

https://dspace.org/

The use of computers in music education in South West Africa

Zolkov, Ashley Mark

2014-08-18
http://hdl.handle.net/10539/15204

Downloaded from a DSpace repository. https://dspace.org/

THE USE OF COMPUTERS IN MUSIC EDUCATION IN SOUTH WEST AFRICA

Ashley Mark Zolkow

A Dissertation Submitted to the Faculty of Arts
University of the Witwatersrand, Johannesburg
for the Degree of Master of Music

Windhoek, South West Africa 1986

ABSTRACT

THE USE OF COMPUTERS IN MUSIC EDUCATION IN SOUTH WEST AFRICA

ZOLKOV, Ashley Mark, M. Mus. University of the Witwatersrand, Johannesburg, 1986.

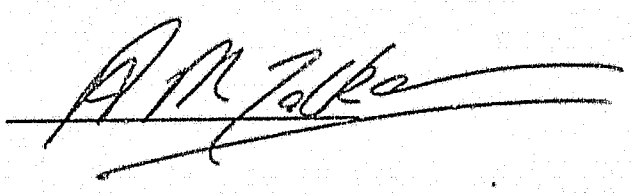
This study compared CAI with conventional group-class instruction to determine the degree of skill proficiency in interval and rhythm dictation obtained by students exposed to the alternate forms of instruction. Forty-three students attending the Windhoek Conservatoire, aged between eleven and fifteen years, volunteered to participate. A modified pre-test/post-test control group design was used. A researcher-built pre-test was administered and students were matched according to interval scores and grade level. Each pair was then randomly assigned to either the experimental (CAI) or the control (teacher) group: Intervals. An inverse assignment of these intact groups was made. The control group now became an experimental group (CAI: Rhythms), while the pre-defined experimental group was treated as its control (teacher: Rhythms). Each student received CAI and group-class instruction for two half-hour sessions per week for six months (14-18 hours of instruction). CAI was administered using the Micro GUIDO Ear Training System, specially adapted by the researcher to suit study at a grade level.

Results of the non-parametric tests indicated no difference between E and C groups ($p = .05$). Results favouring the E group in interval recognition were obtained ($p = .10$). Further, the C group showed a greater proficiency in ability to notate rhythms correctly ($p = .10$). No differences were observed in a comparison of sex, age and degree of theory knowledge among students receiving CAI ($p = .05$). A positive response by students to CAI was indicated in an attitudinal questionnaire.

It was concluded that CAI served as a feasible alternative to conventional instruction but that optimum benefits would be derived if used as an adjunct to conventional instruction.

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Music in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



24th day of December, 1986.

In Memory of

Rachael Kenner

1907 - 1986

TABLE OF CONTENTS

1.0 INTRODUCTION: OVERVIEW AND FOCUS OF THE STUDY 1
1.1 Context 1
1.2 Aim and rationale 2
1.3 Specific areas to be investigated 2
1.3.1 A survey of the literature 2
1.3.2 Comparative study between CAI and traditional instruction 2
1.4 Proposed research statements 3
1.4.1 Hypothesis 1 3
1.4.1.1 Definitions of the variables for Hypothesis 1 . . 4
1.4.1.2 Definition of concepts 5
1.4.1.3 Rationale for Hypothesis 1 7
1.4.2 Hypothesis 2 8
1.4.2.1 Definition of the variables for Hypothesis 2 . . 8
1.4.2.2 Rationale for Hypothesis 2 8
1.4.3 Hypothesis 3 9
1.4.3.1 Definition of the variables for Hypothesis 3 . . 10
1.4.3.2 Rationale for Hypothesis 3 11
1.4.4 Brief outline of Methodology 13
1.4.4.1 Design of the Comparative Study 13
1.4.5 Control of Variables 14
1.4.6 Representativeness of the sample to the population . 15
1.4.7 Data Analysis 15
1.4.8 Questionnaires, interviews and observation 16
1.4.9 Interpretation of results of the comparative study . . 17
1.5 Significance of the study 17

