COMPUTER-BASED REMEDIATION IN CAPE SENIOR CERTIFICATE STANDARD GRADE MATHEMATICS

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GLOSSARY

1. List Of Abbreviations:

CED	-	Cape Education Department.
CAI	-	Computer-Aided Instruction.
H.G.	-	Higher grade is the highest level at which academic pupils can study a subject in CED schools.
his	-	His or her
IQ	-	Intelligence Quotient.
IBM	-	International Business Machines Company.
matric	-	The final examination written at the end of the last year at CED schools. This external examination, the Cape Senior Certificate, is often referred to as matric since under certain circumstances, matriculation exemption can be awarded.
PC	-	Personal Computer.
SERGO	-	An acronym for the Afrikaans translation of Centre for Computer-Aided Instruction.
S.G.	-	Standard grade is the middle level at which academic pupils can study a subject in CED schools.
std. dev.	-	standard deviation.

2. Senior Secondary Phase — This comprises Standards 8, 9 and 10. These are the final 3 years of schooling in the 12 year CED school system.

ABSTRACT

This dissertation begins by reviewing the difficulties experienced in teaching mathematics to pupils, weak in mathematics, in the Senior Secondary phase of Cape Education Department schools.

The possible use of computer-aided instruction (CAI) in improving the examination performance of such pupils is considered. A suitable CAI software program, viz. the SERGO system, is identified and its operation is described in detail.

The researcher investigates, both from a quantitative and a qualitative aspect, the change in mathematics examination performance of a number of weak in mathematics pupils, as a result of receiving an extended period of extra tuition on the SERGO system. It needs to be noted that these pupils are passing candidates in other sujects, and have above average intelligence. They are not slow learners.

The researcher identifies three categories of pupils who are weak in mathematics. Different programmes of remediation are recommended for each category.

The possible use of the SERGO system as a stand-alone instrument of remediation, for pupils working in pairs, and the possible use by H.G. pupils in combined H.G./S.G. classes are also investigated.

CHAPTER 1: DIFFICULTIES EXPERIENCED IN TEACHING MATHEMATICS IN THE SENIOR SECONDARY PHASE TO PUPILS WEAK IN MATHEMATICS

1.1: Reasons For Pupils Offering Mathematics In Matric

A pass in mathematics in matric is regarded as essential for entrance to many courses offered at tertiary educational institutions. Such a pass is also used as an instrument of selection for employment in the work place. To meet the manpower needs of South Africa as a developing country, the H.S.R.C. Report (1981), also known as the de Lange report, stated that "mathematics and science should be part of the equipment of every person in the modern world". A pass in mathematics in matric is clearly desirable.

For these reasons, as well as the increasing number of pupils remaining at school to complete matric, there has been an increasing number of pupils, weak in mathematics, offering mathematics in the senior secondary phase of education in the CED. Although this research is restricted to the CED, many of the issues raised and the recommendations made are likely to be applicable to the mathematics education at the same level throughout South Africa.

1.2: Selection Of Pupils To Offer Mathematics In The Senior Secondary Phase

Std.7 is the final year of compulsory mathematics in CED schools. "He can't do maths" is not only an oft-heard assessment of pupils weak in mathematics who continue to offer mathematics as a subject after std.7, but also the despairing cry of their parents who are obsessed by the need for their children to pass mathematics in matric.

Viljoen (1983) in his investigation of the reliability of the std.7 year-end mathematics mark as a predictor of the final matric mark included the following in his findings:

For doing Standard grade, a std.7 year-end mark of:

* 60% + : Yes, but should consider Higher grade.
* 50% - 60% : Yes
* 40% - 50% : Yes, but only after very careful screening
* 34% - 40% : Only in exceptional circumstances
* Below 34% : No.

Notwithstanding these findings, many pupils scoring below 40% continue to offer mathematics in the senior secondary phase for the reasons given in Section 1.1.

1.3: The Researcher's Attempts To Improve The Examination Performance Of Weak Secondary Mathematics Pupils

Papert (1980) said that "It is important to remember the distinction between mathematics - a vast domain of enquiry whose beauty is rarely suspected by most non-mathematicians - and something else which I shall call school maths or maths." To the researcher, as teacher, this differentiates the teaching of a good H.G. class from a weak S.G. class.

In 1982 the researcher as teacher was faced with his first experience of a very weak matric S.G. mathematics class. On average these pupils had failed mathematics at the end of std.9 (it must be remembered that this research is about pupils who are weak in mathematics but passing in other subjects). In order to improve their examination results, the syllabus taught was reduced to a

minimum, and the accent was on drill work. Finally the third term was devoted to an intensive cycle of revision, test, remedial lesson after school (for those who failed the test), and re-test (after school). Unfortunately the results achieved by these pupils were most disappointing.

After promotion, at a different school, the researcher found that this problem was aggravated by having a mixed ability S.G. class which included many pupils who were failing mathematics. As a result of the findings of Wegerhoff (1982) regarding the readability of textbooks, the researcher, as teacher, had begun using " Classroom Mathematics" (Laridon et al.: 1986) as a textbook. This recently published textbook, besides being suitable for all levels of pupils because of its readability, contained a wealth of suitable examples for drilling pupils. However the researcher as teacher´s matric pass rate in 1987, though considerably improved, was still only 28 out of 32 candidates.

In 1988 the researcher, as teacher, moved to his present school as headmaster. At this school where many pupils came from a deprived background, the matric pass rate had been above the CED provincial mean for many years. It was evident that the teaching emphasis, in all subjects, was on drill and practice as a means to ensure that all pupils would pass matric. The researcher found that this emphasis extended throughout the high school and had its roots in the primary section of the school. Due to the poor socio-economic background of many of these pupils, they only remained at school in order to pass their examinations. The researcher, as teacher, was able to teach mathematics with a strong emphasis on drill-and-practice because the pupils expected this mode of teaching. As a result, weak pupils who would have failed at the the researcher´s previous school, passed matric

1.4: First Impressions Of The SERGO System

In January of 1989 the researcher was invited to assist in the investigation of the SERGO CAI mathematics system for primary schools as well as the SERGO CAI high school system for std.6-7 as part of an evaluation undertaken by the Education Department of Rhodes University. After carrying out a preliminary investigation, the researcher did not contribute to the report tabled by Marsh and Marsh (1989) as he felt insufficiently qualified and insufficiently experienced in the teaching of mathematics in these standards to do so. However, from his preliminary investigation, the researcher concluded that the most salient of the conclusions of the Marsh and Marsh report were also true for std.1-7 pupils weak in mathematics. One of these conclusions was that "it is a good drill-and-practice medium for remedial purposes".

The researcher's preliminary investigation included making field notes on a small sample of pupils, who were weak in mathematics, whilst they used the SERGO system. This served as a pilot study for his investigation into "computer-based remediation in the Cape Senior Certificate S.G. mathematics."

CHAPTER 2: COMPUTERS AND THE TEACHING OF SENIOR SECONDARY PUPILS WEAK IN MATHEMATICS

2.1: Computers In Education

Taylor (1980) considers that all applications of the computer in education can be classified into one of 3 modes, viz. the computer as tutor, tool or tutee. In the tutor model according to Adams (1988); "the computer, programmed by experts, presents subject material to the student who responds. The computer evaluates the response and makes a decision about what action to take next."

Kansky (1982) divides the applications of computers in education into 12 divisions of which 4 can be classified as "computer as teacher" (which correspond to the tutor mode of Taylor). These 4 divisions, which help to clarify the tutor mode, are:

* Computer as Teacher - where the computer assumes total or partial responsibility for instructing the pupil who is learning facts, skills or information for the first time. These computer programs are characterised by a dialogue between the pupil and the computer in which the directional level and tempo of the lesson are shaped by the pupil input (Blignaut: 1985);
* Reinforcement (or Drill and Practice) - these programs assume previous instruction in the skill, concept or fact being addressed. They present a controlled sequence of exercises designed to drill the recall of certain pairings. Once the pupil has shown that he has mastered the learning content, the program should proceed to more difficult questions or the pupil should be able to select the degree of difficulty himself. A good program will diagnose and provide

remediation in areas of weakness, and extension and enrichment where the pupil shows ability. Immediate feedback is provided (Blignaut);

* Testing Operational Mode - these are evaluative programs which monitor the effectiveness of the computer lesson. Immediate feedback is available to both pupil and teacher (Kansky);
* Instructional Management Mode - continuous assessment reports and prescription recommendations can be made by the computer based on the pupil's performance in the first three divisions (Kansky).

Advantages listed by Doerr (1980) which relate to CAI (as the tutor model is generally referred to) include:

* relevant education - using computers in the computer age;
* an opportunity for great teaching - teachers freed from negative role of judges, and free to expand their role as mentors. Also frees the teacher from tedium of drill and practice work;
* increased student motivation - the non-threatening and non-competitive nature of the learning environment is a positive stimulation to the under-achieving and average and above-average pupils;
* feedback - errors pointed out and another chance presented immediately;
* individual instruction - increases the rate of learning by allowing pupils to proceed at their own pace, and by allowing teachers to make better use of their time.

There are strong critics of computers in education. Patterson (1973) includes in his list of five flaws of the technology that "the training to minimal competence in well-defined skills is not what the education process

should be." Appel and Appel's (1987) criticisms of CAI are many and include that "dialogue is the human practice of conversation which has no set number of appropriate responses". This is supported by Patterson's "instruction can only be personalised by a person".

Papert (1980) attacks modern approaches to learning, what happens in schools, and the difference between what is mathematics and something else, which he calls school mathematics. Papert, who fears that the most common use of computers will become that of rote learning of the same old indigestible material as in the past (using CAI learning presumably), is perhaps the most scathing of the tutor model. Papert's involvement in LOGO is well known. LOGO is an example of those programs which are aimed at teaching pupils to learn by enquiry rather than by the memorising of techniques. These programs have exciting possibilities for the teaching of mathematics, but they are representative of another aspect of the use of computers in education. Thus Bork (1984) sees the use of CAI programs as ever-increasing in the U.S.A. as good teachers leave teaching for financial reasons. According to him, only CAI will enable rural schools to offer scarce subjects such as high school mathematics and science.

2.2: Learning Theories And The Teaching Of Mathematics

An elementary school definition of mathematics could be "a body of computational rules and procedures" according to Resnick and Ford (1981). This definition is later extended to include "the need to recall number facts to do more complicated computations called algorithms". These algorithms contain steps and pupils need to know the steps and to perform them in the proper order so that these algorithms can be applied to solve word problems.

In order to learn these computational rules, Thorndike (1922), the founding father of the psychology of mathematical instruction, proposed the Law of Effect:

> "When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection is increased, when followed by an annoying state of affairs it is decreased."

This was the birth of the stimulus-response theory of learning, which was later generalised by Skinner (1958), for all learning, in the Law of Reinforcement. This law, which defines the shaping of behaviour through reinforcers, is the cornerstone of the Behaviourist theory of learning.

Thorndike saw computational rules as a series of bonds, and that each new individual bond learnt, when fitted together with other bonds already learnt, would act together as a total organised unified force. The idea of small pieces of new information being learnt as the correct response to the given stimulus with immediate feedback (reinforcement) was one of the applications of behaviourism which resulted in programmed learning. With the development of the computer, this in turn led to computer-aided instruction (CAI).

Other theories of learning include that of cognitive psychology and that of humanism. Bruner (1966) saw conceptual development as implying a certain sequence of instruction. He asserted that mathematical structures can be built up in the minds of learners by providing experiences that allow them to develop enactive, iconic and symbolic representations of concepts, in that order.

This information processing theory is not concerned with changes in behaviour, but with the internal processing of information. Cognitive psychology frequently utilises the computer, but for Simulation programs which are used to develop information processing in the minds of the pupils and not CAI drill-and-practice programs.

According to Rogers (1969), humanistic psychology defines significant learning as involving direct experience, thoughts and feelings. It is self-initiated and involves the whole person. This learning is faster when the subject is relevant to the learner, and is enhanced by the reduction of external threats.

Today, teaching is often based on a combination of these three learning theories:

* Acknowledgement of success and positive reinforcement where new work is presented as a series of small understandable steps (behaviourism);
* Structuring the content to enable the internal processing of information to best occur (cognitive psychology);
* Respect for the total pupil in a supportive classroom (humanism).

Good CAI incorporates principles of behaviourism, cognitive psychology and humanism. Provided the teacher uses CAI programs as part of the learning process then:

> "CAI proves itself especially effective when it is used to supplement the traditional teaching and when it is used in the subject matter of mathematics." (Hativa: 1984).

2.3: Learning Disorders

Since the researcher was primarily concerned with pupils weak in mathematics and who were not necessarily weak in other subjects, he looked to what sort of learning disabilities such pupils could have. According to Myers and Hammill (1969) the key word in the various definitions of learning disability is "disparity". The principle of disparity implies that the learning disabled child can be recognised by the presence of a meaningful difference between what he is capable of doing and what he is accomplishing, that is, a marked under-achievement in school related activities. To the researcher, who was investigating pupils who achieve satisfactorily in their other subjects but not in mathematics, this seemed an important avenue to consider.

Attention is drawn by Myers and Hammill to 22 terms being used as synonyms for "learning disabled", and that one of these is "remedial education". This leads to a need to understand what is meant by remedial education, also called remedial instruction. According to Otto, McMenemy & Smith (1973):

> "Remedial instruction is appropriately reserved for the relatively few pupils who have extreme achievement deficits in basic school subjects and whose deficits appear to stem from delimiting factors that demand highly individualised attention. Remedial instruction is therefore offered to small groups or individuals outside the regular classroom."

Otto, McMenemy & Smith (p.35) go on to describe the optimum conditions for such instruction. Remedial instruction requires intensive diagnosis and tutoring. It needs to occur outside the regular classroom. Disabled

learners are pupils who are capable, in terms of general intelligence, of responding positively to remedial instruction when it is adequately focussed.

Remedial instruction must not be confused with corrective instruction which occurs in the normal classroom situation and is typically offered by the classroom teacher. However such corrective instruction is increasingly given by subject experts who are skilled in diagnostic and remedial techniques (Otto, McMenemy & Smith).

Those pupils requiring corrective or remedial instruction are not to be confused with those requiring adaptive instruction. The latter, whose IQ's tend to fall between 70 and 90, require instruction at the pace and expectations adapted to their slower rate of learning i.e. special education.

2.4: Conclusion

The pupils weak in mathematics in the senior secondary phase then could either require remedial or corrective instruction. Yet corrective instruction is increasingly being given by the expert subject teacher who has diagnostic and remedial teaching skills. The researcher was therefore in need of a CAI mathematics program which was sufficiently sophisticated to store details of the pupil's performance and with a built-in decision making apparatus to allow for remediation when the pupil was not able to understand the mathematics with which he was being presented. The researcher chose the SERGO system which is a South African produced, sophisticated mathematics CAI program, which includes a management program capable of making decisions to allow for remediation.

CHAPTER 3: THE SERGO CAI MATHEMATICS SYSTEM

3.1: Origin Of The SERGO System

The origin of the SERGO system, its authors and their effort to make it a superior CAI drill and practice mathematics program, specifically for South African needs from std.1 to std.10, are outlined by Appel and Appel (1987:279). However, at the date of submission (April 1986) of this article, only the Primary School mathematics system had been completed, as the High School system for std.6-7 was released in 1987 and the Senior Secondary system for std.8-10 was released in 1990.

Since the publication of this article, there have been changes to the teacher's management (or control) program, which have eliminated some of the problems in operating the SERGO programs which were identified by Appel and Appel. These changes, together with the user-friendliness of the program and the level of mathematics presentation, made the SERGO system eminently suitable for the researcher's requirement of a sophisticated CAI drill-and-practice program to give extra lessons to senior secondary pupils weak in mathematics.

3.2: Operation Of The SERGO Senior Secondary System

The SERGO system consists of two linked programs. The first of these is the Control program, also referred to as the management or teacher's program (see Appendix 1). The pupil must first be registered as a student user. Next the teacher must select a suitable path of study (for paths of study, see Appendix 1, and for an example of a typical path, see Appendix 2) and an item (or lesson) for the pupil to begin using the Student program.

The second program which is called the Student program is linked to the Control program, so that the procedure described above is necessary before the pupil can use the Student program. The pupil calls up the Student program by typing STUDENT. The program then asks the pupil for his (registration) number, and when this is given the chosen lesson begins. For an example of a typical lesson see Appendix 3.

When the pupil has completed this lesson, the program puts the pupil onto the next lesson unless one of the following occurs:

* the pupil has been put back to an earlier lesson as a result of getting three problems incorrect. (This lesson being the lesson which had dealt with the theory preceding that which was covered by the lesson that the pupil had just failed, i.e. automatic remediation);
* the teacher decides to change the pupil's path or lesson;
* the teacher ends the lesson for the day by pressing E for end.

The Control program also enables the teacher to:

* call up and read off the screen or print a report of the work completed by each pupil, or by a class of pupils;
* erase a pupil's records;
* change the norms for operating each lesson.

The norms refer to the following:

* the number of problems correct before moving on to the next lesson (normally 5);
* the number of attempts allowed at getting a correct answer before a problem is marked wrong (normally 1);
* the number of attempts allowed at getting a correct

answer before the answer is given (normally 2);

* the number of problems allowed to be incorrectly answered before the SERGO system sends the pupil back to an earlier section of work (normally 3);
* the pass mark for a test in order for the pupil to continue to the next lesson (normally 60%).

The numbers given in brackets are those which are already in the SERGO system. These values can be changed at the teacher's discretion for each of the approximately 300 lessons and tests found in the SERGO Senior Secondary system.

3.3: Syllabus Content Of The SERGO Senior Secondary System

It was not the intention of the researcher to evaluate the extent to which the SERGO system has covered the CED senior secondary phase syllabus. According to the company which markets the SERGO systems, no such evaluation had been done by the end of 1990, nor were they aware of any such an evaluation being done.

Since no such evaluation of the senior secondary phase has been done, the researcher feels that the results of the evaluation of the SERGO Primary system by Drost and van Zyl (1988) for the H.S.R.C. are worth mentioning. This evaluation consists of four parts, of which the first three parts are an evaluation of the std.2, std.4 and the geometry part of the std.5 sections of the SERGO Primary system. One of the five criteria used by Drost in this evaluation is that of mathematical content, which is sub-divided into mathematical and syllabus requirements. The average scores for these two sub-criteria are 87,4% and 88,0% respectively (these figures were calculated by the researcher by averaging the scores

given in the three reports). These figures indicating syllabus coverage, in the researcher's opinion, based on his use of the program, are likely to be similar in the case of the Senior Secondary system.

3.4: Difficulties Experienced In Using The SERGO Senior Secondary System

It was not the intention of the researcher to evaluate the SERGO Senior Secondary system as a CAI program as had been done by Marsh and Marsh (1989) for the Primary and for the High School (std.6-7) systems. However the researcher is in agreement with the general conclusions drawn by Marsh and Marsh (p.3). In addition to the time-consuming and irritating problem of moving a pupil from one lesson to another which is mentioned in this report, the researcher experienced difficulty in the following three areas:

* Incorrect "right" answers in the program which in some cases caused pupils to be put back incorrectly;
* Asking for answers to be given correct to one decimal place (e.g. 1/4 = 0,3) which created problems when this inaccurate answer had to be used to substitute at a later stage in the same problem;
* No difference in paths for S.G. and H.G. pupils, which means that not all the lessons were relevant to S.G.pupils.

