that many of us does not know it. This describes fully that the elements are responsible for our lives are Carbon and Oxygen. Since we know that Carbon and Oxygen would not be present if the other Diatomic gases molecules were not there and the diatomic gases molecules would not be there if these two basic gases were not there, because gases are going hand in hand with others to form one another.*

The repeated use of the pronoun 'we', as it appears in this paragraph, is quite permissible in scientific writing. Also one could easily modify the text and transform it into a paragraph using impersonal style.

Are the Compositions self-Sufficient?

The reader does not have any difficulty in understanding the texts. The compositions do not contain reference to events or occurrences which cannot be understood by a reader who has not participated in science lessons in the school.

The teacher's remark for composition 3 is:

Lesson description quite well detailed. It is obvious from the writing that the writer was making models of molecules and determining bond angles.

For composition 2 the comment is:

Very little detail included on topic of composition. Writer discusses mathematics as a whole.

For composition 4 the following remark appears:

Very difficult for a non-scientist to follow the details of this composition.

Summarising these comments, one may say that in so far as information is missing from the compositions this is caused not by assuming that the writer's particular circumstances are well known to the reader but rather by the fact that the writer has not dealt with the topic at a satisfactory level of depth (e.g. comp. 2) or by the fact that the writer had a misconception of the readership (e.g. comp. 4: writing to non-scientist in a style which would probably fit the scientist reader).

Are the compositions well organised?

The critique written on the organisation of the selected compositions is listed below.

Composition 1:

Thematic cohesion evident - no redundancy. Length of introduction appropriate; end obvious but a little short. Cohesive links used between paragraphs.

Composition 2:

Little thematic cohesion. Writer does not describe one lesson and elaborate. Introduction fair. Ending poor. Redundancy.

Composition 3:

Thematic cohesion evident - no redundance. Introduction could have been set apart in separate paragraph. First paragraph is more than introduction, it also describes the lesson. Paragraphs not well linked. End well defined.

Composition 4:

Little thematic cohesion, as three different topics are discussed. Introduction weak. Writer decided to describe a Physics lesson and then described Chemistry in para 1 and Physics in para 2 and 3. End short and abrupt.

Four types of problems are mentioned in the critique.

Redundancy. This appears mainly in composition 2, and it appears in a very rudimentary form. Expressions and sentences are repeated in a way which disrupts the smooth flow of ideas.

Lack of thematic cohesion. This problem is noted in three compositions, though with varying severity. Only one composition is described as having a satisfactory thematic cohesion, and that composition is structured according to the chronological principle. There is no doubt that the chronological principle facilitates the maintenance of thematic cohesion. The writer skillfully uses chronological sequence for building cohesion. The writer knows how to convey the feeling of suspense, and indeed succeeds in raising the feeling of suspense in the reader too.

Weak introduction. Two flaws of the introduction are mentioned in the critique. Firstly, it does not really introduce the reader into what follows. In other words, it raises expectations which are not realised in the composition. Secondly, it is not well separated from descriptive elements which do not belong in the introduction.

Abrupt end. This flaw is mentioned for composition 4, although 2 is also characterised as having a poor end. A short ending is not necessarily an inadequate end. But by using the word abrupt, the critic suggests that it would have been better to have a more elaborated ending for this composition. A mere reference to what was said in the introductory paragraph, in this particular case, is not sufficient

Are reasons specified?

"Specifying reasons" does not appear in standard lists of evaluative criteria for writing. Indeed there is no need to specify reasons in all kinds of writing.

Thus, for example, in chronological articulated composition (no. 1) the story itself explains why the writer enjoyed the lesson.

The critic recognises this fact in commenting:

Reasons for the writer enjoying the lesson are explained indirectly but are quite evident.

Critical comments appear for compositions 2 and 4:

Very little elaboration of reasons why a specific lesson was found interesting.

Attempts made to explain why some aspects of chemistry were liked but reasons are not clearly stated, similarly with description of atomic theory.

Two flaws are mentioned: lack of clarity and poor elaboration.

What kind of conjunctions are used?

There is not much variety in the conjunctions used by the writers. They tend to use short sentences. Only basic conjunctions such as "like", "as", "and", "but", "because" are used.

In some cases one would expect to find a greater variety of conjunctions in a composition. Nevertheless, the fact that in whole series of compositions one does not find a greater variety of conjunctions suggest that the level of sophistication of the writing of pupils in this group is relatively low.

Summary

This article describes an empirical study by the English teaching team of the Shell Science Centre aimed at improving the teaching of writing to the pupils of the CEP course.

The empirical basis of the study was a composition written by all participants of the CEP course; a list of criteria compiled by the teaching staff to be used in judging the merit of the compositions; and comments on a selected subset of compositions, which specified the merits and the demerits of each composition separately according to each criterion.

This empirical data set served the purpose of

- ❑ Identifying problems encountered by pupils in writing compositions; it thus served as a needs assessment study (Suarez 1985).
- ❑ Providing input for staff meetings dealing with problems of teaching writing, thus serving the needs of staff development activities.
- ❑ Developing school-based instructional materials which directly respond to the needs of pupils in the course (Sabar et al. 1987).