2.0 SURVEY : DEVELOPMENTS OF CAI IN MUSIC EDUCATION 19
2.1 History 19
2.1.1 General 19
2.2 Applications of computers to music education 24
2.3 Survey of the literature 26
2.3.1 Performance 27
2.3.2 Composition 28

2.3.3 Theory 30
2.3.4 Ear training 31
2.3.5 Comparative studies : CAI and traditional instruction 37

3.0 OVERVIEW OF THE MICRO GUIDO EAR TRAINING SYSTEM 42
3.1 Background and apparatus 42
3.2 Student options 43
3.2.1 Interval Recognition 44
3.2.2 Rhythm Dictation 48
3.3 Reconfiguration of the Micro GUIDO Ear Training System 50
3.3.1 CAMETS Program in Interval Recognition 52
3.3.2 CAMETS Program in Rhythm Dictation 55
3.4 The CAMETS syllabus 60
3.4.1 CAMETS syllabus in Interval Recognition 60
3.4.2 CAMETS syllabus in Rhythm Dictation 61
3.4.3 Validation of the CAMETS syllabus 62
3.5 Choosing the apparatus for computer-assisted instruction 62

4.0 METHODOLOGY 64
4.1 Quantitative method 64
4.2 The innovatory programme 65
4.3 Choosing the sample 66
4.4 Matching 67
4.5 Design of the experiment 67
4.5.1 Procedures for validation of the CAMETS tests . . . 71
4.6 Choosing the appropriate statistical tests 72
4.7 Degree of closure: control of variables 74
4.8 Qualitative methodology 78

5.0 DESIGN OF THE COMPARATIVE STUDY 79
5.1 Subjects 79
5.2 The task 80
5.3 Sampling procedure 80
5.4 Matching procedure 84
5.5 Implementation of the research design 86
5.6 Treatment 87
5.6.1 Group classes 87
5.7 Additional variables under control 88

5.8 Procedures 91
5.9 Descriptive procedures of treatment 94
5.9.1 Computer-assisted music instruction 94
5.9.2 Group-class instruction 97
5.10 Post-tests 99
5.11 Schematic display of the comparative study 100

6.0 RESULTS OF THE COMPARATIVE STUDY 102
6.1 Operational restatement of Hypothesis 1 102
6.2 Data analysis 102
6.3 Operational restatement of Hypothesis 2 110
6.4 Data analysis 112
6.5 Operational restatement of Hypothesis 3 113
6.6 Data analysis 115
6.7 Post hoc analysis: student proficiency in notating rhythms 117

7.0 DESCRIPTIVE DATA : QUESTIONNAIRES, INTERVIEWS AND OBSERVATION 122
7.1 Questionnaire : students 123
7.2 Questionnaire : Music lecturers 127
7.3 Interviews: group-class instructors 136
7.4 Observation 139
7.4.1 Observation: group classes 139
7.4.2 Observation: computer lessons 141

8.0 RELIABILITY AND VALIDITY OF THE CAMETS TESTS 143
8.1 Test reliability 143
8.2 Test validity 145
8.3 Validation 148
8.3.1 Validation : music authorities in RSA 148
8.3.2 Validation : group-class instructors 155
8.3.3 Validation : students in sample concurrent study . 156

9.0 INTERPRETATION OF RESULTS OF THE COMPARATIVE STUDY 158
9.1 Conclusions 158
9.2 Discussion 159
9.3 Post hoc analysis 163

9.3.1 Student proficiency in notating rhythms correctly . 163
9.3.2 Students' understanding of the CAI interval program 164
9.4 Interpretation 166

10.0 RECOMMENDATIONS 174
10.1 Recommendations for program improvement 174
10.1.1 The Micro GUIDO Ear Training System 174
10.1.2 The CAMETS programs 179
10.1.3 The CAMETS syllabus and tests 181
10.2 Recommendations to decision-makers 182
10.3 Recommendations for further study 189