3.5: SERGO And COMPUTUTOR

Of interest, is that modules of the SERGO system are marketed under the COMPUTUTOR label. At present, although the lessons are the same, there is no Control program linked to the Student program, thus no records are kept, nor is there an automatic remediation option.

CHAPTER 4: RESEARCH DESIGN

4.1: Introduction

The main aim of this research is to investigate the following 2 hypotheses:

4.1.1. that the SERGO Senior Secondary system can be used to improve the examination performance in mathematics of senior secondary pupils weak in mathematics;

4.1.2. that the SERGO system can be used as a stand-alone instrument of remediation in mathematics for senior secondary pupils weak in mathematics.

As this research is to be presented as a piece of Action Research, it is necessary to pause and relfect as to what Action Research entails. Cohen and Manion (1985) defines Action Research as "a small scale intervention in the functioning of the real world and the close examination of such intervention." As this method's evaluative frame of reference is to add to the practioner's functional knowledge of the phenomenon being dealt with, Action Research lends itself to educational research, according to Corey (1953). For this reason further hypotheses which will also be investigated by this research are mentioned later in this section.

In his research design, the researcher was strongly influenced by Blease (1986). Blease (p.96) points out that in software evaluation it is important for teachers to conduct classroom research:

"even though software may already have been carefully

> selected as being suitable by the teacher or by some other higher authority e.g. subject head, it is important to then evaluate the software to assess its effectiveness as a teaching and learning resource when it is actually in use."

To the researcher, this is why his research, done in the school or under quasi-school conditions, is of particular value to the practising mathematics teacher and those in authority in senior school mathematics.

Although Blease (p.97) does not specifically name the research methods he advocates for classroom research, in this instance for the evaluation of software, as Action Research, he sees evaluation in the classroom as being "a small-scale curriculum research and development, conducted by serving teachers in relation to the curriculum and resources of their own schools."

This approximates closely to the conventional definition of Action Research quoted from Cohen and Manion earlier. Indeed, much of what Blease has to say about evaluation in the classroom is in keeping with the Action Research chapter in Cohen and Manion. However, what was significant to the researcher was that Blease was specifically looking at Action Research in the field of software evaluation. The researcher has therefore used Blease's (pp.98-130) software evaluation guidelines in his research. This was because the researcher felt that evaluating whether a CAI program can improve examination performance or not, was sufficiently overlapping with evaluating how effective a selected piece of software is as a teaching and learning resource.

While actively involved in observing pupils using the SERGO system, the researcher decided that investigating

additional hypotheses, as well as other ideas, was permissible in Action Research. The following hypotheses will therefore also be investigated in this research (as well as certain other ideas which will be mentioned later):

4.1.3. that the SERGO system can be used by better ability pupils to improve their understanding of mathematics, particularly at the Higher Grade level, in the senior secondary phase;

4.1.4. that the SERGO system can be operated successfully by pupils working in pairs to improve their understanding of mathematics;

4.1.5. that the degree to which a pupil will benefit from extra lessons on the SERGO system will depend on certain personality factors.

Blease (p.98) emphasises the value of the triangulation method, a method which is described in greater detail in Cohen and Manion (p.254). For this reason the researcher decided to use both quantitative and qualitative methods of gathering data, especially in the light of his limited resources.

4.2: Available Resources

The researcher had on loan from SERGO the SERGO Senior Secondary Mathematics system. This system, which had been modified so as to be accepted by a hard-drive IBM compatible PC, had been released in May 1990. The length of the program is between 4 and 5 megabytes. As the researcher had only a single hard-drive PC available at his school, as well as one at his home, he was only able

to operate a single computer at a time, i.e. at his school or at home. The researcher was on study-leave during the 3rd term of 1990, and did most of his experimental research during this period of time. The research design necessarily had to fit the available resources.

4.3: Research Design

A total of 18 pupils were selected to receive extra lessons on the SERGO system. Only the first 5 groups of pupils (16 pupils) took part in the quantitative experiment. These 18 pupils, the selection of whom will be discussed later, were made up of the following groups:

4.3.1. 4 pupils from the researcher's own std.10 class;
4.3.2. 4 pupils from the researcher's own std.9 class;
4.3.3. 2 pupils from another teacher's std.8 class at the researcher's own school. (The researcher was not teaching std.8 during 1990);
4.3.4. 4 std.9 pupils from a large co-ed. school near to the researcher's home;
4.3.5. 2 std.8 pupils from a large boys' school near to the researcher's home;
4.3.6. 2 H.G. pupils from the researcher's own std.10 class.

The research was designed to include both a quantitative and a qualitative approach. Blease (p.99) states that

> "There is a very strong case for combining quantitative and qualitative evidence as a means of acquiring a broader picture of how effective a program might be."

The researcher felt that this would enable some degree of

triangulation to take place. The design of each of these approaches follows.

4.4: Quantitative Approach

The quantitative approach used here was based on the quasi-experimental method as outlined in Cohen and Manion (p.184). The reason for this being the case was that these 5 groups of pupils (4.3.1 to 4.3.5) were constituted by means other than random selection, and therefore extraneous variables could not be apportioned out or properly controlled for true experimentation.

In this case, the variable being changed was the use of the SERGO system for extra lessons. The variable being observed was the examination performance of the pupils receiving extra lessons. Every effort was to be made to keep all the other variables constant.

The purpose of using pupils from other schools was to widen the investigation beyond the bounds of the researcher's school, i.e. to test the external validity of the research being conducted.

In order to test the main hypothesis viz. that the SERGO system can be used to improve the examination performance in mathematics of senior secondary pupils weak in mathematics, it was necessary to measure the change in the performance of the pupils receiving extra lessons on the SERGO system.

For each pupil, their improvement was measured by p, where

$$p = \frac{s - r}{r}$$

where r = Pre-test score, and s = Post-test score.

Since the Pre-test and the Post-test were not the same test, but respectively the pupil's June and September examination results, the researcher felt that a more reliable p value would be obtained by standardising the Pre-test and Post-test scores using the remainder of the pupils who wrote the same examinations, as a control group. This was done by multiplying the Post-test score by a factor k, where

$$k = \frac{\text{June examination average of the control group}}{\text{September examination average of the control group}}$$

Thus by multiplying s by k, the product ks is the score that the pupil is expected to have got had the control group's average been the same for both the Pre-test and the Post-test.

The amended formula now reads

$$p = \frac{ks - r}{r}$$

The average % improvement P, is then given by

$$P = \frac{p \times 100\ \%}{n}$$

where n = total number of pupils who received extra lessons. In this experiment, n = 16.

Thus P would be the average percentage by which the group of 16 pupils involved in the quantitative aspect of the research would have improved on their June examination mark. Any negative values for p or P would indicate a negative improvement, i.e. in spite of receiving extra

lessons, that the pupil or group of pupils had not improved, but had in fact declined in performance.

4.5: Qualitative Approach

Data for the qualitative approach was obtained as follows:

4.5.1: Field Notes

While pupils were using the SERGO system for extra lessons, the researcher was to make field notes (Blease, p.113). Some of the major advantages of field notes, according to Hopkins (1985), include the following:

* they are simple to keep and no outside help is needed, which is ideal for the teacher working alone,
* they provide a good on-going record,
* the information so gathered can be easily studied in the teacher's own time,
* they can help to relate incidents and explore emerging trends,
* they provide valuable material for case-studies.

However the disadvantages listed by Hopkins include:

* they need to fall back on aids such as question-analysis sheets, tapes and transcripts for specific information,
* that actual conversations are virtually impossible to record by field notes,
* a notebook works well with a small group but not so well with a full class,
* they are initially rather time-consuming "until you get into the swing of things".

* they are highly subjective.

The researcher's field notes were to include:

* All observed behaviour by pupils which the researcher might feel to be pertinent to his study of the five hypotheses listed in 4.1;
* All comments made by pupils when engaged in conversation with the researcher, which might be pertinent to the research. These conversations, or interviews, could take place at any time, but would be most likely to occur at the end of a lesson.

4.5.2: Structured Interview

Soon after the Post-test had been written, the pupils were to complete a structured interview questionnaire (see Appendix 5) designed by the researcher. The purpose of this method of interview was that the researcher foresaw that this would be, in many instances, the last time that he would be seeing the pupils. It would give the researcher the opportunity to ask, and have on record, certain questions which the pupils would not have been ready to answer until they had experienced the Pre-test, extra lessons and the Post-test. The pupils would also have had the chance to reflect on the total experience which they had undergone. These structured interview questionnaire responses were to be used to add to the field notes in the qualitative investigation of the five hypotheses listed in 4.1.

4.5.3: Attitude Questionnaire

At the same time that the pupils were to complete the structured interview questionnaire, they were to be required to complete an attitude questionnaire (see

Appendix 6). The purpose of this questionnaire was to help in investigating the hypothesis 4.1.5. The attitude questionnaire used was an adaption of that constructed by Rodda (1988) in his investigation of the attitudes of pupils using the SERGO Primary system. The researcher adapted her std.4 attitude questionnaire by altering the questions asked so as to be more suitable for senior secondary pupils.

4.5.4: SERGO System Records

The SERGO management or control system was to keep a record of the lessons completed by the pupil while using the teaching program. The complete record for each pupil can be found in Appendix 4.

4.6: Length Of Extra Lessons

In any curriculum, the time spent on a particular activity is significant. The school period is the normal unit of time or module. This is complicated by different schools having different modules, and these modules often vary during the course of the school day. In his initial contact with SERGO, which was with the std. 6-7 system, in January of 1989, the researcher concluded that there were two important factors in selecting the length of lessons. These were:

* The time necessary for the slower-working pupils to complete a single lesson (as the control system only records completed lessons);
* The time not being too long so as to over-tire pupils which would result in them no longer taking in information and so lead to them making unnecessary mistakes.

The SERGO system is written for individual tuition and, as such, is extremely tiring. The times for each SERGO lesson are necessarily different as they deal with different concepts. Looking at Appendix 4 it can be seen that pupils complete different numbers of lessons in approximately equal intervals of time. Note too, that incomplete lessons are not recorded.

The researcher's experiences with the SERGO std. 6-7 led him to conclude that 45 minutes was the most suitable length of time for SERGO lessons.

4.7: Number Of Extra Lessons

Since the extra lessons that pupils were to receive, were for timetable reasons, to differ in length as explained in 4.6, the researcher aimed at two lessons per week for the groups 4.3.2 to 4.3.5. Thus these 4 groups would receive approximately 10 hours of extra lessons.

The researcher aimed at the std.10 group (i.e. 4.3.1.) receiving 4 or 5 lessons per week, depending on the length of each lesson. Each pupil would therefore receive approximately 20 hours of extra lessons. The researcher reasoned that this group should receive double the total time of extra lessons as they had a 2-year syllabus to revise compared to the other groups who only had a 1-year syllabus to revise. The number of lessons and the number of hours of extra lessons each pupil actually received can be found in table 4 (p.41).

The remaining group of two H.G. std.10 pupils (i.e. 4.3.6.) were to receive extra lessons on the SERGO system during normal class periods. This would be when the

teacher (in this case, the researcher) was of the opinion that the lesson in progress was specifically aimed at the S.G. section of the class. Since this group was being used to test hypotheses 4.1.4 and 4.1.5, the number of extra lessons (or the time spent on the program) did not need to be carefully controlled.

4.8: Pupil Selection And Control Groups

Pupil selection is described in detail as, because these pupils were not randomly selected, this research has not been classified as true experimentation, but as quasi-experimentation (according to Cohen and Manion, as mentioned earlier). Pupil selection and control groups have been dealt with using the group numbers allocated in section 4.3.

Group 4.3.1: The std.10 class consisted of 15 pupils. 2 of these were H.G. pupils and one of these had changed from H.G. to S.G. after a poor June examination mark. These three pupils were not considered. Of the 12 remaining pupils, 4 were to be selected to receive extra lessons and the remainder were to constitute the control group for the group 4.3.1.

In selecting the 4 pupils from this group (and from group 4.3.2), the hypotheses 4.1.1 and 4.1.2 were explained to all the pupils in the class. This was so as to ensure that the pupils, especially those receiving extra lessons would participate fully in the proceedings. It must be added that the researcher's greatest fear, at the outset (and in certain cases, well into the research), was that some of the pupils receiving extra lessons would drop out. This was particularly so because of the small number of pupils taking extra lessons.

5 criteria were used in selecting the 4 pupils who were to receive extra lessons. These were as follows:

1. Weak in mathematics;
2. Dependability to complete course;
3. English-speaking (the researcher's school was dual medium);
4. Ability to attend lessons after school hours;
5. A fair distribution of both boys and girls;

The pupils who had come 7th, 10th, 11th and 12th (i.e. last) were chosen (of interest is that all the pupils in both of the researcher's classes volunteered to receive extra lessons, including a pupil who had got an A symbol in the June Examination). The 7th pupil only scored 1,0% more than the 9th pupil and was a repeat pupil, taking only 3 subjects, who was able to come during school time, which was very convenient.

Group 4.3.2: This class consisted of 11 S.G. pupils. The same 5 criteria were applied, and the pupils who came 7th, 9th, 10th and 11th (i.e. last) were selected. The pupil who had come 8th in the Pre-test did not meet the 2nd and 4th criteria. The remaining 7 pupils then constituted the control group for these 4 pupils in group 4.3.2.

Group 4.3.3: The selection of this group of 2 pupils was left to their teacher with specific instructions to bear the 5 criteria in mind. Unfortunately, one of the two pupils selected was actually a weak H.G. pupil, not particularly weak in mathematics at the S.G. level. He had come 5th out of 6 pupils in the H.G. section of the mathematics class. The other pupil selected by this teacher to receive extra lessons had come 3rd out of the 5 S.G. pupils in the class. In each case the remainder

of the pupils taking the same grade then constituted that pupil's respective control group.

Group 4.3.4: The selection of this group was in itself a learning experience for the researcher. This was because it required negotiations with another school, beginning with the headmaster, then the mathematics subject head, then the mathematics class teacher, and finally the pupils doing std. 9 S.G. mathematics. In addressing this class (in fact one of two classes), the researcher was faced with the problem of "selling extra lessons on a CAI system" to pupils who did not know him nor the program. This was made more difficult by the researcher's insistence that the pupils had to be failing or near-failing candidates. Only later, when the researcher received the Pre-test results, which was after the Post-test had taken place, did he discover that only a few members of this class had failed the Pre-test, and of these, some were eliminated because of criterion 3. Mention must be made of the tremendous co-operation by all the members of staff whom the researcher dealt with, particularly the mathematics class teacher.

The researcher had hoped for 6 pupils from this class. This was to allow for the possible drop-out of some of these unfamiliar pupils. Initially 4 pupils volunteered, but one withdrew just before the preliminary viewing of the SERGO system due to transport difficulties. Mention must be made here that these pupils were to receive their extra lessons from 16:30 onwards during week-days or on Saturday afternoons. As the researcher was extremely concerned that these pupils might drop-out, each pupil was asked to pay a user fee of R60, which would be refunded in full, provided the pupil completed the extra lessons, the Post-test and the two questionnaires.

This group, at this stage then, only consisted of 3 pupils. The 4th pupil (9B05) came to be part of this group as a result of a casual comment to his parents in church the following Sunday, when he saw the researcher. When he mentioned that that was the teacher who came and offered extra lessons in maths, his parents reacted swiftly to get him on the course. This anecdote is recorded to reinforce how difficult it is to involve outsiders (pupils from other schools) in research of this nature.

Only after extra lessons were well under way did the researcher discover that one (9B02) of this group had in fact written H.G. mathematics in June, before changing to S.G. She had come 5th (i.e. last) out of 5 such pupils. The remaining 4 pupils then constituted her control group.

The other 3 pupils in this group had come 36th, 44th and 45th out of 47 pupils. The remaining 44 pupils then constituted their control group.

Group 4.3.5: The selection of this group was automatic. These 2 pupils were already attending extra mathematics classes with the researcher at the time of the Pre-test. They agreed to take part in the research. They were now to receive an extra hour of tuition each week on the understanding that they would receive approximately 10 hours of CAI extra lessons on the SERGO system before the September examination.

These 2 pupils, though doing mathematics on the H.G., were already receiving extra lessons because they were weak in mathematics. Unfortunately one of these pupils changed to S.G. shortly after he began extra lessons on SERGO, and did not inform the researcher until just

before the Post-test. The researcher then treated him (8B03) in the same manner as pupil 9B02 in the previous group.

The control group for pupil 8B03 then consisted of the remaining 16 pupils in his standard's mathematics classes who changed grades at the same time. The control group for the other pupil (8B02) then consisted of the remaining 112 mathematics H.G. pupils in his standard who continued with mathematics on the H.G.

At this school the co-operation that the researcher received from the mathematics subject head was most gratifying.

Group 4.3.6: This group of 2 H.G. std.10 pupils from the researcher's own class selected themselves, as they were the only H.G. pupils in this class. It is to be remembered that these 2 pupils worked together and have been referred to as XA06. These 2 pupils only took part in the research relating to the 4th and 5th hypotheses.

CHAPTER 5: COLLECTION OF DATA AND TABULATION OF RESULTS

5.1: Introduction

The collection of data and the tabulation of results for each of the two components of the research have been described separately under their respective headings below. This data and these results will be analysed in the following chapter.

5.2: Quantitative Component

The Pre-test results and the Post-test results for the 16 pupils who participated in this aspect of the research and for those pupils who made up their respective control groups were obtained from their respective teachers once the Post-test had been completed. Using the method of calculation outlined in section 4.4, the individual improvement "p" of each pupil was calculated. The average improvement "P" of all the pupils who received extra lessons on the SERGO system, was then calculated. These results, as well as the data necessary for these calculations, can be found in Table 1 (p.32).

The problem which resulted from certain pupils changing grade between the Pre-test and the Post-test was overcome as described in section 4.8. Their Post-test scores were standardised by using those pupils who also changed grade as their control group. Since the Pre-test and Post-test scores were out of 400 and 300 respectively, these scores were converted to marks out of 100.

In tabulating these results, calculations are shown accurate to one decimal place. However all calculations have been carried out to 8 figures, i.e. the accuracy of a normal pocket-calculator.