The study is the first step in a project, of which the remaining steps are to discuss the summaries with the teaching staff; convert some of the compositions and comments presented here into instructional materials; use them in classes; evaluate the effectiveness of such course-based instructional materials; and, finally, develop additional sets of instructional materials on the same basis.

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Profiles of Participants in the Programme

C Scott

Lynette

It was a case of learning from her elders for Lindiwe (or Lynette) Mzolo who bounced in with gold earrings, fashionable permed hair and school uniform of blue/grey striped tie, blue skirt, and white shirt.

"I don't know anything about Shell," the confident 18-year-old admits. "I just wanted to go. I knew it would teach me a lot. The others who went on it are now at University or into the technikons."

Like every student interviewed, the lack of apparatus at her home school was a major stumbling block. Eighty-seven kids per class doesn't help either. Lindiwe clasped her hands and noted, "I think it's better to have it just like we have it here with few children in class."

Unlike some other CEP students, Lindiwe is highly motivated and articulate. Her priorities: "Education comes first, friends must come second. A lot of my friends aren't able to help me but education can".

That showed in her attendance record. Only six days off - for illness and indulging in good old South African male chauvinism when "the boys at Igagasi (High School) had to play sports and the girls had to cheer them on" - since being selected at the beginning of 1987 by her class teacher.

She wrinkled her nose and laughs, "I like sciences. I wouldn't like it if I were told it was for boys only. I don't like needlework. English is good too. I like Ian Fleming's James Bond stories. He knew how to deal with people who are doing illegal things!"

"We're more free to do experiments on our own, not to see them in books," the Umlazi standard 9 student notes approvingly of CEP. "I want to see how the thing actually happens, not to be told how. I want to do it myself."

Her mentors are family. Father is a Zulu lecturer at the University of Natal while mother is a nursing sister at King Edward VIII Hospital. Eldest brother Phumlan, 24, is a science teacher. While one brother completes a B.Sc., another considers law and the youngest, aged 17, provides Lindiwe with some academic competition.

"I want to go to University to do B.Paed. or become a teacher of science for a high school. I want to be a lecturer at university. I also would like to work in a company like Shell," she said in an off-the-cuff bit of crystal-ball gazing.

What about children? "Hey!" she protests. "I can have one but only when I'm through with my studies." And criticism of CEP? "I can say I have none."

S'bu

"I'll start with maths," says Sibusiso Mthembu, 16. "I had problems with maths at school. I didn't know how to bisect an angle. Here they told me. In physics at school, we have no apparatus. when I came here, I did many wonderful experiments. And this year, Mrs Scottville taught me how to write short summaries. Before this, I spent too much time in comprehension."

"CEP", the standard 9 student concludes, "exercised my brain." But even the best programme will falter when the pupil lives with eight other people in a four-roomed house with no electricity. His widowed mother must support eight children on a Berea domestic servant's wage of R280 a month.

It means rising at 5.30 a.m., and arriving at Zwelibanzi High School at 6.15 for biology revision, followed by 7 hours of school and a 20 minute bus ride across Umlazi for 2 hours of CEP three times a week. Afterwards it's "go home, iron my clothes, eat, then I start studying (by a paraffin lamp, while his younger brother sleeps beside him) until 12." Weekends he breaks from studies to play striker position for a soccer team and attend the Apostolic Church.

"They say when you study very hard, when you grow up it will be very easy," S'bu shrugs, his head cradled in his hand.

But township hardship has already claimed his eldest brother. Xolani, aged 21, didn't attend school. "He's a thug," S'bu explains calmly. "Sometimes when he's at home he beats us. He lives a horrible life, I can be very glad if he can change his ways."

So S'bu shows a touch of panic at being asked to offer constructive criticism of CEP. "It will be a great damage," he protests vehemently. "Shell is doing many favours for we students. Nothing can be changed, it is excellent. It is very nice, I learned many things there."

What is Shell, S'bu? "It's an oil company. From ... America. No? Britain? No? Holland! I didn't know."

The Shell programme has made him aware of his own limits. University is unaffordable and his marks, although an improvement on past exams, aren't top bursary material (maths B, English D, Afrikaans E, Zulu C, physics D, biology D). In addition, there is the financial question of getting five younger brothers and sisters through school.

But, like his classmates, he dreams extravagantly of being a professional. "People just say to me that maths opens all doors to me, I can be a jack of all trades. Maybe I will work for a year then use money to go to University. I would like to be an engineer, either electrical or chemical. When the floods came last September, the cemetery in Lamontville opened and the corpses came out into the river. I would like to prevent things like that. Any my teacher told me here in South Africa, things are ruined by rain. "On the other hand, I would like to be a psychiatrist. I just want to learn about the minds of people, see how they work. I would like to help them."