APPENDIX A. INSTRUCTIONS GIVEN TO STUDENTS 194

APPENDIX B. CAMETS PROGRAM IN INTERVAL RECOGNITION 203

APPENDIX C. CAMETS PROGRAM IN RHYTHM DICTATION . 222

APPENDIX D. CAMETS SYLLABI 260
D.1 CAMETS syllabus in Interval Recognition 260
D.2 CAMETS syllabus in Rhythm Dictation 262

APPENDIX E. UNISA SYLLABUS IN PRACTICAL MUSICIANSHIP 264

APPENDIX F. CAMETS GRADE TESTS 267

APPENDIX G. QUESTIONNAIRE: FACE VALIDATION 298

APPENDIX H. QUESTIONNAIRE: STUDENTS PARTICIPATING IN THE STUDY 304

APPENDIX I. QUESTIONNAIRE: MUSIC LECTURERS 313

APPENDIX J. LETTERS SENT TO STUDENTS, PARENTS AND MUSIC LECTURERS 317

APPENDIX K. HELP-BOARDS 330

APPENDIX L. CAMETS PROJECT: TEST RESULTS AND STUDENT RECORDS 343

REFERENCES 345

PREFACE

This report is the result of research conducted at the Windhoek Conservatoire, Windhoek, South West Africa over a six-month period in 1985. Its purpose was to determine the effectiveness of computer-assisted instruction in developing music aural-perception skills amongst school-going students in Windhoek. The aim of this research was two-fold, namely,

1. to improve an aspect of music education in South West African schools, and

2. to inform decision-makers within the sphere of music education at a primary and secondary level in South West Africa (SWA) in determining whether or not the computer provides a feasible alternative to traditional methodology in certain areas of music education.

My reasons for wishing to undertake this research project were, firstly, to introduce school-going students in SWA to computer- assisted music education and to make use of an available technological tool in music education, while specifically modifying this aid to conform with music educational requirements in SWA. Secondly, I hope to contribute to the body of knowledge from extensive research previously undertaken on the use of computers in music education.

The main emphasis of this research is a comparative study between computer-assisted instruction and traditional instruction in music aural training, in a controlled experiment within the conventional research tradition. The Micro GUIDO Ear Training System (part of the PLATO project), a computer-based aural training program for music education was used in this study. It was adapted specifically to be used by school-going music students in SWA.

The introductory section (Chapter 1) provides an overview of the present study, its context, proposal, brief outline of methodology

and definition of concepts. Chapter 2 provides an historical survey of developments in applications of computers to music education as well as an extensive survey of the literature. Recent research of CAI applications to music performance, composition, theory and ear training is examined and a critical survey of comparative studies involving computer-assisted music education is undertaken. Chapter 3 provides a brief overview of the Micro GUIDO Ear Training System as well as reasons for the adaptation of the program content and structure of the syllabi, to suit both the GUIDO system and the music educational requirements at a primary and secondary level in SWA. The methodology section (Chapter 4) describes the quantitative and qualitative methods used. Chapter 5 fully describes the implementation of the comparative study. Chapters 6,7 and 8 document respectively the results of the study, including statistical analysis of data, the descriptive data obtained from questionnaires, interviews and observation, and validation procedures of the CAMETS tests (the measurement apparatus). Chapter 9 presents the interpretation of results. The final chapter (10) offers recommendations for program improvement, to decision-makers and for further study.

I wish to acknowledge the extensive assistance of my supervisors Dr Mary Rörich, Department of Music and Mr Ray Basson, Department of Education, as well as consultations with Mr Peter Fridjhon, Department of Statistics at the University of the Witwatersrand. I am grateful for the constant help and encouragement of my supervisors during the last five years. I am particularly grateful to Mr Fridjhon for his time, effort and patience in reviewing the statistical aspects of this study. His expertise and willingness to share his insight are respectfully appreciated. I wish to thank music lecturers at universities in the Republic of South Africa: Mrs K. Primos, University of the Witwatersrand; Mr M. Koppers, University of Zululand; Mr P. van Zuilenberg, University of Stellenbosch; Mr J. van Tonder, University of Cape Town as well as Dr J. Zaidel-Rudolph for their valuable contributions made towards the validation of the test apparatus used in this study. I am particularly grateful to Philip Münch and Johan Pieterse, of the Windhoek Conservatoire, for their voluntary services as aural lecturers in this comparative study, both for their notable dedication as teachers and for their continued