TABLE 1: RESULTS OF QUANTITATIVE EXPERIMENT

Group No.	Pupil No.	Out of	Pre-test score	Post-test score	Stand. Post-t score	Improvement (p) %
4.3.1	XA02	300	96	112	102,9	+ 7,2
	XA03	300	100	123	113,0	+ 13,0
	XA04	300	41	134	123,1	+ 200,2
	XA05	300	112	105	96,5	- 13,9
Control Group		300	145	158	145,0	(3 pupils)
4.3.2	9A02	300	58	32	41,6	- 28,3
	9A03	300	42	32	41,6	- 1,0
	9A04	300	96	78	101,4	+ 5,6
	9A05	300	116	78	101,4	- 12,6
Control Group		300	147	113	147,0	(7 pupils)
4.3.3	8A02	400	174	264	259,9	+ 49,4
Control Group		400	215	218	215,0	(5 pupils)
	8A04	300	132	156	176,3	+ 33,6
Control Group		300	137	121	137,0	(4 pupils)
4.3.4.	9B01	300	59	150	121,0	+ 105,1
	9B04	300	101	126	101,6	+ 0,6
	9B05	300	47	126	101,6	+ 116,2
Control Group		300	146	181	146,0	(44 pupils)
	9B02	100	23,3	76,0	36,4	+ 56,2
Control Group		100	39,6	82,5	39,6	(4 pupils)
4.3.5	8B02	400	124	168	172,2	+ 38,8
Control Group		400	231	225	231,0	(112 pupils)
	8B03	100	24,0	40,0	30,7	+ 28,1
Control Group		100	27,0	35,1	27,0	(16 pupils)

Average Improvement Of All Pupils (P) = + 37,2 %

Additional averages

Real Improvement Of All Pupils (R) = + 7,8 %

Apparent Improvement Of All Pupils (A) = + 11.2%

Added to Table 1 are two averages, not mentioned in section 4.4, which the researcher found interesting when

considering the change in performance of those pupils who received extra lessons on the SERGO CAI system.

The first of these averages, called "R", is the average of the standardised percentage improvement that the pupils obtained, e.g. a pupil who improves from 30% to 45% (standardised September mark) will have undergone a real improvement of 15%, as opposed to a calculated "p" value improvement of 50%.

The second of these averages, called "A", is the average of the actual percentage improvement pupils have obtained, e.g. suppose the pupil mentioned in the above example actually got 40% in September, before standardisation was applied, then he would have undergone an apparent, but considered by the pupil as the actual, improvement of 10%.

The results of this table have been analysed in Chapter 6

Table 2 was then drawn up for the purpose of investigating the possible long term effects of receiving extra lessons on the SERGO CAI system. Some of the details from Table 1 have been omitted for tabulation purposes.

Unfortunately the actual scores of the std.10 group were not available and the average mark for the symbol that they obtained has been used. Had the number of pupils in the group as well as the number in the control group been larger, then the results for this group would be more reliable. For this reason, the average improvement of all the pupils, called P2, has been calculated twice, once for all 10 internal pupils, and then again for just the 6 std.8 and std.9 internal pupils (where internal refers to pupils from the researcher's school). The

average improvement for the internal group for the September Post-test, called P1, has also been calculated for both groups. The average improvement of the external pupils, i.e. pupils not from the researcher's own school, has been added here, as well.

TABLE 2: RESULTS OF QUANTITATIVE EXPERIMENT FOR INTERNAL PUPILS, WHICH INCLUDES DECEMBER RESULTS

Group No.	Pupil No.	JUNE Pre-test score	SEPT. Stand. Post-t score	SEPT. Improve-ment(p1) %	DEC. Stand. Exam. Score	DEC. Improve-ment(p2) %
4.3.1	XA02	96	102,9	+ 7,2	118,4	+ 23,3
	XA03	100	113,0	+ 13,0	118,4	+ 18,4
	XA04	41	123,1	+ 200,2	96,4	+135,2
	XA05	112	96,5	- 13,9	96,4	- 13,9
Control	Group	145	145,0	(8 pupils)	145,0	(8 pupils)
4.3.2	9A02	58	41,6	- 28,3	68,0	+ 17,2
	9A03	42	41,6	- 1,0	44,3	+ 5,5
	9A04	96	101,4	+ 5,6	161,7	+ 68,4
	9A05	116	101,4	- 12,6	136,0	+ 17,2
Control	Group	147	147,0	(7 pupils)	147,0	(7 pupils)
4.3.3	8A02	174	259,9	+ 49,4	220,8	+ 26,9
Control	Group	215	215,0	(5 pupils)	215,0	(5 pupils)
	8A04	132	176,3	+ 33,6	145,1	+ 9,9
Control	Group	137	137,0	(4 pupils)	137,0	(4 pupils)

For all the internal pupils: P1 = +25,3%; P2 = +30,8%.
For the std.8-9 internal pupils: P1 = +7,8%; P2 = +24,6%.
For the 6 external pupils: P1 = +57,9%; P2 not calculated as no data collected.

The results of this table have been analysed in Chapter 6

5.3: Qualitative Data

5.3.1: Researcher's Timetable

Before considering the data collected for the qualitative aspect of the research it is as well to look at the researcher's timetable (see Table 3).

TABLE 3: RESEARCHER'S TIMETABLE

Period	Begins	Length	M'day	T'day	W'day	Th'day	F'day
1	7:30	35 min	–	–	–	––	
2	8:05	35 min	–	9M	9B03	XA05	9M
3	8:40	35 min	9A02	–	XA05	9A02	10M
4	9:15	35 min	10M	XA05	9M	–	–
5	10:20	40 min	–	10M*	10M	9M	9A03
6	10:50	40 min	–	10M	10M	9A04	XA05
7	11:30	40 min	–	9A05	–	10M	XA05
8	12:25	35 min	9M	8A04	–	8A02	9M+
9	13:00	35 min	XA05	XA02	–	XA03	–
10	13:45	45 min	XA03	9A04	XA04	9A05	XA03
11	14:30	45 min	XA04	XA04	XA02	XA04	XA02
12	15:15	45 min	XA02	XA03	XA03	XA02	–
13	16:30	60 min	–	8B02	8B03	–	8B02
14	17:30	60 min	9B01	9B02	–	9B05	8B03
15	18:30	60 min	9B05	9B04	–	9B04	–
16	19:30	60 min	9B05	–	–	–	–

Also Saturday: 14:30 (60 min) 9B02
Note: All pupils are referred to by their SERGO registration numbers.
9M and 10M refer to researcher's teaching lessons.
NB: * = 8A02 and + = 8A04, as these pupils received these extra lessons while the researcher was teaching in the same classroom.

From this table the following points, which receive attention later, are to be noted:

* extra lesson periods varied between 35min. and 120min.
* the time of day pupils received their extra lessons.

5.3.2: Pupil Absenteeism

Pupils missed their extra lessons for a number of reasons. These reasons included illness; doctor's visits; lack of transport; parents away from home; and school business, e.g. unscheduled sports fixtures, school fete, Founder's Day preparations and the school play. There were in fact many periods when pupils were absent and there was a limited period of time between the pre-test and post-test. This gave the researcher two problems:

* how to ensure that each pupil completed the required time on the extra lessons.
* whether absenteeism was unavoidable or a result of the pupil not wishing to attend extra lessons.

In the case of the first problem, for internal pupils, absentees were replaced by pupils present, which meant that some pupils had both sessions for the week on the same day. This explains why Appendix 4 shows irregular attendance, not only due to absenteeism, but also due to having a second lesson on the same day because of replacing an absent pupil. Hence the researcher's decision to record time on SERGO as well as the number of periods each pupil received. In the case of external pupils, they were given the opportunity to make up time on Saturday afternoons.

In the case of the second problem, as to whether absenteeism was a result of pupils not wishing to attend

extra lessons, this was strongly denied by all pupils when so questioned. The researcher felt that only one pupil (9B05) actually may have wanted to give up the course, and his response to Question 1 in the structured interview questionnaire (see appendix 5), which was "It (the program) did its bit, I didn't do my best" seems to support this.

5.3.3: Introduction Of Pupils To SERGO System And The Operation Of The System

During recruitment, the drill-and-practice nature of CAI programs such as SERGO was explained to all pupils. Pupils were interested to learn that such programs had their roots in the stimulus-response theory of learning propounded by Skinner (1958), as they were not aware that there were theories of learning.

When each pupil began to use the SERGO system the researcher worked with the pupil to ensure that he would learn to use the program to his best advantage, i.e. maximise this extra lesson learning opportunity. Each pupil was advised to always go through the theory option before attempting the series of problems posed to him. The value of the ESC (for help) option was stressed. Each pupil was advised to ask for help from the researcher when he was in difficulties. These difficulties could be of two kinds:

* with the running of the SERGO system itself;
* with the mathematics as presented by SERGO.

It is to be remembered that all the mathematics presented to the pupil was supposed to have been covered in class, i.e. revision work was being undertaken, which is the purpose of such drill-and-practice programs. Pupils were

also given pen, paper and caculator and urged to use them.

The researcher found that pupils were easily able to follow the program and before the end of their first extra lesson were totally absorbed with the work presented to them by the computer. Since the program always required response from the pupil, the pupils were always busy. Unlike the pupils from Primary School and from std.6-7, whom the researcher had worked with in 1989, the Senior Secondary pupils experienced less difficulty in running the program. In practice, the researcher had to remind pupils to use the ESC key for help and to attract his attention if they did not follow the program or understand the mathematics presented. This was because pupils became so absorbed with the program. This leads to the worrying criticism that the program is so user-friendly and challenging to the weaker mathematics pupil that he is reluctant to ask for assistance, which could have helped him to learn more.

5.3.4: Lesson Plans For Pupils Using SERGO

The Std.10 pupils (group 4.3.1) were allowed to choose the sections of the syllabus (i.e. paths) which they wished to revise. This was done in consultation with the researcher (i.e. their teacher). Even though these pupils worked extremely diligently they were only able to complete an average of 56 lessons out of nearly 200 lessons found in the std.9-10 syllabus. (See Appendix 4 for each pupil's SERGO record).

For both std.9 groups, the pupils began at the beginning of the trigonometry path (see Appendix 2). This meant that they first revised the std.8 syllabus before completing the std.9 syllabus. These pupils then had to

be stopped before they began the std.10 syllabus. In the case of group 4.3.2 they had begun Trigonometry before the Pre-test. This was also revised on SERGO before they completed the std.9 trigonometry. Finally they began surds which was the classwork done after they had completed the trigonometry syllabus. Of interest is that with two extra lessons per week these weak pupils were able to keep up with the work covered in class. This does not imply that they fully understood the work.

With group 4.3.4, the class had begun the std.9 trigonometry syllabus at the beginning of the second term. Their Pre-test date was 30 August and this was to be a control test on the trigonometry work covered by that date, i.e. the work from the beginning of the term to 30 August. For this reason these pupils were put onto path 8 (see Appendix 2) which began with the revision of std.8 work. The researcher restricted their extra lessons to the Post-test syllabus, so that once pupils had completed the syllabus they were then put onto path 0 (see Appendix 2) where they were tested on the work covered and repeated certain exercises. The researcher therefore aimed at 10 hours of extra lessons and not at just revising the work done in class.

In the case of the group 4.3.3, pupil 8A02 completed revising the work that was being done in class, then revised work done earlier in the year. Thereafter he returned to the work done in class in the interim time. The researcher used the pupil's assessment as to whether or not he had done each new lesson that was presented on the computer in class or not. 8A02 was quick to notice if he had done the work before or not. This was the case with most of the pupils which suggests that the program was well presented. The second pupil (8A04) in this group only revised work done after the Pre-test.

Group 4.3.5 represented two pupils who were already receiving extra lessons, privately, from the researcher, of a remedial nature. The SERGO system was integrated into their remedial programme, and the researcher moved them from one lesson to another within path 0. Where these changes occurred can be noted by looking at the SERGO records (Appendix 4) for 8B02 and 8B03, bearing in mind that each consecutive lesson in the SERGO system has a sequential increase of 5,e.g. 8370 is followed by 8375.

The 2 pupils in group 4.3.6 worked without assistance from the researcher during mathematics periods as described in section 4.8. These 2 pupils, the only H.G. pupils in the class, revised parts of the H.G. syllabus which the teacher (i.e. the researcher) was not going to revise due to his involvement with the S.G. section of the class. The only assistance these 2 pupils required while they used the SERGO system, was to be moved on 3 occasions, to work that they had elected to revise.

5.3.5: Field Notes

The field notes made by the researcher with regard to each pupil in all 6 groups can be broadly classified according to the following:

5.3.5.1 SERGO as an aid to learning;
5.3.5.2 Attitude to CAI as a learning method;
5.3.5.3 Degree of assistance required to operate the SERGO system;
5.3.5.4 Degree of assistance required to understand the mathematics in the SERGO system;
5.3.5.5 Absenteeism and reason for absence;
5.3.5.6 Length of time spent receiving extra lessons;
5.3.5.7 Personality, emotional and motivational factors

which could change a pupil's performance;

5.3.5.8 Expectations as a result of receiving extra lessons.

Notes were also recorded of conversations with the external group 9B's teacher, as well as with some of the parents of the external pupils.

The complete field notes are too extensive to include in this dissertation, however the researcher has extracted from these notes in the analysis of data (Chapter 6).

Since classifications 5.3.5.3 and 5.3.5.4 are important in testing hypothesis 4.1.2, Table 4 has been drawn up from the field notes in conjunction with the SERGO records (Appendix 4) for the internal students.

TABLE 4: ANALYSIS OF DATA EXTRACTED FROM FIELD NOTES

Pupil	N1	T(hr)	N2	N3	N4	N5	N6	N7
XA02	27	19,1	15	3	9	3	2	7
XA03	27	19,1	13	3	9	5	3	5
XA04	26	19,6	20	9	4	2	9	1
XA05	31	18,1	24	8	4	3	7	9
9B02	14	8,8	4	8	3	7	8	3
9B03	14	8,8	1	3	4	9	3	0
9B04	13	9,8	5	4	6	2	3	2
9B05	14	10,5	6	4	6	3	3	1
8A02	14	8,8	12	2	2	0	1	0
8A04	14	8,8	7	5	3	4	8	2

N1 = no. of extra lessons; T = time on extra lessons;
N2 = no. of extra lessons that no assistance was given;
N3 = no. of interventions by researcher to run program;
N4 = no. of lessons where minor mathematics help given;
N5 = no. of lessons where major mathematics help given;
N6 = no. of items failed; N7 = no. of times absent.

5.3.6: The Structured Interview Questionnaire

The structured interview questionnaire (see Appendix 5) though not well designed and showing bias towards the SERGO system does elicit some interesting information. The results of the 16 (out of 18) pupils who completed the questionnaire have been tabulated in Table 5 below. The general comments which pupils made voluntarily at the end of each question in the questionnaire are not recorded here, but have, in some cases, been used by the researcher in Chapters 6 and 7. Table 5 needs to be analysed in conjunction with Appendix 5.

TABLE 5: RESPONSES TO THE STRUCTURED INTERVIEW QUESTIONNAIRE

	Question Number																		
Pupil No.	1	2	4.1	4.2	4.3	4.4	4.5	5.1	5.2	6.1	6.2	6.3	6.4	6.5.1	6.5.2	6.5.3	6.5.4	6.5.5	7
XA02	3	+	4	3	4	2	2	1	10	2	1	12/12 7/12	2	1	2	1	2	3	Y
XA03	3	+	3	5	5	1	3	1	10	1	1	12/12 6/12	3	3	1	4	5	3	Y
XA04	3	+	2	4	4	3	3	1	6	1	1	12/12 6/12	4	2	1	1	3	2	Y
9A02	3	+	4	3	5	2	1	1	3	1	1	11/11 *	2	4	2	1	3	5	Y
9A03	3	+	4	4	5	4	1	1	3	2	1	11/11 *	3	1	1	5	5	5	Y
9A04	3	+	4	4	5	3	3	2	5	2	1	11/11 *	2	2	1	1	3	3	Y
9A05	3	+	4	3	5	2	1	2	10	1	1	11/11 *	2	2	1	1	2	3	Y
8A02	2	+	4	2	2	3	2	25	30	1	1	6/12 *	6	1	2	2	3	3	Y
8A04	2	+	4	3	4	2	1	20	35	1	1	4/12 *	5	1	2	2	3	2	Y
9B01	2	-	3	3	3	1	4	5	12	1	1	10/25 *	3	1	1	1	1	2	Y
9B04	3	0	3	4	5	2	1	20	30	2	1	15/25 *	4	2	1	4	3	5	Y
9B05	3	-	3	2	3	1	1	7	10	2	1	10/25 *	2	1	2	1	5	4	N
9B02	2	0	5	4	5	2	2	3	5	2	1	3/25 *	3	2	3	1	4	5	Y
8B02	2	+	3	3	3	2	1	6	10	2	1	15/29 *	2	1	2	1	4	5	Y
8B03	2	+	4	3	3	2	1	10	15	1	1	6/25 *	2	1	1	1	5	4	Y
XA06	3	0	2	3	4	4	3	5	15	2	1	15/15 10/15	3	1	1	1	2	3	Y
Avge	2,6		3,6	3,5	3,8	2,0	1,7	6,9	13	1,5	1	65% 45%	3	1,8	1,5	1,8	3,3	3,6	

4

N.B.: Where 1 refers to question 4.1 in the questionnaire, etc.
* indicates that no response to possibility of lessons after school was considered.

5.3.7: The Attitude Questionnaire

The results of the attitude questionnaire (Appendix 6) referred to in section 4.5.3 have been tabulated in Table 6. These results were calculated using the calculation procedure (Appendix 6) outlined by Rodda (pp 36-38). However no correlations between the first 3 attitude factors and the second 3 attitude factors have been calculated as was done by Rodda. The reason for this is that the researcher was searching for confirmation for his own estimations of certain attitudes of these pupils. The researcher, therefore, used the information gathered in Table 6 for a different purpose to that used in the research done by Rodda.

TABLE 6: RESULTS OF ATTITUDE QUESTIONNAIRE

Pupil No.	1	2	3	4	5	6
XA02	0,38	0,40	0,52	0,76	0,60	0,58
XA03	0,33	0,43	0,52	0,67	0,40	0,67
XA04	0,45	0,55	0,52	1,00	0,60	0,90
9A02	0,42	0,48	0,48	0,19	0,73	0,81
9A03	0,52	0,43	0,77	0,24	0,47	0,71
9A04	0,62	0,45	0,65	0,67	0,47	0,62
9A05	0,60	0,52	0,52	0,48	0,53	0,81
8A02	0,58	0,40	0,48	0,43	0,73	0,58
8A04	0,52	0,44	0,62	0,62	0,80	0,86
9B01	0,58	0,35	0,55	0,53	0,20	0,48
9B04	0,67	0,36	0,81	0,48	0,67	0,71
9B05	0,63	0,24	0,48	0,43	0,13	0,48
9B02	0,22	0,45	0,26	0,48	0,33	0,58
8B02	0,63	0,48	0,68	0,53	0,67	0,62
8B03	0,55	0,41	0,65	0,76	0,47	0,62
XA06	0,50	0,45	0,45	0,76	0,60	0,71

NB.: Column 1 = introvert (1,0) - extrovert (0,0)

Column 2 = work(1,0) - entertainment(0,0) orientated
Column 3 = dependent (1,0) - independent (0,0)
Column 4 = computers: Like (1,0) - dislike (0,0)
Column 5 = mathematics: Like (1,0) - dislike (0,0)
Column 6 = SERGO Program: Like (1,0) - dislike (0,0)

These results will be discussed in Chapter 6.

5.3.8: The SERGO System Records

The record of the lessons completed by each pupil, as well as those lessons which each pupil failed, appear in Appendix 4. These records are of great value to the teacher using the SERGO system as explained in section 3.2 of Chapter 3. These records have also been referred to on many occasions in this dissertation.