God-knows

God-knows Mkhwanazi likes CEP, especially physics, but confessed to being afraid of being interviewed on the subject. "I wonder what you're going to do," he speculated, straightening his green tie. He pushed the cuffs of his shirt under his black jersey but missed seeing the hole forming at the elbow.

But God-knows, a 17-year-old in standard 9 at Ogwini High School, unbent. Soon he was explaining that he liked working with figures more than reactions ("sometimes I have trouble balancing the equations"). He rattled off something about NH_3 (nitric acid?) and heating copper in a test-tube to make a light brown gas and to turn the copper blue which sounded very impressive to the interviewer (who admittedly never did physics, so if there are any mistakes in that, correct it). In addition, the maths course was good because "We are going to use these methods next year, I have seen the syllabus."

"I show friends at school what we learn here. They find it interesting," he said. His willingness to share also prevents any hard feelings.

Like his friend Sibusiso, God-knows has set himself lofty if diverse career challenges, quite unrealistic based on his grades. For God-knows, being a medical doctor has class. Asked if he would even consider joining Shell, he said yes on condition he could become an engineer.

Shell, he explained, was "the largest company for fuel oil. But I don't know where they come from. Are they South African?" Also like S'bu, God-knows suffers from overcrowding. There are fourteen people in his four-roomed house, where his father, a baker at Hyperama, and his mother, a housewife, encourages his CEP classes.

"I study in the kitchen when they're all asleep, until about 11.30 p.m. If I get hungry, there is always bread and eggs," he says.

Schooling doesn't always feature highly in his life. He is responsible for cleaning the family home, likes movie comedies, plays table tennis and soccer, and, as an avid fan of the National Soccer League's Moroka Swallows Club, also known as the Birds, was disgusted at their latest poor showing. But no girlfriends, he insists. "They are troublesome. They can let me forget my schoolwork."

Again, lack of apparatus was a problem at school, where 64 children have to perch on desks because there are not enough seats. He received a D pass in total last year, in agriculture (68%), English (54%), Afrikaans (72%), Zulu (40%), biology (62%), physics (56%), and maths (48%).

Winnie

Winnie Mtetwa is sweet sixteen and not too sure how she ended up on CEP. It's nice, she agrees, but she struggles to explain what the students have been doing.

The KwaShaka High School standard 9 student doesn't like maths and can hardly converse in English. "This programme help me in physics and English," she says. "We making groups to ask other children: What is your name? What do you like? I like English to read short story, what happened to other country, other people."

Winnie says physical science is a waste of time at her school: "No experiment, no test-tube, no copper. Just do blackboard work."

Home life is also not supportive of academic achievement. Aged 7 she nearly dropped out of school when her mother, a clothing quality control supervisor in a Montclair factory, "may not found more money". A childless uncle adopted her and is paying for her schooling. But her face only lights up to discuss Whitney Houston, local reggae star Lucky Dube, or gospel music. She's more enthusiastic about cooking and her digital watch and confides that she stays away from the boys because "I afraid to be found pregnant."

Mr S. Dlamini

Shell tutors clearly go to no end of trouble to make a good impression. Maths and physical science high school teacher Simon Dlamini walked into the teachers' staff room to be interviewed while asking for plasters and gingerly holding his right hand. His thumb and second finger were bleeding. "I was putting the tube into the stopper to collect ammonia gas and it shattered," he explained cheerfully and joked "I'm the king of beneficial disorder." And true to form, it was another Shell person who had the plasters!

Simon, articulate and thoughtful, has been a student as well as a teacher of Shell programmes. He was one of the first teachers to be upgraded, doing six courses a year in physical science after getting his STD at Madadeni College. Now almost 30, he will be marrying a high school maths teacher "next year, when I can pay the R2 000 lobola".

Good points about the Shell programme were many, in his view. Here is a summary of his comments:

- "It exposes students to the usage of apparatus and the practical application of what they study in the outside world. They know that science is a living subject."
- "Some teacher feel we are becoming 'agents of Shell'. They say that Shell is recruiting future staff, so the students will work for them. At the beginning, I thought it was true. But I happened to have a group of standard 10 students through the Shell programme and they were never recruited. Two went for an ordinary B.Sc., and one did a B.Com., one became a social worker, one is studying Chem.Eng., and another B.Paed."
- "Consider that nobody else was doing it. It was the first of its kind".
- "Teachers of different races come together in courses - constructive ideas have been shared. It gives us some idea of establishing one system of education. It breaks the political tension, the division into thinking of some as inferior and some as superior."
- "If Shell invests more in education, the stability of Shell is not going to be threatened. People may not go about preaching the gospel of disinvestment if Shell does this education programme."