CHAPTER 6: ANALYSIS OF DATA

6.1: Quantitative Analysis

6.1.1: Average Improvement P

The method of calculating P, the average improvement of the 16 pupils who received extra lessons, using the remainder of the class in each case as a control group to standardise their Post-test scores has been described in section 4.4 (p.20). The results of these calculations appear in Table 1 (p.32). The value obtained for P was +37,2%.

This means that these 16 pupils, weak in mathematics, after receiving 10 hours of SERGO (in the case of the std.8 and 9 pupils) or 20 hours of SERGO (in the case of the std.10 pupils), achieved September marks, which on average, showed an improvement of +37,2% on their June mark. The average mark obtained in June by these 16 pupils was 28,4%. The standardised average mark obtained in September by these same pupils was 36,4%. It is to be noted that the average mark of all the pupils who made up all the control groups, remained constant at 49,0%. This means that the 16 pupils who received extra lessons on the SERGO system, improved on their own individual marks by 37,2% on average. This represented an average improvement of 8,0% on their actual June examination marks compared to all other pupils who wrote the same examinations. Also, in the June examinations 10 of the 16 pupils failed, whereas in the September examinations only 4 of the 16 pupils failed.

These figures, in the opinion of the researcher, represents sufficient improvement to suggest that the first hypothesis (4.1.1) is true according to this

quantitative analysis. The researcher will examine this result more closely from a statistical perspective in Section 6.1.2, as well as to consider both the internal and external validity of these results in Section 6.1.3.

6.1.2: Statistical Analysis Of The Average Improvement P

The median p-value of the sample (the 16 pupils who received extra lessons) was +20,6%. The range of p-values of the sample was 228.5%. These results indicate that the results are skewed. Calculation of the standard deviation of the p-values (Behr:1973) gave a value of 57,0% (see Appendix 7). Despite this large std. dev., three of the sample had improved by more than one std. dev., and one had got worse by more than one std. dev. This suggests that these 4 cases (XA04; 9A02; 9B01; 9B05) should be investigated further. This has been done in Section 6.2.8 (p.64) by considering the following:

- whether the variables other than the variable being changed, viz. extra lessons, could have changed and so have clouded (Campbell and Stanley:1963) the variable being observed, viz. the improvement of examination performance;
- all the researchers' own pupils from a qualitative perspective, to find out why there is such a wide range (228,5%) of change in examination performace as a result of receiving extra lessons on the SERGO system.

On rejecting these four scores and re-calculating the mean and std. dev. the following results were obtained:

mean = +17,1%; std. dev. = 22.5%

This means that, after rejecting the most extreme changes in performace "p", the average improvement "P" = +17,1%,

which in the researcher's opinion, is sufficiently large and the std. dev. suffiently reduced, to suggest that, from a quantitative perspective, the first hypothesis is true.

6.1.3: Factors Which Could Affect The Internal And External Validity Of Results

The researcher felt that the factors which could have caused clouding and hence affect the validity of the quasi-experiment (which is the quantitative aspect of the research) could all be classified as historical according to Cohen and Manion (p.194). These factors include changes in attitude to mathematics and educational objectives as well as changes in social conditions and emotional relationships affecting each pupil. These factors will be mentioned in the qualitative analysis later.

The other factors, together with the researcher's comments, which were possible threats to the internal validity of the quantitative aspect according to Cohen and Manion include:

* Maturation - not a factor here as the experiment took place over a period of only 3 months;
* Testing - a possible factor as the Pre-test and the Post-test were not the same test, however the Post-test results were standardised using control groups.
* Instrumentation - does not seem to be a factor here.
* Selection - a possible factor, but bias should have been eliminated by selecting the weakest pupils possible, but this in itself might have caused bias as they, in theory, are most likely to improve, but in practice, are perhaps the least likely as they are the weakest.

* Experimental mortality - nil.

A summary of the factors which could jeopardise the external validity of the results of an experiment, according to Campbell and Stanley (1963) and Bracht and Glass (1968) include:

* Failure to describe independent variables explicitly - the independent variables may not have been explained explicitly, but from the description of the research they should be sufficiently explicit;
* Lack of representativeness of available and target populations - here the available population, i.e. CED high schools, would needs be the target population;
* Hawthorne Effect - this effect is inevitable once the subjects are aware of the experimentation. There was the possibility in this experiment that the control groups from the researcher's own classes also made a bigger effort as they had been excluded from taking extra lessons which they all wanted to do. The researcher is saying that the Hawthorne Effect could have worked both ways and can be disregarded for this reason;
* Inadequate operationalising of dependent variables - not a factor as the research was carried out as the CAI program would be used in the school situation;
* Sensitisation to experimental conditions - not a factor as pupils wrote the Pre-test before knowing about the experiment.

In Table 2 (p.34) the average improvement P1 for the 6 external pupils (+57,8%) is greater than that of the 10 internal pupils (+25,3%). This supports the view that the first hypothesis is valid externally as well as internally.

At this point possible reason for a higher value in Pi for the external pupils needs to be commented on. The explanation for this could lie in that, either these external pupils:

* have a greater natural ability in mathematics;
* received more help from the researcher during extra lessons;

or that:

* the internal pupils were already receiving more drill-and-practice orientated teaching during their normal classroom lessons.

Whether the above are factors or not, the external pupils also showed a large positive average improvement "P".

In conclusion the researcher feels that the control of variables was sufficient for the first hypothesis to be internally valid. Since the control of variables of the pupils outside the researcher's school appears to have been within acceptable limits and the P value for these pupils is +57,8 %, the researcher feels that the first hypothesis is externally valid for a target population limited to CED senior secondary pupils weak in mathematics attending school in East London.

6.1.4: Investigation Of The Possibility Of Positive Long Term Effects Of Receiving Extra Lessons On The SERGO CAI System

During the period of time that the pupils were receiving extra lessons, the researcher considered the possibility of these pupils achieving a greater, long-term improvement in their mathematics than simply an improved mark in their next examination. Three possible reasons for this being the case were:

- the inculcation of the deductive method of mathematics which might be carried over to other sections of work;
- an improvement in one area of mathematics leading to a general improvement in confidence;
- an incubation period resulting in full improvement not being realised in the Post-test, i.e. latency.

The results of Table 2 (p.34) indicate that the 10 internal pupils showed a greater improvement (standardised against the same control groups as for the Post-test) at the end of the year, 3 months after their last extra lesson, than they did immediately after completing their extra lessons. These results are insuffient evidence for stating that there are positive long-term effects resulting from receiving extra lessons on SERGO, however this possibility could be worthy of investigation.

6.2: Qualitative Analysis

6.2.1: The Length And Time Of Day Of Extra Lessons

The optimum length of extra lessons was suggested to be 45 min. (Section 4.6). This was not realised (Section 5.3.1), as extra lesson periods varied between 35 and 120 min. Those pupils who received extra lessons after sports practice were often very tired, as were those whose lessons were after 18:30.

The researcher felt that those pupils who received lessons during the afternoon (13:45 - 16:00) benefitted most. However many pupils (see Table 5: p.42) felt that they would prefer to receive their extra lessons during school. Clearly some pupils envisaged the possibility of receiving part of their normal classroom mathematics lessons on the SERGO system. 9B04 said that "he learnt

more quickly as he could work at his own rate and recommended CAI to anyone who liked working on his own and didn't enjoy being taught in the classroom".

6.2.2: Absenteeism From Extra Lessons

An analysis of pupil absenteeism is necessary as this is a pointer to the pupils' attitude to the Sergo System and to CAI in general. No matter how good a learning process is, if pupils do not accept it then that learning process will fail. This is an important point, as writers such as McGinty (1982) and Parsons (1983) foresee that the use of computers in education will, after a brief time, soon die away, as have so many other innovations in education.

From the field notes (see 5.3.6.2) it appears that 3 pupils avoided lessons. Each will now be considered:

9B04, after initially being extremely keen, went through a period of absenteeism which could be attributed to his feeling that he was no longer benefitting from lessons. The researcher had to be extremely persuasive in order to get this pupil to make up missed lessons and so complete the required amount of time on the computer. The researcher's opinion was that this pupil had high expectations of rapid success, but found that it meant more work, but of a structured nature, which he wasn't prepared to do. Hence his comment in the structured interview questionnaire: "It did its bit, I didn't do mine".

Pupil XA05 was absent on 9 occasions. Only after the Post-test had been written did she admit to the researcher that, although she tried hard in the extra lessons, she had decided not to study further after leaving school and had lost interest in schoolwork. She

had in fact passed her senior certificate the previous year, and was re-doing 3 subjects in order to improve her symbols. However, as a result of the researcher's persistence she did catch up the extra lessons that she had missed. At the end of the year she passed maths with an F, after having failed with a G in the previous year's examination. Her comment about the value of the extra lessons on SERGO after receiving her end of the year results was, "It definitely helped. I wouldn't have passed without it".

Pupil 9B01 had his extra lessons after rugby practice on Thursdays and missed twice. The researcher felt that this pupil made a great effort to come to lessons so late in the day, but that without the considerable enthusiasm and encouragement of the researcher, 9B01 would have given up.

These 3 cases indicate widely differing reasons for pupils giving up on a course of action which they all admitted, at a later stage, to have resulted in a positive intervention in their mathematics education. In each of these cases the need for the personal involvement of a teacher in the learning process is evident.

6.2.3: Qualitative Examination Of The First Hypothesis

In Section 6.1 the first hypothesis tests positive. This hypothesis states that the SERGO Secondary System can be used to improve the examination performance in mathematics of senior secondary pupils weak in mathematics.

In accordance with the method of triangulation it is worth considering whether this hypothesis can also be validated qualitatively. Triangulation has been defined

in Cohen and Manion (p.254) as " the use of two or more methods of data collection in the study of human behaviour". Of the principle types of triangulation put forward by Denzin (1970), the researcher has used that of "methodological triangulation (b): different methods on the same object of study".

The field notes record many positive and some negative observations and statements with regard to extra lessons on the SERGO CAI System. A selection is given below:

* Pupil 8A04 arrived promptly and began working immediately - this comment was made many times about most of the pupils over the duration of the extra lessons (17 Aug.-5 Sept.). That this enthusiasm did not wain over such a long period of time, must be taken as an indication that the pupils were convinced that these extra lessons were helping (high school pupils are very good at arriving late or forgetting to come to avoid something that they regard as not worthwhile).
* XA04 was pleased that she had completed 6 lessons by herself the previous afternoon (6 Aug.).
* 9B02: "Whatever else, I am much more confident about trig. as a result of doing these extra lessons (11 Aug).
* 9B04: "I have learnt trig. that I didn't know existed last year (a repeat pupil) (14 Aug.).
* XA03: "The computer has made the difference. I know my work much better now (16 Aug.).

But not all pupils were meeting with success:

* 9A03: was unable to complete the Sine rule lesson, and said that he did not know what was going on (17 Aug.).

* 9B04: When no longer enjoying extra maths lessons, claimed program was faulty as its answers were wrong (28 Aug).

Few interviews were recorded, but the following are significant:

9B02: Last lesson. Worked with tremendous intensity (and speed). .... she enjoyed seeing a print-out of her results and kept a copy. She said, "If I had been using SERGO from the beginning of the year I would probably have been able to stay on H.G." She said that she would definitely like to continue with SERGO extra lessons once a week, after this (research) is finished (28 Aug.).

9B05: Telephonic interview. In response to: "How was your control test (post-test)?", which was posed immediately after test, before the results were known: "I am very disappointed. I had high hopes after my success and hard work on SERGO." He thought he had only got 35% to 40% (in fact he got 42%). On being reminded that he had only got 16% in June, he said "Yes, without SERGO I would have got the same mark (16%). It has made the difference". (30 Aug.)

9B01: Telephonic interview after test, before results. He was very pleased. He felt that he had scored 50-55% (in fact got 50%). He said: "Yes, SERGO helped me do certain questions because they were the same type (NB: researcher did not see the post-test question paper before-hand), and it also helped in others because I could use what I had learnt from the extra lessons to help me do these other types of sums." (30 Aug.)

XA04: As a result of extra lessons was aiming for 40-45% (she had scored 14% in June and scored 45% in September). She said that she had been absent for the 1st 2 weeks of Calculus in the 1st term and now understood it. (21 Aug.)

XA02: On receiving matric results (E symbol): "SERGO definitely helped. I could see the layout on the screen when I was doing that type of sum in the exam." (27 Dec.)

The field notes included outside observers' commments:

* 9B group's teacher: These pupils are now volunteering to answer questions in class, and are motivated to actually try some sums instead of just sitting and saying, "I don't understand". But for three of them this hasn't carried over into the new work (not done on computer), but at least they are now trying. The other one (9B02), who has far more self-confidence now (4 Sept.), is coping with the next chapter.

(This teacher was so impressed by the far more positive attitude to maths shown by her pupils who had received extra lessons that she came to see the system at the researcher's home. She left with enthusiasm intact but again the researcher felt that unless teachers use a good drill and practice program over a long time period they will not be able to assess its full potential. It is too much to take in during a demonstration).

* 8A teacher: Both pupils are working much better now. They are doing their work on their own and answering questions in class. (20 Aug.)

In conclusion, then, evidence from the field notes shows that only one pupil indicated dissatisfaction with doing extra lessons on the SERGO system, and that not all the pupils were able to understand the maths as presented by the SERGO system, but that all felt that they were learning mathematics by attending extra lessons.

In responding to the structured interview questionnaire after the Post-test had taken place, pupils were asked to answer questions freely. Negative responses and frank opinions were encouraged by the researcher.

In Table 5 (p.42) the individual responses of the pupils to the questionnaire are shown. The average score of the pupils to some of the questions as well as the comments made at the end of these questions are now discussed:

Question 1: Pupils rated the help, that they felt that SERGO had given them, as an average of 2,6 on a scale of 1 -5. Here the researcher was of the opinion that the pupils had scored 3 as "average help" and 2 as "good help" and not as shown on the questionnaire scoring system. The reason for this opinion is that most of the comments which pupils made at the end of question 1 were very positive:

XA02: It taught me to not make so many stupid mistakes.
XA03: It taught me to tackle a sum, step by step, and to be careful.
9A03: It helped me to understand maths better and will help.
9A04: What you do remains in your memory.
9A05: It taught me what I could never understand before.
8A02: It was great revision.
8A04: It helped a lot where I didn't understand before.
9B02: It made trig. very clear and easy to understand.

8B04: ESC helped me as it showed me what to do.

But one comment was somewhat negative, yet again reflecting a higher expectation:
9B05: Did not help as much as I hoped it would.

Question 2: There were 11 positive and 2 negative comments made by respondents to their school friends about receiving drill-and-practice extra lessons.

Question 6.1: An average score of 1,5 (halfway between very good and excellent) was given for spending money on setting up a computer room so as to offer SERGO system extra maths lessons.
Question 6.2: All respondents scored 1 (definite) for extra maths lessons on the SERGO system if they were available at their school.
Question 6.3: Pupils felt that, on average, 65% of the pupils in their classes would avail themselves of extra lessons during the school day (but only 45% would do so if extra lessons took place after school).

In conclusion, then, evidence from the structured interview questionnaire shows that all the pupils indicated by their responses that they felt that extra lessons on the SERGO system had helped them with their mathematics. This was especially so as all the pupils said that they would take extra lessons on SERGO if it was offered at school. However some pupils did expect to improve by more than they actually did.

Thus the evidence from the field notes and the structured interview questionnaire when triangulated with the results of the quantitative analysis both serve to strengthen the conclusion that the first hypothesis is true.

6.2.4: Qualitative Examination Of The Second Hypothesis

The second hypothesis states that the SERGO system can be used as a stand-alone instrument of remediation in mathematics for senior secondary students weak in mathematics.

An analysis of the data extracted from the field notes (Table 4, p.41) shows that of 194 extra lessons attended by the 10 internal pupils, 107 (55,2%) of these lessons took place without any assistance from the researcher. Of the 137 occasions that pupils required assistance, 49 interventions were with the running of the program (i.e. non-mathematical) while 88 required help with the mathematics as presented by the program. Of these 88 mathematical interventions, 50 were minor (brief clarification or explanation) and 38 were major (thorough explanation; looking for the point of breakdown, i.e. remedial work).

The conclusion, then, from the field notes is that the second hypothesis must be rejected, though pupils can, more often than not, work without supervision.

An analysis of the data collected from the structured interview questionnaire which is relevant to the second hypothesis shows the following:

Question 4: Pupils, when asked to rate the need for assistance when working on SERGO, rated no teacher (3,6), computer trained teacher (3,5), non-maths teacher (3,8), maths teacher (2,0), and expert maths teacher (1,7). Clearly pupils felt that a maths teacher needed to be present.

Question 5: Pupils did not feel that each pupil required their own teacher, as in this question the average for

the optimum number of pupils receiving extra lessons on the SERGO system was 6,9, while the average for the maximum number of pupils that one teacher could deal with at a time was 13,0.

Open ended comments at the end of question 4 included the following responses:

XA03: Definitely need a maths teacher to help.
XA04: I enjoyed working independently, with the occasional aid of a maths teacher.
9A02: I'd need a maths teacher to help me out of situations.
9A03: This would not work if the maths teacher was not there.
9A04: There must be a teacher if you are really in difficulty.

But also:

9B02: Expert maths teacher not needed (this comment adds to the suspicion that this pupil was not really weak in mathematics, but needed the sort of revision that SERGO could give). Also XA06, the good H.G. pupil who states, "I don't need any help from teachers".

The conclusion, then, from the structured interview questionnaire, is that the second hypothesis must be rejected.

From these two sources there is little doubt that a teacher, preferably mathematics teacher, is required to be present during SERGO extra lessons. It does however indicate that for more than half the lessons the pupils did not require any assistance whatever, and this raises the possibility that a single teacher could perhaps supervise what, are essentially individual tuition extra

lessons, for between 7 and 13 pupils at a time. The conclusion is that the second hypothesis is not true.

6.2.5: Qualitative Examination Of The Third Hypothesis

The third hypothesis states that the SERGO system can be used by better ability pupils to improve their understanding of mathematics, particularly at the Higher Grade level, in the senior secondary phase.

As explained in Section 4.1, this hypothesis was proposed after the main experiments were underway, an acceptable strategy in Action Research. The two H.G. pupils in the researcher's own Std.10 class were invited to work on the SERGO system during their maths classes, while the teacher (also researcher) was revising S.G. work with the rest of the class.

From the field notes dated 8 August:
2 matric H.G. pupils worked on Std. 10 H.G. maths for 70 min. without a pause. Did not ask for help from researcher, (said that they were using ESC key for help) and had learnt on their own. From Appendix 4 it can be seen that XA06 completed 4 lessons with an average mark of 85% on 8 August.
From the structured interview XA06 responded to question 1: It helped me understand a few things that I did not understand properly before. And to question 4: I don't need any help from the teacher. However he gave a rating of 1 (definite) to take mathematics (and physical science) on the computer if such drill-and-practice programs were available.

In conclusion, then, both from the field notes and the structured questionnaire, the researcher felt that there was insufficient evidence to support the third hypothesis

as being true, but that this hypothesis could not be rejected.

6.2.6: Qualitative Examination Of The Fourth Hypothesis

The fourth hypothesis states that the SERGO system can be operated successfully by pupils working in pairs to improve their understanding of mathematics.

The pair of 2 H.G. pupils (i.e. 4.3.6) worked extremely well together. Each pupil took turns at operating the keyboard while the other did the calculation. Answers were discussed before they were punched in.

Pupil numbers 9A04 and 9A05 worked together on two occasions due to transport difficulties. In their case they did each problem independently and then compared answers (at the request of the researcher) so as to keep tuition as individual as possible. If their answers disagreed, the one operating the keyboard explained to the other what she had done. Discussion then ensued.

Pupil XA04 so enjoyed working on the SERGO system and using the computer (see Table 6 for attitude scores) that she often stayed behind to watch XA03 or XA02 working on SERGO. Soon she would get involved with assisting the working pupil. However XA04 was discouraged by the researcher as this was a possible cause of invalidation due to altering a fixed variable in the case of the first and second hypotheses, i.e. independent extra lessons on SERGO system.

With pupils 9B04 and 9B05, when 9B05's lift home was late on occasions he was keen to explain the maths of the lesson that he had just done to newcomer 9B04.
Of the 4 examples quoted only the first was as the

researcher set out to test this hypothesis. These two pupils worked well together and presumably were learning mathematics as it was voluntary to work on the computer. How much did they learn? How much more could they have learnt working individually? These and other variables need to be investigated in greater depth before the researcher would feel satisfied that this hypothesis has been sufficiently tested.

Undoubtedly pupils can work in pairs. Furthermore some would prefer working in pairs. And if finance restricts pupils to sharing computers and software, the researcher is of the opinion that sufficient learning would take place to warrant two pupils per computer provided it was strictly controlled. However the researcher favours individual learning for best results on the SERGO system.

In conclusion then, the researcher did not find enough evidence to accept or reject this hypothesis.

6.2.7: Qualitative Examination Of The Fifth Hypothesis

The fifth hypothesis states that the degree to which a pupil will benefit from extra lessons on the SERGO system will depend on certain personality factors.

This hypothesis raises the question of whether certain personality types benefit more from extra lessons on the SERGO system than others. The field notes indicated that certain pupils appeared to be making better progress than others. The wide range in "p" values suggested that there were other factors contributing to the differing improvement of each pupil. Yet efforts had been made to keep the independent variables constant during the extra lesson, especially to ensure validation of the first hypothesis. According to Cohen and Manion (p.193), this

can best be achieved by matching the control group with the experimental group. This is extremely difficult with personality factors.

Rodda (1988) investigated personality factors under criterion 6 of the H.S.R.C. research on the SERGO system for mathematics in the Primary School. This criterion was that of "pupils' feelings towards the SERGO system". Her findings, based on correlation co-efficients, included that pupils who like mathematics and were work orientated had a more positive attitude to SERGO than those who were entertainment orientated and did not like mathematics. Rodda did not attempt to test whether a positive attitude to SERGO would result in an improved performance in mathematics. This would be interesting to test. However as explained earlier (Section 5.3.7, p.43) this was not how the researcher used this questionnaire.

Two pupils (XA02 and XA04) were overtly pleased with their progress in mathematics (their own assessment). Both these pupils had positive "p" values. Some of their personality factors and attitude factors will now be examined by using the results of the attitude questionnaire (Table 6). Both pupils' scores (0,38 and 0,45) indicated that the pupils were more introverted than extroverted, and more so than the group on average (0,51). One pupil (XA02) was entertainment orientated (0,40) but the other was work orientated (0,55). Both scored 0,52 on the "Dependent/Independent worker" item, which was similar to the average of the group (0,56).

Of interest was that both had a liking for computers and for mathematics compared to the group. Disappointing to the researcher was that the 3 pupils (9A02, 9A03 and 9A05) who had negative "p" values, all scored high on their attitude to the SERGO system.

The results obtained from the attitude questionnaire did not present a clear personality type with regard to being extrovert/introvert, work or play orientated, or dependent/independent worker. The field notes, which caused the researcher to investigate personality factors, seemed to indicate that pupils less likely to ask questions in class (possibly shy, or fearful of criticism) and who were hardworking seemed to enjoy working most on SERGO. A positive attitude to the SERGO system (see Table 6), however, did not necessarily lead to an improved performance in mathematics examinations.

Perhaps the researcher should have investigated motivational, emotional state or inherent mathematical potential factors, rather than personality factors, in searching for a prognostic instrument to help identify those pupils most likely to improve their mathematics performance if they received extra lessons on the SERGO system.

In conclusion, then, the researcher was unable to identify any definite personality factors which could be used to decide whether a pupil would benefit from extra lessons on the SERGO system or not. Such factors, which may exist, are likely to be clouded by other factors such as motivation, emotional state and inherent mathematical ability. This hypothesis is therefore rejected.

6.2.8: A Brief Assessment Of Some Pupils Who Took Part In The Research

The purpose of this assessment of these pupils was to try to find reasons for the wide range in "p" values scored by the 16 pupils who took part in the investigation of the first hypothesis. When the researcher set out to

measure the average improvement "P", his expectation was that all pupils would improve, as any positive intervention such as extra lessons should cause a positive outcome, and that the std. dev. would also be small, e.g. P = +25%, with pupils improving between 10% and 40%, giving a std. dev. in the region of 10%. Since this was not the case the researcher had looked for personality factors, which could explain the large range of "p" values (see 6.2.7). As this investigation was inconclusive, the researcher has used his field notes and the observation of his own pupils to attempt to explain this phenomenon (see earlier reference in 6.1.2).

XA02: (p = +7,25%) - Very quiet and well mannered. Apologised to computer when he made a mistake. Clearly enjoyed getting immediate feedback on each input he made. Worked out each question very carefully before entering his answers. He said that the step by step layout of the work as presented by the SERGO program helped him understand the work better and that when he came to do similar examples in the exams (even in November) that he could remember the layout and so do the sums. This, he said was especially so in analytic geometry and in calculus. He was very pleased (motivated?) when he received his progress report at the end of each week. He also said that the program taught him not to make so many stupid (careless?) mistakes.

XA03: (p = +13,0%) - An erratic worker with the highest IQ of all the pupils who received extra lessons. Normally asked questions in class, but when faced with the SERGO program which required a response from her for each question, she admitted that she copied in class, especially off the board, so as

to cover up her lack of understanding. Once she was forced to make responses herself, to each SERGO system question, the improvement in her work and in her confidence was immediately evident in class. Her year-end result supports the researcher's view that the breakthrough that the SERGO system caused in her maths, by forcing her to answer the questions herself, resulted in a permanent improvement. The researcher, as teacher, did not identify this cause of her poor performance in mathematics in the period of 18 months that he taught her prior to the SERGO lessons.

XA04: (p = +200,2%) - An extremely quiet pupil who never once asked or answered a question in class prior to SERGO lessons. She worked extremely hard and quickly (see Appendix 4 for her SERGO record). She said that she had been absent when calculus had been introduced in class. After receiving SERGO lessons for a few weeks, she began increasingly to participate in classroom lessons. The individual instruction that she received from SERGO and the using of a computer (she was the only pupil who also did typing as a subject and had a speed of 45 w.p.m.) clearly were positive factors. She characterises the shy pupil who wants to learn but without being "seen". She said that she could see the screen at night when she was lying in bed. However,she may have learnt more, had she asked for assistance more often while receiving extra lessons.

XA05: (p = -13,9%) - Once this pupil made the decision that she no longer needed to improve her previous year's matric results, her efforts on SERGO (and

school attendance) declined. Her difficulties in mathematics were, in the researcher's opinion, of a remedial nature, and though her loss of motivation may have caused her negative "p" result, her improvement in receiving extra lessons on SERGO may well still have been small as she consistently declined assistance from the researcher (as teacher). After receiving her year-end result which was an F, compared to a G the previous year, she said that working on SERGO had made the difference.

9A02: (p = -28,3%) - Appeared to have reached an academic plateau at the beginning of Std.9. Lazy, homework showed little effort. SERGO showed that his difficulties in mathematics required remedial assistance. Perhaps his negative "p" value was a result of a reverse in the Hawthorne Effect, in that, since he was receiving extra lessons on SERGO he felt that he need not work at his mathematics because he would automatically do better.

9A03: (p = -1,0%) - As with 9A02, had there been no extra lessons on SERGO in the offing he would have stopped doing mathematics as a subject after his poor result in the June examination. The only difference in comment to 9A02 is that 9A03 did not ask any questions in class.

9A04: (p = +5,6%) - A hard worker who had previously passed Std.8 H.G. mathematics. Maths level above that of remediation. The researcher is of the opinion that this pupil (as for XA02 and others) typifies the group of pupils who would most benefit from receiving extra lessons on a drill-

and-practice program such as SERGO.

9A05: (p = -12,6%) - A similar pupil to 9A04, but not having as good an understanding of mathematics. Extremely weak in trigonometry but fair in algebra. For this reason she would also benefit greatly from regular SERGO lessons.

The remaining 8 pupils were not taught by the researcher. Any similar commentary on these pupils would be less reliable than that made above. However the researcher feels that these remaining pupils could be classified into 3 distinct categories as could the above pupils. These categories are:

* Weak in mathematics pupils who are corrective instructional and not remedial instructional cases (see Section 2.3, page 6);
* Pupils who have lost confidence in their mathematical ability;
* Pupils who are remedial instructional cases.

The 1st category includes pupils such as XA02 and 9A04. These pupils would benefit from long-term extra lessons on the SERGO system. Teacher involvement would be slight.

The 2nd category includes pupils who have experienced problems such as:

* a sufficiently long absence from school (XA04);
* a major emotional upset due to home circumstance (XA03);
* a move from one province to another (9B02);
* a lack of confidence to ask questions at a critical time in class (8A02).

These pupils would benefit from extra lessons in specific areas, over a limited period of time, until their confidence returned. Teacher involvement during lessons would diminish from about 25% of the lesson to no more than that of occasional assistance.

The 3rd category includes pupils such as XA05 and 9A02. The researcher's experience is that the teacher needs to observe this type of pupil making responses to the program. After a short while the teacher will detect the point of breakdown (by repeated wrong responses) which is crucial in remedial teaching. It is essential that the pupil does not get assistance from the teacher before he gives his responses. This is often the mistake made by the teacher inexperienced in remedial work. If the teacher does offer assistance to help the pupil get the right answer the pupil begins to guess the right answer from the teacher's input (Holt:1964). Teacher involvement may be as much as 30% of time spent on extra lessons. This is still less than the time required by normal remediation lessons.

For these 3 categories of pupils requiring extra lessons, the researcher feels that:

For the 1st catergory, the re-calculated average improvement P = +17,1% with standard deviation of 22,5% (see p.46) is the sort of improvement and range of improvement that he would expect after a term of extra lessons.

For the 2nd category, the researcher would expect a greater average improvement, P, but a larger standard deviation from the mean.

For the 3rd category, the researcher would expect the

average improvement, P, of such pupils to depend on how effectively the teacher can utilise the SERGO system for remedial purposes, as well as on how great the learning disorder is of each such pupil.

In conclusion, then, the researcher found that not all pupils weak in mathematics have the same learning disorders (see Section 2.3, p.6), and that the needs of each pupil should first be identified before a programme of extra lessons is begun. The programme of extra lessons that the teacher places the pupil into, needs to fit the category of pupil as identified by the researcher earlier in this section.

It needs to be mentioned here that none of these pupils fall into the category of needing adaptive instruction (p.11), as none of them have an IQ below 90. Of interest is that the range in IQs for the 16 pupils was 94 - 125, with an average value of 107.

Finally, the researcher is convinced that unless the pupil himself asks for extra lessons and is prepared to work at these lessons as an extra and not in place of homework, the pupil will not succeed and will soon drop out. This is substantiated by the fact that the only "No" response to question 7 of the structured interview questionnaire: "Do you miss your SERGO lessons?" was from the only pupil who did not himself volunteer to receive extra lessons, but who was "volunteered" by his parents.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1: Conclusions

The conclusions, which follow, summarise the findings of the research. It is noted that the samples used in the quantitative analysis were small, and for this reason they were triangulated with the qualitative analysis (see Section 4.1).

7.1.1: The First Hypothesis

The first hypothesis, that the SERGO Senior Secondary system can be used to improve the examination performance in mathematics of senior secondary pupils weak in mathematics, tested true. This was supported both by the quantitative (p.45) and the qualitative (p.52) investigations.

This hypothesis was found to be valid, not only for the researcher's own school, but for other CED high schools in East London (p.47). Furthermore, evidence was found to support that extra lessons on the SERGO system resulted in a greater improvement in examination performance, a term after completing a course of extra lessons than immediately after such a course of extra lessons, for pupils from the researcher's own school (p.49).

7.1.2: The Second Hypothesis

The second hypothesis, that the SERGO system can be used as a stand-alone instrument of remediation in mathematics for senior secondary students weak in mathematics, tested not true (p.58).

At some stage, all pupils weak in mathematics, needed assistance to a greater or lesser extent in understanding the mathematics as presented by the SERGO system. Assistance was also required with the management program, which was to be expected. However, more often than not, pupils were able to complete each extra lesson without any assistance from the researcher.

7.1.3: The Third Hypothesis

Insufficient evidence was found to accept or reject the third hypothesis, that, the SERGO system can be used by better ability pupils to improve their understanding of mathematics, particularly at the Higher Grade level, in the senior secondary phase.

The Action Research method, used by the researcher, resulted in this investigation. Though inconclusive, the investigation suggests two possibilities:

* Can weak H.G. pupils receive corrective instruction (p.6) on the SERGO system?;
* Can H.G. pupils in combined H.G./S.G. classes learn on their own using the SERGO system while the teacher is teaching the S.G. section of the class?.

7.1.4: The Fourth Hypothesis

Insufficient evidence was found to accept or reject the fourth hypothesis, that the SERGO system can be operated successfully by pupils working in pairs to improve their understanding of mathematics (p.61).

The SERGO system, like all drill-and-practice CAI is written for individual instruction. The researcher was unable to find any record of research done on the use of

such programs for pupils working in pairs. Though the researcher favours, by far, the use of the SERGO system for individual instruction, the researcher observed that senior secondary pupils at his school were able to work to a reasonable extent, independently, in pairs. There was insufficient evidence to determine how successful these pupils were at improving their understanding of mathematics. However, there are important financial implications, if this is true.

7.1.5: The Fifth Hypothesis

The fifth hypothesis, that the degree to which a pupil will benefit from extra lessons on the SERGO system will depend on certain personality factors, was rejected as not true as no such factors were evident (p.62). The researcher concluded that if such factors did exist, then they are likely to be clouded by factors other than those of personality.

7.1.6: Investigation Of The Wide Range In Improvement In The Marks Of Pupils Who Received Extra Lessons

The wide range in improvement shown by the pupils as a result of receiving approximately equal amounts of tuition on the SERGO system led the researcher to investigate this aspect further. This was done by means of a series of brief case studies of the internal pupils (p.64). As a result of this investigation, the researcher identified three distinct categories into which these pupils could be placed (p.68). Furthermore, the pupils in each category require different treatment in order to maximise the effectiveness of receiving extra lessons on the SERGO system.

The first category consists of pupils who are in need of

regular corrective instruction (p.6) in the classroom situation. Unfortunately, such factors as class size, remedial teaching ability of the teacher, and the personality of the pupil greatly affect whether or not such a pupil will join the ranks of those pupils generally classified by teachers as being "unable to do mathematics". The research shows that such near failing or failing pupils benefit from regular extra lessons on the SERGO system. With only a little assistance from the teacher, CAI programs such as the SERGO system, should enable this category of pupil to pass.

The second category identified by the reseacher includes those who are normally passing pupils, but whose marks suddenly drop. Such pupils do not have a learning disorder, but need additional instruction in a particular section of the syllabus to understand that section of work well enough to continue. Many CAI programs are written specifically for such instruction. The teacher involvement initially may be high, but this should decrease as the pupil begins to grasp these particular mathematical concepts.

The third category identified by the researcher includes those in need of remedial instruction (p.6). The pupils who fall into this category do have a serious learning disorder in mathematics, and need remedial instruction. Such pupils are not slow learners. Suggested guidelines for using the SERGO system for such instruction are given in Chapter 6 (p.69).

7.2: Recommendations

Recommendations for possible areas of further research which arise from these findings are as follows:

7.2.1 The testing of the validity of the first hypothesis for a wider population than the CED high schools in East London.

7.2.2 The quantitative testing of the third hypothesis.

7.2.3 Investigating the two possibilities suggested in Section 7.1.3 (p.72).

7.2.4 The quantitative testing of the fourth hypothesis

7.2.5 Further investigation of the three categories of pupils requiring additional teaching.

7.2.6 Other methods of remediation.

7.3: Postscript For Practising Teachers

This evaluation of the SERGO Senior Secondary system was undertaken by the researcher to investigate whether this CAI program would be of assistance in teaching the weak mathematics pupils at the researcher's own school so as to pass S.G. mathematics in matric. The findings of the research show that this is true, not only for pupils from the researcher's own school, but also for pupils from other schools as well.

A great deal of time is needed to carry out a thorough investigation of any new teaching aid. It is hoped that this research will help practising teachers in deciding whether or not to use a good CAI program, such as the SERGO system, to improve their teaching of weak std.8-10 mathematics pupils.

APPENDIX 1

THE SERGO SYSTEM'S MANAGEMENT (OR CONTROL) PROGRAM

This is a separate program linked to the work done by each of the students. This enables the teacher to do the following:

1. Register new pupils; 2. Read on screen or print the records of pupils;
3. Change the exercise that the pupil is doing or about to do;
4. Change the path of study being undertaken by the pupil;
5. Change the norms for operating individual lessons;
6. Erase a pupil's records.

List of paths (available for std. 10):

1. Entire syllabus (one path per standard);
2. Revision (one path per standard);
4. Algebra;
5. Geometry;
6. Functions and graphs;
7. Statistics;
8. Trigonometry;
9. Analytical Geometry;
10. Calculus;
11. Exponents and logs.

APPENDIX 2

STANDARDS 8-10: PATH 8: TRIGONOMETRY

INDEX	DESCRIPTION	ESCAPE
8460	Trigonometric ratios 1	8460
8465	Trigonometric ratios 2	8460
MASTERY LEVEL 8A		
8470	Trigonometric functions	8460
8475	Trigonometric expressions	8460
8485	Right-angled triangles 1	8460
MASTERY LEVEL 8B		
8490	Shift trigonometric equations	8475
8495	Right-angled triangles 2	8475
8500	Angles of elevation & depression	8475
MASTERY LEVEL 8C		
9360	Trigonometric ratios	8460
9365	Trigonometric identities 1	8460
9370	Trigonometric identities 2	9360
9375	Calculations with the calculator	9360
9385	Reduction formulae	9360
MASTERY LEVEL 9A		
9390	Co-ratios	9360
9395	Angles in other quadrants	9365
9400	Function values of (360 + x)	9390
9410	Trigonometric equations 1	8490
9415	Trigonometric equations 2	9410
9420	Special angles	9360
9425	Special angles	9410
MASTERY LEVEL 9B		

PAGE 2

INDEX	DESCRIPTION	ESCAPE
9435	Graphs of trig functions	9360
9440	The Area rule	9440
9445	The Sine rule 1	9440
9450	The Sine rule 2	9445
9460	The Cosine rule 1	9445
9465	The Cosine rule 2	9460
9470	Practical trig problems 1	9445
9475	Practical trig problems 2	9445
MASTERY LEVEL 9C		
X320	Trigonometric identities 1	9365
X325	Trigonometric equations	9410
X330	Compound angles 1	9360
X335	Compound angles 2	X330
MASTERY LEVEL 10A		
X345	Compound angles 3	X330
X350	Formulae for tan(A + B)	X330
X355	Compound angles 4	X330
X360	Trigonometric identities 2	X320
MASTERY LEVEL 10B		
X370	Graphs of trig functions 1	9435
X375	Graphs of trig functions 2	9435
X380	Graphs of trig functions 3	X370
X385	Graphs of trig functions 4	X370
X395	More trigonometric equations	X325
X400	More difficult trig equations	X325
MASTERY LEVEL 10C		

APPENDIX 3

A TYPICAL SERGO LESSON

Item 9410: Simple Trigonometrical Equations

Screen A1: A user-friendly statement of introduction to the pupil, John, in this case.