But there were difficulties as well:

- "There are very few students, some from Chesterville, Lamontville, and Umlazi, taking the course. For the black people, it's not contributing that much, just a drop in the ocean. Most of them are left on the outside."
- "Selecting a few kids is dangerous. They're only dealing with the intelligent students, they're doing nothing for the duller ones. A duller child needs to be more exposed to the apparatus than a bright one. Remember it's easier to learn by doing than listening. It would be better if we were mixing IQs. It would make sure of the success of the project. If the duller do well, we will know it's effective. The Shell programme is not going to give us a true reflection of what needs to be done if it's all intelligent students. The brighter are a good investment but we need to take risks."
- "We need apparatus in ordinary classrooms. Shell started these good programmes to upgrade the teachers and improve the quality of in-service courses. But it only benefits the teachers who sit in on the course, the student on the course, not the community. When we go back home we do not have the apparatus to work with. It means you can be a good teacher or a good student here and not be so good at school."
- "What about tests to gauge the effectiveness?"
- "It's rough on the teachers who sit in on the courses to give up their time without being paid for it and watch while more and more full-time organisers are needed, who get a company car and a housing subsidy."
- "Teachers must learn more than just the standard 9 and 10 syllabus, or they get bored and only come out of a sense of duty."
- "Science is especially hard to upgrade. We need longer-term projects to increase the teachers' quality."
- "Subject co-ordinators should work more closely with teachers in various schools."
- "Could the Centre supply teachers with reference books for resources?"
- "I think more feedback from the teachers is useful."

His final words were encouraging. " I appreciate the programme. I like it very much. The type of teacher I am now is better than I was when I came out of college because of Shell. This is my 'advertisement' by way of thanksgiving."

Matriculation Results

A Lewy and P Hobden

Introduction

The curriculum extension programme was initiated with the aim of helping students of physical science and mathematics to pass the matriculation examinations. The programme was based on providing systematic tutoring in physical science, mathematics and English language. Thus the organisers of the course had an interest in establishing whether the matriculation examination results of school pupils improved from their attendance of the programme.

Initial achievement tests

With this in mind, at the institution of the programme achievement tests were administered to all standard 8 pupils studying both physical science and mathematics at higher grade for the matriculation examination in the schools from which participants were recruited for the programme. The tests consisted of a battery of questions in mathematics, physical science, and English language. These three tests served as a proxy for a test of general ability level. Use of an achievement test as a measure of general learning ability proved successful in studies by the International Association for the Evaluation of Educational Achievement (Peaker 1975).

Experimental Design

Defining the CEP pupils as an experimental group and their classmates studying both physical science and mathematics who did not participate in the programme as a control group, one may view the comparison of the two groups' matriculation symbols regressed on the initial ability-level tests as a quasi-experimental design using non-equal pre- and post-test measures.

Such a design allows comparison of two groups (control and experimental) with different levels of ability at the start of tutoring. Although frequently used in educational research, the design has serious shortcomings (Campbell and Stanley 1963). Certain factors may threaten the validity of inferences derived from the data and researchers must find ways of eliminating these, a task which is not easy in an experiment of 3 years' duration. Dropping out of the course ("experimental mortality") is one of these factors; another is the Hawthorne effect. To the traditional list of confounding factors, we may add local ones like unrest conditions and irregular attendance of the course. These factors raise the question of the validity of generalisations derived from the findings. Nevertheless, it was felt that use should be made of the data for at least four reasons.

The first was adherence to common-sense management requirements. With the course at its end and the matriculation results available, it would be wrong simply to disregard those. Secondly, the descriptive data are of importance to Centre staff and others interested in promoting the achievement in mathematics and physical science of the group of the target population. Thirdly, granted that the design used in this study, for the reasons given, is weaker than what is acceptable to social sciences researchers, techniques of meta-analysis available together with other generalisations from similar or sounder designs may be used to compensate for this and increase the validity of inferences. Fourthly, the scarcity of longitudinal data on pupils taking part in fostering programmes justifies the analysis of even incomplete data. Interpretation of the results of this study should be tempered with these considerations.

Results of data analysis

The purpose of the study was to find out whether the programme had contributed to raising the matriculation achievement level of pupils who participated in the programme. As already noted in the introduction, in a quasi-experimental study of events lasting 3 years it is difficult to obtain data yielding a conclusive answer. Nevertheless we present summary data on the initial entry tests; the matriculation results of all the CEP pupils and of the control group, who did not attend the programme; and then compare the two groups in a way which takes into account differences in their entry levels of achievement.

Initial differences

The number of pupils from the four schools of the target population participating in the CEP programme from 1987-9 was 79. [1] Some of these pupils were in the programme for only one or two years, and joined it after the 1987 control or entry tests were administered. Only 49 CEP students took the 1987 entry tests, and this report will focus on their senior certificate results as compared with those of their non-CEP classmates. The results of the entry test in English are presented in table 1.

Table 1. English 1987 entry test results

	Control			Project		
School	Mean	SD	N	M	SD	N
I	44,7	14,4	38	58,2	10,5	16
K	34,8	10,8	40	48,5	13,5	8
O	64,8	10,7	49	73,9	11,7	15
Z	44,4	10,8	30	62,8	17,6	10
All	48,4	16,5	157	62,3	15,4	49

Note: Of the 210 pupils tested in 1987, four pupils from the control group missed the English test.