Screen T1: The first entry explains what this item is going to do, and that it follows the work done in item 9375 (not, in this case, the previous item).
The second entry is a reminder about reciprocal identities in calculations involving cot, sec & cosec;
The third entry is a user-friendly statement "Let's do a typical example."
(Note that each entry is brought about by a suitable prompt e.g. the return key)

Screen T2: 1st entry: the question asked in the example which is about to be worked out;
2nd entry (n.b. brought about by a prompt as described above): "First of all ,look at the sign (-),(referring to the question), then decide in which quadrants the function (cos) has that sign"
3rd entry:
"Step 1: cos is neg in the 3rd & 4th quadrants"
4th entry:
"Step 2: θ = 180 - ? or θ = 180 + ?
Now we express the the angles in the relevant quadrants in terms of 180 - ? (2nd); 180 + ?(3rd); and 360 - ? (4th)."

5th entry: Explanation of step 2 is now replaced

by what the user must now do: "Complete step 2 by using your calculator to determine the acute angle: 1st press 0,627 , then press the cos key and read off the angle"

At this point it is to be noted that all instructions given to the user are given below a solid line near the bottom of the screen. When this 5th entry is given, the user, or pupil, is instructed as follows:

"Try this, then give the answer correct to 1 decimal place."
At the same time the 1st question mark is replaced by a prompt sign :

(The user is now expected to look up the value of θ using his calculator as explained in the instructions, and then to type in the 2nd quad value & then the 3rd quad value, where the prompt moves to, after the 1st answer is correctly given.

An incorrect answer results in the user being told so, & being instructed to press the space bar and to try again;

A correct answer is rewarded with a user friendly comment such as "that's correct, John!" when the problem is completed correctly.)

When the correct answers have been filled in, the 2nd step looks as follows:
"Step 2: θ = 180 - 51,2 or 180 + 51,2 "
On pressing the space bar, the following is added on the screen:

" Step 3: So θ = 128,8 or 231,2
Finally we simplify the angle.....,"
and on pressing the return key (a variety of keys are used as to prompt the program along, presumably to keep the user on his toes), this sentence is completed, as well as the sum:
".....and give the approximation
θ = 129 or 231 "
On pressing the prompt, the question, and the working steps remain on screen for the user to check, together with the new line
"Let's do another example."
(which of course is strong motivation for the pupil to check this first worked example!)
The instructions, which are, as usual, found below the solid line at the bottom of the screen, are as follows: "Press C to continue or B to page back"

On pressing C, the screen is wiped clean as T2 is replaced with a new page of text, T3. T3 is about example 2. In this example a reciprocal function is used, and the example is worked through as before with the user having to make responses and do calculations for the program to run. Step 3 is also speeded up, and a different degree of accuracy is asked for.
At the end of T3, on pressing C, T4 appears as follows:
"Do you want to look at the theory again before starting the problems?
Press Y for YES or N for NO"
This gives the pupil the opportunity to work through the theory again.
On pressing N, the program continues with the following:
"John, in the exercise which follows, we will be solving simple trigonometrical equations,
In each case approximate the answer as required"

After the next prompt, the following is added:
"In this exercise you must do 5 problems correctly"
The next prompt brings up screen P3, which has the scoreline as the heading:

"Problem 1 : 0 correct so far."

Under the underlined heading comes the 1st question:
"Use a calculator to find θ ([0 ; 360], if sec θ = 2,128"
as well as the following:
Step 1: sec is pos. in quadrants and
(n.b. is the prompt for the 1st answer. Once this is answered, the prompt will move to where the next answer is required).
The instructions (which are given at the time, below the solid line at the bottom of the screen) are as follows:
"Give the numbers of the relevant quadrants.
Type your answer, then press the 'Return Key'
Press ESC if you need help"
If the escape key is now pressed, the following is displayed:
"HELP: 2nd Quad: Only sin and cosec pos.
3rd Quad: Only tan and cot pos.
4th Quad: Only cos and sec pos.
Press the space bar to continue or E to End"

On completing step 1 correctly, the following is added to the screen:
"Step 2: θ = or θ = 360 - "
At the same time the instructions read:
"Use your calculator to determine the acute angle
Give the answer correct to 2 dec. places
Press ESC if you need help"

The pupil must then calculate the value of θ for which sec0 = 2,128 in the 1st quadrant, and enter the answer.
If the answer is correct, step 2 then reads:
"Step 2: θ = 61,97 or θ = 360 - "

And the user now has to enter his next calculated answer at this new prompt.

If the answer is NOT correct, the instructional section displays:
"No, John, that is not correct!
Press the 'space bar' and try again
Press ESC if you need assistance"

When the space bar is now pressed the wrong answer is removed and is replaced by the prompt. If the answer is wrong again, the instructional section displays:
"No, John, that is not correct!
Press the return key to find out the correct answer"

And instructions on how to continue are given at the same time. If the sum has not been completed, the user must continue working through the sum until it is completed, whether he has made an error or not.

Unless the norms are altered in the control (or management) program, one wrong answer in the sum means that the sum will not be recorded as being answered correctly.
On pressing the space bar, problem 1 is cleared from the screen and problem 2 appears, together with the score. In the case of a wrong answer, the heading will read:
"Problem 2: 0 correct so far"
And so the program runs until the user has got 5 correct, in which case the next item (called lesson in the program) can be called up by pressing the required prompt key, or the user ends his lesson by pressing the E key. This E, for END, key can be used to end the lesson at any time whilst using the Sergo program. The program ends with the items (or lessons) completed by the user listed on the screen. (Unfortunately if an item is not completed, no record is kept. Also, it is not possible to move to a new item, until the previous item has

been completed).

If, however, the user gets 3 sums incorrect in a row, the management progam sends the user back to an earlier lesson (in this case, back to 8490, which is work covered in std. 8) which, according to the Sergo system, needs to be revised before returning to the working lesson (9410). The user is informed of this decision by the following message on the screen:
"John you have not done well enough in this exercise.
Let us do some revision on a few exercises. I am sure that you will do better next time!
Press return to continue"

On pressing return the user is presented with exercise 8490. On completing this exercise, the next exercise in trigonometry is presented.

Appendix 4

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*****************************************
* CENTRE FOR COMPUTER AIDED INSTRUCTION *
*                                       *
*            PROGRESS REPORT            *
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XA02

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-19	5	X410	Ratio and proportion	8	5	7s	62%
90-07-20		X415	Proportionality theorems	7	5	16s	71%
		X420	Similar triangles	5	5	16s	100%
90-07-23		X425	The theorem of Pythagoras	6	5	16s	83%
90-07-24	10	X165	Calculating function values	6	5	8s	83%
90-07-25		X170	Calculating limits	6	5	3s	83%
90-07-26		X175	Derivative: Use of definition	8	5	3s	62%
		X180	Derivative: Value at a point	7	5	15s	71%
90-07-27		X190	Gradient of a curve	9	7	4s	77%
90-07-30		X195	Rules of differentiation	7	5	10s	71%
		X200	Tangents to curves	9	5	12s	55%
90-07-31		X205	Normals to curves	6	5	18s	83%
90-08-01		X215	Rate of change	8	5	10s	62%
90-08-03		X220	Increasing/decreasing functions	6	5	12s	83%
90-08-15		X225	Maximum and minimum points	6	5	12s	83%
		X230	Sketching functions	10	6	3s	* 30%
90-08-16		X235	Maxima and minima: Applications	8	6	19s	75%
	9	8260	Slope and y-intercept of a line	5	5	3s	100%
90-08-17		8265	Gradient of a straight line	8	5	8s	62%
		8270	Equation of straight line 1	6	5	16s	83%
		8275	Equation of straight line 2	5	5	7s	100%
		8295	Equation of a straight line 3	10	5	4s	50%
		8305	Parallel straight lines	5	5	7s	100%
90-08-20		8310	Perpendicular straight lines	5	5	13s	100%
		8370	Radius of a circle	5	5	4s	100%
		8375	Equation of a circle 1	6	5	5s	83%
		8380	Equation of a circle 2	5	5	5s	100%
90-08-22		X245	Distance between two points	6	5	65s	83%
		X250	The midpoint of a line segment	5	5	15s	100%
90-08-23		X255	Gradient of a straight line	10	5	27s	50%
90-08-27		X260	Parallel and perpendicular lines	7	5	14s	71%
90-08-28		X270	Equation of a straight line	4	1	139s	* 12%
90-08-29		X295	The circle, centre the origin	6	5	8s	83%
90-08-30	0	X025	Logarithmic function: Definition	5	5	14s	100%
		X030	Laws of logarithms	8	5	6s	62%
90-09-03		X035	Laws of logarithms: Applications	6	5	4s	83%
		X040	Laws of logarithms: Values	6	5	9s	83%
		X045	Test: Logarithms 1	20	17	16m	85%

Number of exercises: 37 Average for exercises..: 76%
Number of tests....: 1 Average for tests.....: 85%

```
*****************************************
* CENTRE FOR COMPUTER AIDED INSTRUCTION *
*                                       *
*            PROGRESS REPORT            *
*****************************************
```

XA03

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-17	0	9010	Quadratic eqtns: Substitution	5	5	22s	100%
		9015	Test: Quadratic equations 1	10	7	18m	70%
90-07-18	5	X410	Ratio and proportion	8	7	11s	87%
90-07-20		X415	Proportionality theorems	8	5	10s	62%
90-07-23		X420	Similar triangles	10	6	10s	60%
		X425	The theorem of Pythagoras	5	5	8s	100%
90-07-25	8	8460	Trigonometric ratios 1	5	5	12s	100%
		8465	Trigonometric ratios 2	6	5	6s	83%
		8470	Trigonometric functions	6	6	8s	100%
90-07-26		8475	Trigonometric expressions	8	5	9s	62%
90-07-27		8485	Right-angled triangles 1	8	5	12s	62%
		8490	Simple trigonometric equations	7	5	7s	71%
90-07-30		8495	Right-angled triangles 2	6	5	18s	83%
		8500	Angles of elevation & depression	6	5	23s	83%
		9360	Trigonometric ratios	7	5	7s	71%
		9365	Trigonometric identities 1	7	5	2s	71%
		9370	Trigonometric identities 2	5	5	12s	100%
90-08-01		9375	Calculations with the calculator	6	5	5s	83%
		9385	Reduction formulae	7	5	3s	71%
		9390	Co-ratios	3	0	57s	* 0%
		9360	Trigonometric ratios	6	5	6s	83%
		9365	Trigonometric identities 1	6	5	2s	83%
90-08-06		9390	Co-ratios	6	5	9s	83%
		9395	Angles in other quadrants	3	0	28s	* 0%
		9385	Reduction formulae	5	5	4s	100%
90-08-07		9395	Angles in other quadrants	5	5	8s	100%
		9410	Trigonometric equations 1	7	5	10s	71%
		9415	Trigonometric equations 2	5	5	25s	100%
		9420	Special angles	9	5	3s	55%
		9425	Special equations	8	5	7s	62%
90-08-08		9435	Graphs of trig functions	7	5	7s	71%
		9440	The Area rule	9	7	6s	77%
90-08-09		9445	The Sine rule 1	5	5	57s	100%
90-08-10		X370	Graphs of trig functions 1	7	5	5s	71%
		X375	Graphs of trig functions 2	6	5	12s	83%
90-08-13		9460	The Cosine rule 1	6	5	13s	83%
		9465	The Cosine rule 2	5	5	20s	100%
90-08-16	10	X165	Calculating function values	6	5	28s	83%
		X170	Calculating limits	5	5	2s	100%
90-08-22		X175	Derivative: Use of definition	7	5	4s	71%
		X180	Derivative: Value at a point	6	5	7s	83%
		X190	Gradient of a curve	5	5	4s	100%
90-08-23		X195	Rules of differentiation	10	5	4s	50%
		X200	Tangents to curves	7	5	6s	71%
90-08-24		X215	Rate of change	7	5	5s	71%
90-08-27		X220	Increasing/decreasing functions	6	5	2s	83%
		X225	Maximum and minimum points	8	6	7s	75%
		X230	Sketching functions	6	5	7s	83%
90-08-29		X235	Maxima and minima: Applications	10	4	8s	* 20%

XA03 Progress Report cont'd.

		X220	Increasing/decreasing functions	5	5	5s	100%
	4	9160	The remainder theorem	7	5	7s	71%
90-08-30		9165	The factor theorem	5	5	11s	100%
		9170	Factor theorem: Factorisation	7	5	28s	71%
90-08-31		9175	Factor theorem: Applications	8	5	4s	62%
		9185	Surds	5	5	4s	100%
		9190	Surds: Comparing expressions	6	5	7s	83%
		9195	Surds: Multiply and divide	5	5	4s	100%
		9200	Surds: Add and subtract	6	5	11s	83%
		9205	Surds: Rationalisation	5	5	12s	100%
90-09-04		9215	Laws of exponents	7	5	4s	71%
		9220	Eqtns with rational exponents 1	7	5	5s	71%
		9225	Eqtns with rational exponents 2	5	5	18s	100%
		9230	Exponential equations 1	7	5	7s	71%

Number of exercises: 62 Average for exercises..: 78%
Number of tests....: 1 Average for tests.....: 70%

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*****************************************
* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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XA04

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-17	0	9010	Quadratic eqtns: Substitution	6	5	21s	83%
		9015	Test: Quadratic equations 1	10	6	15m	60%
90-07-18	10	X165	Calculating function values	6	5	21s	83%
		X170	Calculating limits	9	5	1s	55%
90-07-19		X175	Derivative: Use of definition	9	5	9s	55%
		X180	Derivative: Value at a point	6	5	5s	83%
90-07-23		X190	Gradient of a curve	4	1	8s	* 12%
		X170	Calculating limits	10	5	2s	50%
		X175	Derivative: Use of definition	8	5	9s	62%
		X180	Derivative: Value at a point	5	5	15s	100%
90-07-24		X190	Gradient of a curve	6	5	2s	83%
		X195	Rules of differentiation	8	5	2s	62%
		X200	Tangents to curves	7	5	9s	71%
		X205	Normals to curves	6	5	14s	83%
90-07-25		X215	Rate of change	10	5	5s	50%
		X220	Increasing/decreasing functions	8	5	2s	62%
90-07-26		X225	Maximum and minimum points	4	0	23s	* 0%
		X220	Increasing/decreasing functions	5	5	3s	100%
		X225	Maximum and minimum points	6	2	10s	* 16%
90-07-31		X220	Increasing/decreasing functions	5	5	3s	100%
		X225	Maximum and minimum points	10	5	7s	50%
90-08-01		X230	Sketching functions	7	6	5s	85%
90-08-06	9	8260	Slope and y-intercept of a line	6	5	2s	83%
		8265	Gradient of a straight line	5	5	6s	100%
		8270	Equation of straight line 1	6	6	7s	100%
		8275	Equation of straight line 2	5	5	5s	100%
		8295	Equation of a straight line 3	7	5	4s	71%
		8305	Parallel straight lines	5	5	6s	100%
90-08-07		8310	Perpendicular straight lines	5	5	6s	100%
		8370	Radius of a circle	7	6	1s	85%
		8375	Equation of a circle 1	5	5	3s	100%
		8380	Equation of a circle 2	6	5	3s	83%
		8385	Points on a circle	6	5	3s	83%
90-08-08		X245	Distance between two points	9	5	6s	55%
		X250	The midpoint of a line segment	6	5	9s	83%
90-08-09		X255	Gradient of a straight line	8	5	11s	62%
		X260	Parallel and perpendicular lines	3	0	40s	* 0%
90-08-13		X260	Parallel and perpendicular lines	10	5	19s	50%
90-08-14		X270	Equation of a straight line	7	3	63s	* 21%
90-08-15		X275	Intercepts on axes	9	5	5s	55%
		X280	Division of a line segment	3	0	91s	* 0%
90-08-16		X250	The midpoint of a line segment	5	5	8s	100%
90-08-20		X295	The circle, centre the origin	8	5	1s	62%
90-08-21	4	9160	The remainder theorem	5	5	6s	100%
		9165	The factor theorem	5	5	15s	100%

XA04 Progress Report con'd.