From table 1 it is evident that approximately a quarter of the standard 8 pupils taking both higher grade science and mathematics for the matriculation examination registered for the programme, although there are small differences in the proportion from school to school.

As expected, those who registered for CEP already had a higher level of achievement at the time of entering the programme than their classmates, although there is a partial overlap in the achievement range of the two groups. The results of the mathematics and science entry tests, which are not presented here, reflected a similar pattern of attainment.

Matriculation examination pass rate

Coding of the matriculation results:

The matriculation symbols of the pupils were coded numerically. [2] The subject scores were aggregated in a routine way. Since some pupils' symbols in Afrikaans and biology had not been released at the time the data analysis of this study was carried out, it was decided to estimate the missing scores on the basis of the weighted average of the available scores. The scores of 50 pupils were estimated in this way.

Examination pass rates

Table 2 provides information on the number of students in the two groups who sat for and who passed the matriculation examinations. It is remarked in passing that merely sitting for the examinations is praiseworthy as showing staying power in school to the end of standard 10 and a willingness to undergo examination. (Staying in the course at school but failing the examinations may be a harmful or a useful experience depending on circumstances such as availability of alternative educational facilities, the labour market, and on one's attitude to failing.) If we assume that the difference between the number of persons who took the 1987 entry test and those

Table 2. Number of pupils writing and passing senior certificate examination

Control (n=161)				CEP group tested in 1987 (n=49)			Total CEP group (n=79)		
ENGLISH									
Total		Sat	Passed	Total	Sat	Passed	Total	Sat	Passed
38	I	12	9	16	13	12	17	14	13
42	K	14	11	8	5	4	22	15	14
49	O	27	27	15	15	15	15	15	15
32	Z	6	6	10	3	3	25	14	14
161		59	49	49	36	34	79	58	56
PHYSICAL SCIENCE									
Total		Sat	Passed	Total	Sat	Passed	Total	Sat	Passed
38	I	11	0	16	13	3	17	14	4
42	K	4	0	8	5	1	22	15	4
41	O	27	6	15	15	12	15	15	12
32	Z	3	2	10	3	3	25	14	14
161		45	8	49	36	19	79	58	34
MATHEMATICS									
Total		Sat	Passed	Total	Sat	Passed	Total	Sat	Passed
38	I	11	0	16	13	3	17	14	4
42	K	13	0	8	6	1	22	16	5
41	O	27	3	15	15	10	15	15	10
32	Z	3	2	10	3	3	25	14	14
161		54	5	49	37	17	79	59	33
AGGREGATE									
Total		Sat	Passed	Total	Sat	Passed	Total	Sat	Passed
38	I	12	0	16	13	4	17	14	4
42	K	14	5	8	6	4	22	16	12
49	O	27	19	15	15	15	15	15	10
32	Z	6	5	10	3	3	25	14	14
161		59	29	49	37	26	79	59	45

***Note:** One student from the CEP group sat for mathematics test only, missing both the English and physical science.*

who sat for the examination is caused by dropping out of school, and that one may disregard the small number of students who transferred to another school, then the proportion of persons who sat for examination to those who took the entry test is an index of the retentivity of the school.

Table 2 also gives data for those CEP students who did not take the entry test in 1987. This was done because in 1988, and to a lesser extent in 1989, a large group of students joined the programme. The documentation of the impact of CEP would be incomplete without data on total passes of programme participants. Of course due to the lack of entry test results, this group of students is not included in the analysis reported in the next section.

Patterns emerging

Looking at the last line of the aggregate section in table 2, one may say that the control and programme groups differed greatly in the proportion of persons sitting for the examinations and also in the proportion passing. In the control group 37% of pupils sat for the examination (59 out of 161) and 49% of these passed the examination. In the total programme group 75% of students sat for the examination and 76% of these passed. A similar pattern is found in the CEP group tested in 1987, with 76% of the group taking the examination and 70% of these passing. This is shown graphically in figure 1.

It is of interest that the pattern of results in English is different from that in the other two subjects. A salient feature of the subject-related data in table 2 is that no substantial differences between groups were observed in the English results while the differences in science and mathematics passes were quite substantial. In the control group 8 of 45 (18%) passed science, in the total CEP group 59% and in the entry-tested group 53%. A similar pattern was observed in mathematics. This is because the aim was to improve achievement in physical science and mathematics, with the English intervention also serving this aim. The fact that the superiority of the CEP group was evident in science subjects may be considered a sign of the programme's success.