		9170	Factor theorem: Factorisation	7	5	32s	71%
90-08-22		9175	Factor theorem: Applications	8	5	4s	62%
		9185	Surds	5	5	4s	100%
		9190	Surds: Comparing expressions	5	5	10s	100%
		9195	Surds: Multiply and divide	6	5	3s	83%
		9200	Surds: Add and subtract	5	5	10s	100%
90-08-23		9205	Surds: Rationalisation	6	5	2s	83%
		9215	Laws of exponents	9	5	4s	55%
		9220	Eqtns with rational exponents 1	8	5	3s	62%
		9225	Eqtns with rational exponents 2	6	5	4s	83%
90-08-27		9230	Exponential equations 1	6	5	6s	83%
		9235	Exponential equations 2	7	5	8s	71%
		X025	Logarithmic function: Definition	5	5	3s	100%
		X030	Laws of logarithms	3	0	14s	* 0%
		X025	Logarithmic function: Definition	6	5	3s	83%
90-08-28		X030	Laws of logarithms	4	1	12s	* 12%
		X025	Logarithmic function: Definition	5	5	4s	100%
		X030	Laws of logarithms	8	5	6s	62%
		X035	Laws of logarithms: Applications	4	1	19s	* 12%
		X025	Logarithmic function: Definition	7	6	5s	85%
		X030	Laws of logarithms	6	5	2s	83%
		X035	Laws of logarithms: Applications	6	5	6s	83%
		X040	Laws of logarithms: Values	8	5	3s	62%
90-08-29	0	X045	Test: Logarithms 1	20	14	15m	70%
		X055	Logarithmic equations 1	5	5	4s	100%
90-09-04	5	9275	Midpoint chord & centre circle	6	5	40s	83%
		9280	Perpendicular bisector of chord	12	7	2s	58%
90-09-05		9285	Angles at centre and at circle	7	5	4s	71%
		9290	Angles in a semicircle	8	6	36s	75%
		9295	Angles in the same segment	10	6	3s	60%
		9305	Cyclic quad: Opposite angles	8	7	2s	87%
		9310	Exterior angle of a cyclic quad	10	5	7s	50%

Number of exercises: 75 Average for exercises..: 70%
Number of tests....: 2 Average for tests.....: 65%

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*****************************************
* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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XA05

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-26	0	X410	Ratio and proportion	5	5	18s	100%
90-07-27		X415	Proportionality theorems	6	5	32s	83%
		X420	Similar triangles	12	6	12s	50%
90-07-30		X425	The theorem of Pythagoras	6	5	7s	83%
		X430	Test: Geometry	10	1	18m	* 10%
		X430	Test: Geometry	10	7	27m	70%
90-08-01	8	8460	Trigonometric ratios 1	6	5	8s	83%
		8465	Trigonometric ratios 2	5	5	18s	100%
		8470	Trigonometric functions	6	5	15s	83%
		8475	Trigonometric expressions	6	5	13s	83%
90-08-02		8485	Right-angled triangles 1	9	5	18s	55%
90-08-06		8490	Simple trigonometric equations	7	5	7s	71%
		8495	Right-angled triangles 2	6	1	44s	* 8%
90-08-07		9360	Trigonometric ratios	3	0	60s	* 0%
		8460	Trigonometric ratios 1	6	5	7s	83%
90-08-08		8465	Trigonometric ratios 2	10	5	10s	50%
		8470	Trigonometric functions	6	5	5s	83%
		8475	Trigonometric expressions	6	5	11s	83%
		8485	Right-angled triangles 1	5	0	71s	* 0%
		8460	Trigonometric ratios 1	5	5	8s	100%
		8465	Trigonometric ratios 2	9	5	9s	55%
		8470	Trigonometric functions	7	5	3s	71%
		8475	Trigonometric expressions	7	5	8s	71%
90-08-09		8490	Simple trigonometric equations	7	5	3s	71%
		8495	Right-angled triangles 2	6	5	23s	83%
90-08-10		9360	Trigonometric ratios	5	5	13s	100%
		9365	Trigonometric identities 1	6	5	6s	83%
		9370	Trigonometric identities 2	4	1	22s	* 12%
		9360	Trigonometric ratios	6	5	28s	83%
		9410	Trigonometric equations 1	6	5	11s	83%
90-08-15		9420	Special angles	10	5	5s	50%
		9425	Special equations	7	5	17s	71%
		9435	Graphs of trig functions	7	5	5s	71%
90-08-16		9440	The Area rule	5	5	14s	100%
90-08-27	10	X165	Calculating function values	7	5	19s	71%
		X170	Calculating limits	3	0	37s	* 0%
		X165	Calculating function values	8	5	16s	62%
		X170	Calculating limits	5	5	2s	100%
90-08-28		X175	Derivative: Use of definition	8	5	2s	62%
		X180	Derivative: Value at a point	6	5	20s	83%
		X190	Gradient of a curve	6	5	6s	83%
		X195	Rules of differentiation	8	5	2s	62%
		X200	Tangents to curves	8	5	6s	62%
		X205	Normals to curves	9	5	10s	55%
		X215	Rate of change	12	7	1s	58%
		X220	Increasing/decreasing functions	5	5	6s	100%
90-08-30		X225	Maximum and minimum points	11	5	14s	45%
90-09-04		X230	Sketching functions	8	6	4s	75%
	0	X030	Laws of logarithms	8	6	3s	75%

XA05 Progress Report con'd.

		X035	Laws of logarithms: Applications	6	5	3s	83%
		X040	Laws of logarithms: Values	6	5	5s	83%
		X045	Test: Logarithms 1	20	13	14m	65%
		X050	Logarithms: Changing the base	5	5	23s	100%
90-09-05		X055	Logarithmic equations 1	6	5	3s	83%
		9200	Surds: Add and subtract	7	6	6s	85%
		9210	Test: Surds	20	11	28m	* 55%
90-09-06	5	9275	Midpoint chord & centre circle	8	7	4s	87%

Number of exercises: 53 Average for exercises..: 70%
Number of tests....: 4 Average for tests.....: 50%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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9A02

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-19	8	8460	Trigonometric ratios 1	8	5	6s	62%
90-07-25		8465	Trigonometric ratios 2	5	5	22s	100%
		8470	Trigonometric functions	3	0	22s	* 0%
		8470	Trigonometric functions	6	5	4s	83%
90-08-06		8475	Trigonometric expressions	11	3	3s	* 13%
90-08-09		8485	Right-angled triangles 1	8	4	46s	* 25%
		8490	Simple trigonometric equations	6	5	10s	83%
		8495	Right-angled triangles 2	3	0	225s	* 0%
90-08-20		9435	Graphs of trig functions	3	0	47s	* 0%
		9440	The Area rule	8	5	13s	62%
90-08-22		9445	The Sine rule 1	9	5	36s	55%
90-08-23		9460	The Cosine rule 1	7	5	16s	71%
90-08-27	0	8505	Test: Trigonometry 2	10	3	44m	* 30%
90-08-30		9380	Test: Basic trigonometry	10	4	12m	* 40%
		9405	Test: Trigonometric ratios	10	5	16m	* 50%
90-09-03		9185	Surds	8	5	3s	62%
		9190	Surds: Comparing expressions	9	5	10s	55%
90-09-06		9195	Surds: Multiply and divide	7	5	8s	71%
		9200	Surds: Add and subtract	7	5	17s	71%

Number of exercises: 16 Average for exercises..: 50%
Number of tests....: 3 Average for tests.....: 40%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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9A03

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-18	8	8460	Trigonometric ratios 1	3	0	86s	* 0%
90-07-20		8460	Trigonometric ratios 1	7	5	14s	71%
		8465	Trigonometric ratios 2	3	0	312s	* 0%
		8460	Trigonometric ratios 1	6	5	8s	83%
90-07-23		8465	Trigonometric ratios 2	11	5	8s	45%
90-08-01		8470	Trigonometric functions	6	5	5s	83%
90-08-08		8475	Trigonometric expressions	5	5	34s	100%
90-08-10		9435	Graphs of trig functions	5	5	26s	100%
90-08-15		9440	The Area rule	7	5	11s	71%
90-08-17		9445	The Sine rule 1	3	0	77s	* 0%
90-08-24		9445	The Sine rule 1	5	5	47s	100%
90-09-04	0	9185	Surds	5	5	4s	100%
		9190	Surds: Comparing expressions	5	5	19s	100%
90-09-05		9195	Surds: Multiply and divide	10	6	2s	60%
		9200	Surds: Add and subtract	9	5	12s	55%

Number of exercises: 15 Average for exercises..: 64%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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9A04

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-17	0	8015	Products: Quadratic expressions	7	5	15s	71%
		8020	Test: Linear expressions	10	6	19m	60%
90-07-19		8030	Common factors 2	6	5	5s	83%
		8040	Test: Factorisation 1	10	8	10m	80%
	8	8460	Trigonometric ratios 1	9	5	7s	55%
90-07-24		8465	Trigonometric ratios 2	6	5	15s	83%
		8470	Trigonometric functions	10	5	2s	50%
		8475	Trigonometric expressions	4	1	5s	* 12%
90-07-27		8460	Trigonometric ratios 1	7	5	8s	71%
		8465	Trigonometric ratios 2	6	5	5s	83%
		8470	Trigonometric functions	7	5	7s	71%
		8475	Trigonometric expressions	6	5	10s	83%
90-07-31		8485	Right-angled triangles 1	9	8	16s	88%
90-08-07		8490	Simple trigonometric equations	7	6	7s	85%
90-08-09		8495	Right-angled triangles 2	4	1	89s	* 12%
		9360	Trigonometric ratios	7	5	18s	71%
90-08-14		9365	Trigonometric identities 1	7	5	6s	71%
		9375	Calculations with the calculator	6	5	5s	83%
		9385	Reduction formulae	6	5	3s	83%
90-08-16		9390	Co-ratios	4	1	54s	* 12%
90-08-21		9435	Graphs of trig functions	10	5	3s	50%
		9440	The Area rule	5	5	5s	100%
90-08-23		9445	The Sine rule 1	5	5	8s	100%
		9450	The Sine rule 2	7	5	35s	71%
90-08-28		9460	The Cosine rule 1	5	5	10s	100%
		9465	The Cosine rule 2	7	5	8s	71%
90-08-29	0	9185	Surds	5	5	4s	100%
90-08-31		9190	Surds: Comparing expressions	6	5	8s	83%
		9195	Surds: Multiply and divide	5	5	4s	100%
		9200	Surds: Add and subtract	6	5	13s	83%

Number of exercises: 28 Average for exercises..: 72%
Number of tests....: 2 Average for tests.....: 70%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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9A05

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-17	0	8015	Products: Quadratic expressions	7	5	15s	71%
		8020	Test: Linear expressions	10	6	19m	60%
90-07-19		8030	Common factors 2	6	5	5s	83%
		8040	Test: Factorisation 1	10	8	10m	80%
	8	8460	Trigonometric ratios 1	9	5	7s	55%
90-07-24		8465	Trigonometric ratios 2	6	5	15s	83%
		8470	Trigonometric functions	10	5	2s	50%
		8475	Trigonometric expressions	4	1	5s	* 12%
90-07-27		8460	Trigonometric ratios 1	7	5	8s	71%
		8465	Trigonometric ratios 2	6	5	5s	83%
		8470	Trigonometric functions	7	5	7s	71%
		8475	Trigonometric expressions	6	5	10s	83%
90-07-31		8485	Right-angled triangles 1	9	8	16s	88%
90-08-07		8490	Simple trigonometric equations	7	6	7s	85%
90-08-09		8495	Right-angled triangles 2	4	1	89s	* 12%
		9360	Trigonometric ratios	7	5	18s	71%
90-08-14		9365	Trigonometric identities 1	7	5	6s	71%
		9375	Calculations with the calculator	6	5	5s	83%
		9385	Reduction formulae	6	5	3s	83%
90-08-16		9390	Co-ratios	4	1	54s	* 12%
90-08-21		9435	Graphs of trig functions	10	5	3s	50%
		9440	The Area rule	5	5	5s	100%
90-08-23		9445	The Sine rule 1	5	5	8s	100%
		9450	The Sine rule 2	7	5	35s	71%
90-08-28		9460	The Cosine rule 1	5	5	10s	100%
		9465	The Cosine rule 2	7	5	8s	71%
90-08-29	0	9185	Surds	5	5	4s	100%
90-08-31		9190	Surds: Comparing expressions	6	5	8s	83%
		9195	Surds: Multiply and divide	5	5	4s	100%
		9200	Surds: Add and subtract	6	5	13s	83%

Number of exercises: 28 Average for exercises..: 72%
Number of tests....: 2 Average for tests.....: 70%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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8A02
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DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-17	0	8000	Products: Linear expressions 1	6	5	19s	83%
90-07-19		8260	Slope and y-intercept of a line	6	5	3s	83%
90-07-24		8265	Gradient of a straight line	6	5	12s	83%
		8270	Equation of straight line 1	8	5	8s	62%
		8275	Equation of straight line 2	5	5	8s	100%
		8280	Test: Straight lines 1	10	9	11m	90%
		8285	Points on a straight line 1	5	5	8s	100%
90-07-31		8290	Points on a straight line 2	5	5	9s	100%
		8295	Equation of a straight line 3	12	5	3s	41%
		8300	Test: Straight lines 2	10	8	6m	80%
		8305	Parallel straight lines	5	5	14s	100%
	1	8020	Test: Linear expressions	10	7	22m	70%
90-08-07		8030	Common factors 2	7	5	5s	71%
		8040	Test: Factorisation 1	10	8	13m	80%
		8045	Difference of squares	7	5	4s	71%
90-08-14		8055	Factorising trinomials 2	6	5	13s	83%
		8065	Test: Factorisation 2	10	9	14m	90%
		8085	Algebraic fractions: Simplify 2	5	5	18s	100%
90-08-16		8090	Test: Algebraic fractions 1	20	13	16m	65%
90-08-21		8115	Fractions: Multiply and divide	9	5	10s	55%
		8125	Alg fractions: Add/subtract 3	6	5	20s	83%
		8130	Test: Algebraic fractions 3	10	8	21m	80%
90-08-23		8145	Linear equations 3	7	5	17s	71%
		8150	Test: Linear equations	10	8	21m	80%
90-08-24		8155	Quadratic equations	9	5	7s	55%
		8165	Test: Quadratic equations	10	7	17m	70%
90-09-04	0	8460	Trigonometric ratios 1	9	5	6s	55%
		8465	Trigonometric ratios 2	5	5	16s	100%
		8470	Trigonometric functions	3	0	15s	* 0%

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Number of exercises:  20   Average for exercises..:  74%
Number of tests....:   9   Average for tests......:  78%
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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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BA04

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-20	0	8260	Slope and y-intercept of a line	7	5	5s	71%
		8265	Gradient of a straight line	5	0	35s	* 0%
90-07-26		8265	Gradient of a straight line	11	5	7s	45%
90-07-27		8270	Equation of straight line 1	3	0	93s	* 0%
		8260	Slope and y-intercept of a line	6	5	2s	83%
		8265	Gradient of a straight line	8	5	5s	62%
90-08-03		8270	Equation of straight line 1	8	5	8s	62%
		8275	Equation of straight line 2	9	5	4s	55%
		8280	Test: Straight lines 1	10	7	8m	70%
90-08-04		8285	Points on a straight line 1	7	5	3s	71%
		8290	Points on a straight line 2	9	6	5s	66%
90-08-07		8295	Equation of a straight line 3	3	0	46s	* 0%
		8295	Equation of a straight line 3	5	5	9s	100%
		8300	Test: Straight lines 2	10	5	7m	* 50%
		8285	Points on a straight line 1	6	5	3s	83%
90-08-10		8290	Points on a straight line 2	6	5	6s	83%
		8295	Equation of a straight line 3	6	5	5s	83%
		8300	Test: Straight lines 2	10	8	4m	80%
		8305	Parallel straight lines	5	5	6s	100%
90-08-14		8310	Perpendicular straight lines	10	7	14s	70%
		8315	Test: Straight lines 3	10	4	9m	* 40%
		8315	Test: Straight lines 3	10	7	8m	70%
90-08-17		8320	Two linear eqtns: Graphic soln	5	5	4s	100%
		8325	Two linear eqtns: Algebraic	3	0	26s	* 0%
90-08-28	1	8015	Products: Quadratic expressions	6	5	21s	83%
		8020	Test: Linear expressions	10	7	22m	70%
90-08-29	0	8460	Trigonometric ratios 1	5	5	11s	100%
		8465	Trigonometric ratios 2	7	5	6s	71%
90-08-30		8470	Trigonometric functions	8	5	2s	62%
		8475	Trigonometric expressions	3	0	113s	* 0%
90-08-31		8460	Trigonometric ratios 1	6	5	10s	83%
		8465	Trigonometric ratios 2	5	5	13s	100%
		8470	Trigonometric functions	7	5	3s	71%
90-09-04		8475	Trigonometric expressions	3	0	66s	* 0%

Number of exercises: 28 Average for exercises..: 60%
Number of tests....: 6 Average for tests.....: 63%

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*****************************************
* CENTRE FOR COMPUTER AIDED INSTRUCTION *
*                                       *
*            PROGRESS REPORT            *
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9B01

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-28	8	8460	Trigonometric ratios 1	5	5	13s	100%
		8465	Trigonometric ratios 2	8	5	4s	62%
		8470	Trigonometric functions	6	5	11s	83%
90-07-30		8475	Trigonometric expressions	7	5	12s	71%
90-07-31		8485	Right-angled triangles 1	4	0	122s	* 0%
		8460	Trigonometric ratios 1	7	5	4s	71%
		8465	Trigonometric ratios 2	3	0	66s	* 0%
90-08-05		8490	Simple trigonometric equations	5	5	6s	100%
90-08-07		9365	Trigonometric identities 1	8	5	4s	62%
		9375	Calculations with the calculator	11	5	5s	45%
90-08-14		9385	Reduction formulae	7	6	2s	85%
		9390	Co-ratios	3	0	88s	* 0%
90-08-21		9395	Angles in other quadrants	3	0	78s	* 0%
		9385	Reduction formulae	5	5	6s	100%
		9395	Angles in other quadrants	6	5	6s	83%
		9400	Function values of (360 + x)	7	6	10s	85%
90-08-25		9420	Special angles	4	0	95s	* 0%
		9420	Special angles	6	5	26s	83%
90-08-27		9425	Special equations	11	5	18s	45%
	0	9405	Test: Trigonometric ratios	10	7	15m	70%

Number of exercises: 19 Average for exercises..: 56%
Number of tests....: 1 Average for tests.....: 70%

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*****************************************
* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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9B04

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-31	8	8460	Trigonometric ratios 1	5	5	8s	100%
		8465	Trigonometric ratios 2	5	5	20s	100%
		8470	Trigonometric functions	5	5	4s	100%
		8475	Trigonometric expressions	6	5	7s	83%
90-08-02		8485	Right-angled triangles 1	6	5	19s	83%
		8490	Simple trigonometric equations	6	5	7s	83%
		8495	Right-angled triangles 2	9	5	15s	55%
90-08-07		9360	Trigonometric ratios	9	5	8s	55%
90-08-09		9365	Trigonometric identities 1	9	5	3s	55%
		9385	Reduction formulae	7	5	2s	71%
90-08-14		9395	Angles in other quadrants	8	5	5s	62%
		9400	Function values of (360 + x)	6	5	7s	83%
		9410	Trigonometric equations 1	9	5	7s	55%
90-08-16		9420	Special angles	3	0	149s	* 0%
	0	8480	Test: Trigonometry 1	10	8	8m	80%
90-08-28		9420	Special angles	10	5	5s	50%
		9380	Test: Basic trigonometry	10	5	10m	* 50%
		9405	Test: Trigonometric ratios	10	9	11m	90%

Number of exercises: 15 Average for exercises..: 69%
Number of tests....: 3 Average for tests.....: 73%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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9B05

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-30	8	8460	Trigonometric ratios 1	6	5	9s	83%
		8465	Trigonometric ratios 2	5	5	9s	100%
		8470	Trigonometric functions	7	6	3s	85%
		8475	Trigonometric expressions	10	6	5s	60%
90-08-02		8485	Right-angled triangles 1	3	0	214s	* 0%
		8485	Right-angled triangles 1	6	5	25s	83%
90-08-06		8490	Simple trigonometric equations	5	5	9s	100%
90-08-09		9360	Trigonometric ratios	5	5	8s	100%
		9365	Trigonometric identities 1	7	5	5s	71%
		9370	Trigonometric identities 2	3	0	16s	* 0%
		9375	Calculations with the calculator	6	5	7s	83%
90-08-13		9385	Reduction formulae	6	5	6s	83%
		9410	Trigonometric equations 1	7	5	16s	71%
90-08-16		9415	Trigonometric equations 2	4	0	62s	* 0%
		9410	Trigonometric equations 1	5	5	23s	100%
90-08-20	0	8480	Test: Trigonometry 1	10	6	11m	60%
		8490	Simple trigonometric equations	5	5	7s	100%
		8505	Test: Trigonometry 2	10	6	21m	60%
90-08-23		9380	Test: Basic trigonometry	10	6	12m	60%
		9405	Test: Trigonometric ratios	10	2	15m	* 20%
		9385	Reduction formulae	5	5	6s	100%
		9390	Co-ratios	7	5	13s	71%
		9395	Angles in other quadrants	6	5	4s	83%
		9400	Function values of (360 + x)	7	5	5s	71%
		9405	Test: Trigonometric ratios	10	7	7m	70%
90-08-27		9420	Special angles	4	0	51s	* 0%
		9420	Special angles	9	5	40s	55%
		9425	Special equations	7	5	8s	71%
		9430	Test: Trigonometric equations	10	3	16m	* 30%

Number of exercises: 23 Average for exercises..: 68%
Number of tests....: 6 Average for tests.....: 50%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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9B02

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-31	8	8460	Trigonometric ratios 1	6	5	8s	83%
		8465	Trigonometric ratios 2	5	5	13s	100%
		8470	Trigonometric functions	5	5	4s	100%
		8475	Trigonometric expressions	6	5	13s	83%
90-08-02		8485	Right-angled triangles 1	5	5	24s	100%
		8490	Simple trigonometric equations	6	5	9s	83%
90-08-07		8495	Right-angled triangles 2	9	5	10s	55%
90-08-11		9360	Trigonometric ratios	7	5	18s	71%
		9365	Trigonometric identities 1	6	5	4s	83%
		9375	Calculations with the calculator	5	5	10s	100%
90-08-14		9385	Reduction formulae	5	5	16s	100%
		9390	Co-ratios	11	5	29s	45%
90-08-18		9395	Angles in other quadrants	7	5	6s	71%
		9400	Function values of (360 + x)	6	5	5s	83%
		9410	Trigonometric equations 1	6	5	14s	83%
90-08-25		9420	Special angles	6	5	8s	83%
		9425	Special equations	7	5	6s	71%
	0	8480	Test: Trigonometry 1	10	6	9m	60%
		8505	Test: Trigonometry 2	10	7	23m	70%
90-08-28		9380	Test: Basic trigonometry	10	9	6m	90%
		9405	Test: Trigonometric ratios	10	9	8m	90%
		9430	Test: Trigonometric equations	10	6	27m	60%

Number of exercises: 17 Average for exercises..: 82%
Number of tests....: 5 Average for tests.....: 74%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*             PROGRESS REPORT           *
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8B02

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-07-27	0	8170	Intervals on real number line	6	5	25s	83%
		8375	Equation of a circle 1	5	5	5s	100%
		8380	Equation of a circle 2	5	5	7s	100%
90-07-31		8395	Points on a hyperbola	5	5	9s	100%
		8400	Hyperbola through a given point	5	5	6s	100%
90-08-03		8340	Points on a parabola 1	5	5	17s	100%
		8345	Points on a parabola 2	5	5	36s	100%
		8350	Parabola: Intercepts on axes	5	5	22s	100%
90-08-07		8355	Properties of a parabola	8	5	16s	62%
		8360	Equation of a parabola	7	5	22s	71%
90-08-10		8365	Test: Parabolas	10	7	10m	70%
90-08-21		8460	Trigonometric ratios 1	5	5	30s	100%
90-08-28		8465	Trigonometric ratios 2	5	5	29s	100%
		8470	Trigonometric functions	7	5	3s	71%
90-09-01		8480	Test: Trigonometry 1	10	6	19m	60%
		8025	Common factors 1	6	5	6s	83%
		8030	Common factors 2	7	5	4s	71%
90-09-04		8160	Formulae: Changing the subject	5	5	6s	100%
		8165	Test: Quadratic equations	10	7	38m	70%

Number of exercises: 16 Average for exercises..: 90%
Number of tests....: 3 Average for tests.....: 66%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*            PROGRESS REPORT            *
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8B03

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-08-03	0	8340	Points on a parabola 1	8	5	11s	62%
90-08-10		8405	Mixed problems on graphs	10	6	13s	60%
90-08-17		8465	Trigonometric ratios 2	14	5	4s	35%
90-08-22		8470	Trigonometric functions	9	5	5s	55%
		8475	Trigonometric expressions	7	5	9s	71%
90-08-24		8480	Test: Trigonometry 1	10	8	11m	80%
		8485	Right-angled triangles 1	6	5	18s	83%
		8490	Simple trigonometric equations	5	5	9s	100%
90-08-29	1	8020	Test: Linear expressions	10	7	15m	70%
90-08-31		8030	Common factors 2	7	5	5s	71%
		8040	Test: Factorisation 1	10	8	13m	80%
		8045	Difference of squares	8	6	2s	75%
90-09-05		8055	Factorising trinomials 2	8	5	15s	62%
		8065	Test: Factorisation 2	10	6	7m	60%
		8085	Algebraic fractions: Simplify 2	7	5	18s	71%

Number of exercises: 11 Average for exercises..: 67%
Number of tests....: 4 Average for tests.....: 72%

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* CENTRE FOR COMPUTER AIDED INSTRUCTION *
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*             PROGRESS REPORT           *
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XA06

DATE	PATH	IND	DESCRIPTION	DONE	CORRECT	TIME	GRAD
90-08-07	8	X320	Trigonometric identities 1	12	8	3s	66%
90-08-08		X325	Trigonometric equations	15	12	4s	80%
		X330	Compound angles 1	8	5	5s	62%
		X335	Compound angles 2	5	5	5s	100%
		X345	Compound angles 3	5	5	9s	100%
90-08-10		X350	Formulae for tan(A + B)/(A - B)	7	7	6s	100%
90-08-15		X355	Compound angles 4	9	6	13s	66%
		X360	Trigonometric identities 2	7	5	6s	71%
		X370	Graphs of trig functions 1	5	5	9s	100%
		X375	Graphs of trig functions 2	5	5	12s	100%
90-08-16		X380	Graphs of trig functions 3	5	5	5s	100%
		X385	Graphs of trig functions 4	6	5	4s	83%
		X395	More trigonometric equations	8	6	8s	75%
90-08-22	0	X000	Exponential functions: Graphs 1	5	5	6s	100%
		X005	Exponential functions: Graphs 2	6	5	5s	83%
		X010	Logarithmic functions: Graphs 1	5	5	8s	100%
		X015	Logarithmic functions: Graphs 2	5	5	7s	100%
		X020	Test: Graphs exp and log funct	10	10	4m	100%
		X025	Logarithmic function: Definition	5	5	5s	100%
90-09-05		X065	Logarithmic inequalities 1	6	5	15s	83%
		X070	Logarithmic inequalities 2	5	5	10s	100%
		X075	Test: Logarithms 2	10	10	18m	100%
90-09-06		9125	Absolute values: Equations	7	5	7s	71%

Number of exercises: 21 Average for exercises..: 87%
Number of tests....: 2 Average for tests.....: 100%

APPENDIX 5

STRUCTURED INTERVIEW QUESTIONNAIRE

SERGO RESEARCH QUESTIONNAIRE NO 2

1st Name _____ School _____

Thank you for taking time to answer the following questions. Your answers will make a valuable contribution to the teaching of mathematics to pupils such as yourself.

Where answer space begins with an * please use the following 5 point scale: 1 - Excellent, totally agree, etc; 2 - Very good; 3 - Good; 4 - Neutral; 5 - Poor, disagree etc.

At the end of each question there will be a line which begins with an # sign. This is for you to make any additional comments that you may wish to make.

1. In discussion with Mr Elgie you said that you felt the SERGO had improved your maths. Now that you have received your marks, how much do you think it really helped? *_____

#_____

2. Did you talk to your schoolfriends about SERGO ? Yes/No

#_____

3. Did you talk to your maths teacher about SERGO ? Yes/No

#_____

4. If your school were to purchase SERGO, and operate it on a network system consisting of between 4 and 24 terminals, how effective do you think this system would be for you personally if you worked independently with:

4.1 No teacher present, *_____

4.2 A computer-trained operator present, *_____

4.3 A non-maths teacher present, *_____

4.4 A maths teacher present, *_____

4.5 An expert maths teacher present * _____

#_____

5. What is the maximum number of pupils that you think that one supervising teacher could service:

5.1 Optimally _____

5.2 Adequately _____

#_____

6.1 Do you think that your school should spend R12 000 on such maths computer software, as well as R18 000 on a 16 terminal system (considered sufficient for a maximum of 32 pupils), bearing in mind that these computers can be used for other subjects and activities ? *_____

6.2 If such a system were installed at your school, would you make use of it ?

* For Maths: _____, For Science: _____, For Biology: _____

6.3 How many of your class might make use of such a system for extra maths ? _____

6.4 How many 45min. lessons per week in Maths would you opt for ? _____

6.5 What would your needs from such a system be:

6.5.1 Revision of current classwork ? *_____

6.5.2 Revision of work covered earlier in the year ? *_____

6.5.3 Teaching of work missed through absenteeism ? *_____

6.5.4 Enrichment of current classwork ? *_____

6.5.5 Teaching yourself new work ? *_____

#_____

7 Do you miss your SERGO lessons ? Yes/No

Thank you for completing this questionnaire, you are a star !

APPENDIX 6

ATTITUDE QUESTIONNAIRE

Name:..... Std..... School.....

Indicate how you feel when you read the following words or sentences by putting an X in the space below the heading that is nearest to how you would feel.

		UNHAPPY	INDIFFERENT	HAPPY	VERY HAPPY
1.	I eat ice cream	___	___	___	___
2.	I wake up in the morning ..	___	___	___	___
3.	I have a lie in	___	___	___	___
4.	I work on my own	___	___	___	___
5.	I am involved in outdoor activities	___	___	___	___
6.	I am alone in my activities	___	___	___	___
7.	I get up early	___	___	___	___
8.	I am involved indoors	___	___	___	___
9.	I am with my best friends..	___	___	___	___
10.	I am with friends	___	___	___	___
11.	I start my homework	___	___	___	___
12.	I have finished my homework	___	___	___	___
13.	I listen to music on my own	___	___	___	___
14.	I quietly complete my home-work	___	___	___	___
15.	I talk to friends about my schoolwork	___	___	___	___
16.	Friends spend the whole day with me	___	___	___	___
17.	SERGO	___	___	___	___
18.	I watch TV	___	___	___	___
19.	I read a book	___	___	___	___
20.	I write a letter	___	___	___	___
21.	I draw a picture	___	___	___	___

PAGE 2

		UNHAPPY	INDIFFERENT	HAPPY	VERY HAPPY
22.	I talk to somebody	___	___	___	___
23.	I listen to poetry	___	___	___	___
24.	I am involved in a group activity	___	___	___	___
25.	I care for a pet	___	___	___	___
26.	I talk on the phone	___	___	___	___
27.	I play computer games	___	___	___	___
28.	I go round with best friends	___	___	___	___
29.	I play computer games on my own	___	___	___	___
30.	I talk to my parents about schoolwork	___	___	___	___
31.	I talk to my teacher about schoolwork	___	___	___	___
32.	I play computer games with friends	___	___	___	___
33.	The bell rings and the SERGO period is over	___	___	___	___
34.	My friends come and work on my computer	___	___	___	___
35.	I tell my parents about computers	___	___	___	___
36.	I do Maths on a computer ..	___	___	___	___
37.	I read a book about computers	___	___	___	___
38.	I look at the SERGO report.	___	___	___	___
39.	I do a Maths paper	___	___	___	___
40.	I get my school report	___	___	___	___
41.	Monday	___	___	___	___
42.	Maths	___	___	___	___
43.	I help my teacher	___	___	___	___

PAGE 3

		UNHAPPY	INDIFFERENT	HAPPY	VERY HAPPY
44.	I sing if I am alone	___	___	___	___
45.	I make progress with my schoolwork	___	___	___	___
46.	I am forced to work on a computer	___	___	___	___
47.	I exercise to keep fit	___	___	___	___
48.	I stop doing my homework because friends come to chat	___	___	___	___
49.	I spend my month's allowance on computer software..	___	___	___	___
50.	The SERGO period starts ...	___	___	___	___
51.	My Mathematics textbook ...	___	___	___	___
52.	I go to bed early	___	___	___	___
53.	Maths on SERGO	___	___	___	___
54.	Library	___	___	___	___
55.	Friday	___	___	___	___
56.	A power failure and SERGO does not work	___	___	___	___
57.	I work all alone on a SERGO lesson	___	___	___	___
58.	The teacher helps me with a SERGO lesson	___	___	___	___
59.	Friends help me with a SERGO lesson	___	___	___	___
60.	My friends and I work on a SERGO lesson together	___	___	___	___
61.	Logo	___	___	___	___
62.	I try to do some work on SERGO I find difficult	___	___	___	___
63.	Computers are banned at school	___	___	___	___

METHOD OF CALCULATION

1 General Principles

1.1 Introduction

This appendix gives the technical information on how the personality and attitude variables from the questionnaire in Appendix A were arrived at.

Data from all the questionnaires were entered onto a spreadsheet. If the block below the first face (i.e. on the left) was marked, that item was given a value of 1, the second a value of 2 and so on.

1.2 Random items

The items were randomly created. They were not standardized or validated since the investigation was a pilot study.

The items were chosen with a view to measuring aspects of the pupils' personality and their feelings about the SERGO system, Mathematics and computers.

If a similar test were to be used again the researcher would try to arrange an equal number of positive and negative items for each variable. This would compensate for those pupils who are either very negative or very positive about everything.

1.3 Rating scale

Experts in the Institute for Psychometric and Edumetric Research (IPER) as well as colleagues in the Institute for Educational Research (IER) were consulted on the number of choices the pupils should be given. A neutral point was preferred by the test experts (but not insisted on). They also said that the fewer the choices the better for respondents who were not used to this kind of test.

The following scale was accordingly decided upon:

Standard 2: 3 choices
Standard 4: 4 choices
Standard 5: 5 choices

1.4 Formula to convert factors to percentages

A number of items were grouped together to represent each of the six factors. Some of the items were considered to be positive and others negative. The highest value and the lowest value that the sum of the group of items could be is called the min and max in

the formula below. The value of x is the sum of all the values in the group.

The formula is as follows:

score = (x - min)/(max - min)

Where x = the sum of the scores
max = highest possible score
min = lowest possible score

The formula to get min and max is as follows:
max = (No_positive_items * large) - No_negative_items
min = No_positive_items - (No_negative_items * large)

where "large" has the value 3, 4 or 5 depending on the number of choices (see 1.3 above).

2 Personality factors

2.1 Extrovert/Introvert

With respect to the pupils' questionnaire (see Appendix A) the following items were summed to give an Extrovert/Introvert score:

(9 + 10 + 16 + 22 + 24 + 32 + 34 + 43 + 59 + 60)
- (4 + 6 + 13 + 20 + 21 + 23 + 29 + 44 + 54 + 57)

If the formula in 1.4 above is applied, the following values for min and max would be obtained. (The value for large is 3, 4 and 5 for Standard 2, 4 and 5 respectively.)

		Std 2	Std 4	Std 5
max =	(10 * large) - 10 =	20	30	40
min =	10 - (10 * large) =	-20	-30	-40
dif =	max - min =	40	60	80

A Standard 2 pupil for example, who has given a 3 for each of the positive items and a 1 for each of the negative items would have been scored as follows for the Extrovert/Introvert scale:
((10 * 3 - 10)+20)/40 = 1.00
(This pupil would be a total extrovert.)

If a pupil in the same class had marked a 2 (middle face) the pupil's Extrovert/Introvert score would have been as follows:
((10 * 2) - (10 * 2)+20)/40 = 0.50
(This would be a pupil with equal extrovert and introvert tendencies.)

2.2 Work/Entertainment oriented

This variable was intended to give a score of the attitude of a

pupil to work as opposed to entertainment. It may not be correct to view this variable as a continuum with work oriented and entertainment orientated being the two extremes, but in the context of this pilot study it is acceptable.
The following items were summed to give the value for the variable:

(2 + 4 + 7 + 10 + 11 + 14 + 15 + 19 + 20 + 30 + 31 + 40 + 41 + 43 + 47 + 52 + 62) - (3 + 5 + 6 + 18 + 26 + 27 + 48 + 55)

A person with a very high (near 1) score would be considered to be strongly work oriented and a person with a zero would be considered to be strongly entertainment oriented.

2.3 Dependent/Independent workers

The extent to which a pupil prefers to work or play with others, i.e. a dependent person, as opposed to the loner or independent worker (value of near 0) is measured by this variable. A high score (near 1) in this variable indicates a dependent worker.

The items are as follows:

(10 + 15 + 30 + 31 + 32 + 58 + 59) - (4 + 14 + 25 + 29 + 57)

3 Attitude to Computers, Mathematics and SERGO

3.1 Computers

The high score (nearer 1) in this and the next two variables indicates a positive attitude and a low score a negative attitude.

The pupils' feelings towards computers were measured by the following items:

27 + 29 + 35 + 37 + 49 + 61 - 63

3.2 Mathematics

Pupils' attitude towards Mathematics was measured by the following items:

36 + 39 + 42 + 51 + 53

3.3 SERGO

The pupils' attitude to SERGO was measured by the following:

17 + 38 + 36 + 50 + 53 + 62 - 56

APPENDIX 7

CALCULATIONS OF STANDARD DEVIATIONS

			1ST CALCULATION: ALL PUPILS		2ND CALCULATION: 12 PUPILS ONLY		
Pupil No.	p value (X)	Rank order	P-p $(X-\bar{X})$	$(X-\bar{X})^2$	p value X	P-p $X-\bar{X}$	$(X-\bar{X})^2$
XA02	+ 7,2	10	- 30,0	900	+ 7,2	- 9,9	98
XA03	+ 13,0	9	- 24,2	585	+13,0	- 4,1	16
XA04	+200,2	1	+163,0	26 602	Reject	-	-
XA05	- 13,9	14	- 51,1	2 611	-13,9	-31,0	961
9A02	- 28,3	16	- 65,5	4 209	Reject	-	-
9A03	- 1,0	13	- 38,2	795	- 1,0	-18,1	328
9A04	+ 5,6	11	- 31,6	999	+ 5,6	-11,5	132
9A05	- 12,6	15	- 49,8	2 480	-12,6	-29,7	882
8A02	+ 49,4	5	+ 12,2	149	+49,4	32,3	1 043
8A04	+ 33,6	7	- 3,6	13	+33,6	16,5	272
9B01	+105,1	3	+ 67,9	4 610	Reject	-	-
9B04	+ 0,6	12	- 36,6	1 340	+ 0,6	-16,5	272
9B05	+116,2	2	+ 79,0	6 241	Reject	-	-
9B02	+ 56,2	4	+ 19,0	361	+56,2	+39,1	1 529
8B02	+ 38,8	6	+ 1,6	3	+38,8	+21,7	471
8B03	+ 28,1	8	- 9,1	83	+28,1	+ 9,0	81
	X=+37,2 average or mean	+20,6% median	$\sqrt{\frac{\Sigma(X-\bar{X})^2}{16}} = \sqrt{\frac{52059}{16}}$ Std Dev=57,04%		X=+17,1 average or mean	$\sqrt{\frac{\Sigma(X-\bar{X})^2}{12}} = \sqrt{\frac{6085}{12}}$ Std Dev=22,5%	

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