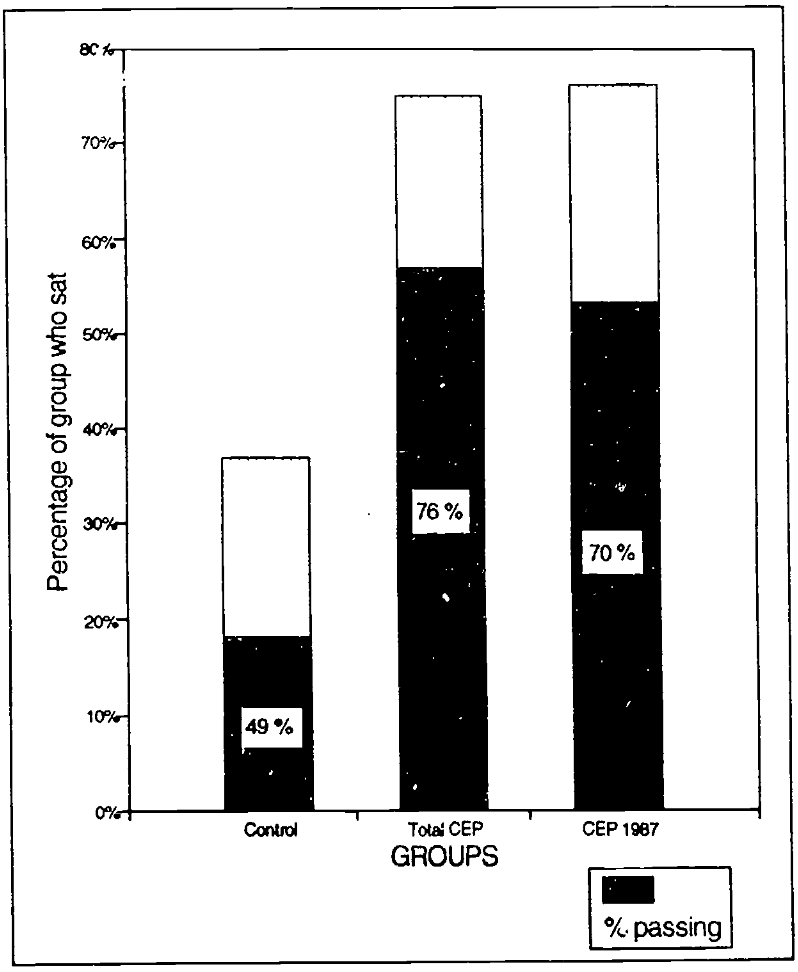

Figure 1. Differences in percentage of pupils from each group sitting for the examinations and passing.

The differences between the CEP group and the control are more salient if one looks at results in individual schools. In schools I and K none of the control group passed the examination in physical science. Although the proportion of passes in the CEP group is low, the number passing may serve to demonstrate to teachers and pupils in these schools that it is possible to achieve a pass in physical science.

It is also encouraging that in school Z all students participating in the programme passed physical science. Considering the aggregate scores in one school all CEP students sitting for the examination passed.

Control of entry-stage differences

As, at entry, the CEP group had higher attainments than their classmates, the differences in matriculation examination performance may be attributable to differences in the entry-stage attainment or potential and not necessarily to the programme.

To control for the initial differences between the two groups, two data summary techniques were used, in which matriculation passes of equal entry-level pupils from the two groups were compared, and analysis of covariance was used.

Comparison of equal entry level pupils.

The whole group of pupils, that is both the entry-tested CEP group and the control group from all four schools, was put into rank order of their composite scores on the three entry tests. This list of pupils was divided into four quartiles, labelled upper, second, third and lowest. Within a single quartile one would then find pupils with reasonably similar entry attainments.

Table 3 analyses matriculation examination passes (an aggregate score of all examination results) according to quartiles.

Table 3. Number of passes in various quartile groups

		Control		Programme	
School	Qu	Sat	Pass	Sat	Pass
	U	0	0	7	3
I	2	2	0	4	1
	3	6	0	1	0
	L	4	0	1	0
	U	0	0	1	1
K	2	1	1	2	2
	3	10	4	1	1
	L	3	0	1	0
	U	10	9	14	14
O	2	14	9	0	0
	3	3	1	1	1
	L	0	0	0	0
	U	2	2	3	3
Z	2	2	2	0	0
	3	1	1	0	0
	L	1	0	0	0
	U	12	11	25	21
All	2	19	12	6	3
	3	20	6	4	2
	L	8	0	2	0
Totals		59	29	37	26

Qu=quartile; U=Upper, L=Lower, 2=Second, 3=Third

The table is based on information for students who had received their matriculation results in most subjects. Where some students lacked symbols for one or two subjects at the time of analysis of the results, the missing scores were estimated on the basis of the available ones.

The table allows comparison of the proportion of passes in the CEP group and control group among pupils having quite similar entry attainments. Looking at the last lines of table 3, one finds the relative advantage of the CEP group, as presented in table 2, almost disappearing. Thus in the control group 11 out of 12 upper quartile students passed the matriculation examination, and in the CEP group 21 out of 25.

Analysis of covariance.

A more sophisticated technique for examining the difference between the two groups is the analysis of covariance test (ANCOVA). It is to be expected that those pupils who were high achievers in Std 8 will have high achievement in the matriculation examination, and those who had weak results in Std 8 will have weak results in the matriculation examination; therefore there will be a positive correlation between initial test results and matriculation results. This was seen in Table 2. The ANOVA technique removes the portion of each pupil's matriculation score that is in common with his or her initial test. With part of the variance in the matriculation examination scores that is not due to the CEP programme "treatment" removed, the precision of the analysis is improved (Ary A.R., 1972)

Analysis of covariance also takes into consideration the coded aggregate matriculation score of each pupil and uses these scores, and not merely the designation of the quartile, to indicate final level of achievement (i.e. the dependent variable). Moreover, analysis of covariance enables us to use the three 1987 test results, namely the scores in English, science and mathematics, individually as an index of the initial level of achievement (i.e. the covariates).

Analysis of covariance was carried out on two sets of data separately: firstly on the 96 persons who sat for the matriculation examination (59 from control group and 37 from CEP group) and secondly on the whole group of 210 persons who took at least one of the three entry tests in 1987. In this way the effect of participation in CEP was considered respectively upon examination performance and upon perseverance in school through to sitting for examinations.

The covariates correlated with the examination results in both cases. As expected, the correlations were higher for the whole set of data (where it must be remembered that many of the control group dropped out and their matriculation score was set to 0) than for the restricted set of cases (only those who sat for the senior certificate examination). The multiple correlation of the three covariates for the restricted set of data was

,635 and for whole set was ,729 . The highest correlation coefficient value of a covariate with the dependent variable was ,562 (the science test).

The analysis of covariance result did not support the hypothesis in the case of the differences between the CEP group and the control group in the restricted set of data, but it did support the hypothesis in the whole set of the 210 persons. However the results do suggest that the impact of the CEP programme contributed to the retentivity of the schools. Those who participated in the CEP, also after eliminating the effect of the entry achievement level using ANOVA, had a stronger tendency to stay in the school than their classmates who did not participate in the programme.

Another hypothesis which could not be tested with the available data is that the pupils and teachers participating in the programme influenced the achievement of the control group. This was quite likely to occur as pupils were requested to share their knowledge via peer tutoring. Teachers by participating were receiving a form of INSET and resources which they could utilize when teaching back at school. This was bound to improve the performance of their whole class which included pupils from the CEP group and control group.

Summary

In 1987 several secondary schools for the black population of the Durban area were invited to send high-achieving pupils in science and mathematics from standard 8 to participate in an afternoon tutoring programme. The achievement level of pupils studying higher grade physical science and mathematics for the matriculation examination was tested in the participating schools in 1987. The test measured attainment in English, physical science, and mathematics with the aim of establishing the entry level achievement of the CEP group as compared with those who did not take part in the programme. During the course more students joined the programme, and no documentation was available for their entry level attainment. Nevertheless, due to the scarcity of longitudinal data on participants in fostering programmes, we decided to study the examination results of the whole CEP group as well as of those tested in 1987. The results revealed that the proportion of students both sitting for the examination and passing was higher in the CEP group.

Substantial differences were found between the two groups in mathematics and science. Moreover in some schools none of the control group passed while several of the CEP group passed in physical science. The importance of these results to the schools lies in the demonstration that bringing the programme to the schools can lead to success in one of the more difficult subjects.

Forty nine pupils from the four schools participated in the CEP programme for three years, of whom 36 wrote the senior certificate examination in 1989 while of the 161 pupils who were in the same schools in 1987 but did not take part in the CEP programme (the control group), only 59 sat for the examination. As students in the four schools had been tested in physical science, mathematics, and English through a uniform set of achievement tests, it was possible to carry out an analysis of covariance of the matriculation examination results to examine the effect of the CEP programme on the scores obtained by these students. The analysis of covariance results showed that the CEP programme reduced the drop-out rate from the schools. Although the pass rate and the average coded matriculation scores of the CEP group were higher than those of the control group, the difference was not statistically significant at the p=,05 level.

Thus significant differences between the two groups attributable to participation in the programme were found mainly in the ratio of students staying in school through to the examinations. If it had been possible to carry out the investigation described in this study on all those who sat for the matriculation examination, and for pupils from non-participating schools, the impact of the CEP programme on the matriculation results might well have been demonstrated with a higher level of validity.

Notes

Note. 1 In another article contained in this volume the attendance data refer to pupils from the four schools of this study plus those from another two schools who joined the project in 1988.

Note. 2 The symbols of the matriculation examination aggregates were coded as shown.

			HG					
Did not sit	Fail	Converted to SG "F"	F	E	D	C	B	A
0	1	2	3	4	5	6	7	8

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The Curriculum Extension Programme: Retrospect and a Look Ahead

P M C Botha

In 1990, when the summary report of the curriculum extension programme (CEP) was completed, the Centre focused on providing in-service training to teachers and suspended tutoring activities dealing directly with secondary school pupils. During the first five years of its operation the Centre's efforts were spread over the two areas of direct work with students and work with teachers. The CEP constituted a meeting point for activities from these two areas. A unique feature of the programme was its provision of direct tutoring for a group of pupils and at the same time educational services for their teachers.

During 1985-9 two cycles of the curriculum extension programme of the Centre were completed. The first cycle, for standard 9 and 10 pupils, was run in 1985-6 and the second cycle, an extended one for standard 8 - 10 pupils, in 1987-9. For three years the Centre was pleased to provide services to a group of more than a hundred high school girls and boys studying towards advanced level matriculation examinations in science and mathematics, who belonged to the top achieving group of students in their schools.

There is no doubt that some of these students will continue their studies beyond the secondary school and will enter science and technology oriented careers in industry, research, and education.

It is gratifying for the staff of the Centre to find out that the students enjoyed participating in the CEP studies, worked hard, and viewed their experiences in the programme as useful for their future. The programme allowed pupils who in many cases shared classrooms in their schools with 86 of their fellows to receive individual attention in a class of 12-14 pupils.

One of the participants indicated in the interview article included in this publication wished to become a teacher of science in a high school or a lecturer at university. It is difficult to predict whether she will realise her ambitions, but one may say with some certainty that her CEP experience has motiv[illegible] her, increased her self confidence, and given her the feeling that perseverance in studies might ensure her career success.

Looking back over five years one may note the following features of the programme:

- It provided direct services to the Centre's actual target population, the secondary school. The ultimate goal of any in-service programme is to help teachers to improve the attainments of their students. Indeed, in many evaluation studies on the effectiveness of in-service programmes the criterion of success is growth in the achievement of those who are taught. In-service activities assist teachers, who are supposed to use the knowledge they acquired in teaching others; the tutoring of high school pupils in the framework of the Shell programme offers direct support to those whose success is the ultimate goal of all in-service programmes.
- Dealing directly with high school pupils, examining their level of knowledge and identifying the problems they encounter in their studies can be viewed as a needs assessment study for determining what should be taught in in-service courses. In-service courses are planned on the basis of the school syllabus and teachers' expressed requirements. The Shell Science Centre has established action committees for guiding the programme coordinator in selecting topics to be taught in in-service courses. At the same time, in-service course planning may benefit greatly by first-hand knowledge of deficiencies in the knowledge of pupils and by actual observation of what teachers have failed to explain well.
- The CEP provided an opportunity to Centre staff to establish contact with the community members of catchment areas of the course participants.
- The programme provided an opportunity for personal contact with a group of high-achieving pupils who in the future might fulfill leadership roles in their community or even outside it. This enables the Centre to provide guidance beyond the needs of science education. Issues of personal behaviour, perseverance, and self-confidence were frequently dealt with in the course of classwork and discussion and during breaks

between lessons. Such personal interaction with students, serving as a model for them, is a by-product of intervention programmes.

- The programme introduced a form of in-service training in which highly experienced teachers worked in a team teaching setting together with teachers from the participating schools. This cooperation between the Centre's tutors and the school teachers served to upgrade the professional standards of the latter and was established to facilitate the integration of the programme with what was taught in school and to counteract what might otherwise have come to be felt as a threatening learning environment. The presence of their own teachers during the course was meant to ease pupils' stress and enhance the standing of their own teachers and schools. This in-service training arrangement, an innovation of the CEP experiment deserving of a wider application in this country and elsewhere, was welcomed by tutors, participants, and their regular classroom teachers.

Thus the discontinuance of the curriculum extension programme from financial constraints and the introduction instead of in-service education programmes throughout the network of the Shell Science Centre is not to be taken as suggesting the programme was unsuccessful. On the contrary this overview intends to draw attention to the success of the project and recommend this pattern of education to organisations and institutions the thrust of whose activity is to deal directly with school children.

The Shell Science Centre may itself in the future consider the possibility of continuing to run programmes of this type, depending on budgetary and organisational considerations. The experience gained from the 1987-9 programme suggests that the following requirements must be met if this possibility is to be realised.

- Commitment of participants to attend the programme regularly and participate in all its prescribed activities.
- Reduction of the cost of the project without also reducing the quality of tutoring.
- Involvement of the communities in the programme and recruitment of their support for the programme.
- Rigorous testing of materials used in the programme.
- Greater autonomy for the Centre in working out the programme of the tutoring: while in the 1987-9 experiment the Centre formally enjoyed autonomy in determining the parameters of the programme, it nevertheless had to operate under the non-formal constraints of the existing matriculation examination system. The Centre was not free to teach matter not directly related to the examinations.

These circumstances restricted the Centre's freedom in teaching innovative topics within the framework of the tutoring, and a consideration for the future is for the Centre to negotiate with the examination bodies on the accommodation of this in the examination. The examination system in England and Wales enables schools to ask permission to teach a subject according to a locally developed curriculum. If permission is granted, the examination authorities take care to adapt examinations (called mode 2 and mode 3 examinations) for the users of local curricula.

While the South African examination boards have not yet acceded to the production of such examinations (referred to in England and Wales as mode two and mode three examinations), it may be useful to start negotiating about obtaining such concessions.

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