co-operation throughout the study. I am indebted to them for making this research possible. I thank Dr P. Roos, Head of the Windhoek Conservatoire, as well as my colleagues and the music teachers at schools in Windhoek who attended demonstrations of the GUIDO system and provided valuable input by sharing their opinions of this system with me. I am grateful for assistance received from Prof. F.T. Hofstetter, University of Delaware, in operationalising the GUIDO system and for answering my many letters and queries. I thank the students who participated in this study for their time, effort and positive response throughout. Not least, I am indebted to the Directorate Education, Windhoek, SWA, for the research grant which helped to pay for the GUIDO system. I wish to thank Neil Louw and Bernhard Wiswe for assistance with the draft and use of their computers. Lastly, thanks of a special nature go to my friend, William Hayes, and to my wife, Avrille, for their invaluable assistance in the preparation of this report.

Ashley M. Zolkov
Windhoek Conservatoire
December 1986

LIST OF ABBREVIATIONS

CAI	:	Computer-assisted instruction
CAMETS	:	Computer-Assisted Music Ear Training Study
GUIDO	:	Graded Units for Interactive Dictation Operations
PI	:	Programmed Instruction
PLATO	:	Programmed Logic for Automatic Teaching Operation
RSA	:	Republic of South Africa
SWA	:	South West Africa
UNISA	:	University of South Africa

LIST OF TABLES

1. Student registration at Windhoek Conservatoire as at 15 March 1985 82
2. Students chosen to participate in CAMETS project 83
3. Statistical data of Sign Test: Interval Recognition ...104
4. Statistical data of Sign Test: Rhythm Dictation 105
5. Statistical data of Wilcoxon Matched-Pairs Signed-Ranks Test: Interval Recognition 107
6. Statistical data of Wilcoxon Matched-Pairs Signed-Ranks Test: Rhythm Dictation 108
7. Statistical data of Mann-Whitney U Tests: Interval Recognition and Rhythm Dictation 111
8. Statistical data of Mann-Whitney U Tests on independent variables: sex, age group and music theory 114
9. X^2 Test for Two Independent Groups: mode of instruction and observed competency 116
10. X^2 Test for Two Independent Groups: mode of instruction and observed change in student ability to notate rhythms correctly 121
11. Results of concurrent validity pilot study 148

LIST OF ILLUSTRATIONS

Figure 1. Title Page of Micro GUIDO Ear Training System . . . 44
Figure 2. Key options for GUIDO Interval Dictation Drill . . 45
Figure 3. Reconfigured GUIDO lesson in Interval Recognition . 46
Figure 4. Reconfigured GUIDO lesson in Rhythm Dictation. . . 49
Figure 5. Interval unit editing program of GUIDO system . . . 53
Figure 6. Rhythm unit editing program of GUIDO system 56
Figure 7. Schematic display of CAMETS research design 69
Figure 8. Scatter diagram - Interval and Rhythm scores (pre-test) 93
Figure 9. Design of the CAMETS research project indicated schematically 101
Figure 10. Scatter diagram - test-retest reliability (Intervals). 146
Figure 11. Scatter diagram - test-retest reliability (Rhythm). 147
Figure 12. Interval Recognition (CAI) - expected/observed levels. 168
Figure 13. Rhythm Dictation (CAI) - expected/observed levels. 169
Figure 14. Sample display from GUIDO Rhythm Parameter editor 227

1.0 INTRODUCTION: OVERVIEW AND FOCUS OF THE STUDY

1.1 CONTEXT

Although there has been considerable research directed at computer-assisted music instruction in ear training, the primary emphasis has been placed on program[1] development and program evaluation (Placek 1972, Kuhn 1974, Hofstetter 1975, 1979a, 1980, 1981b, Deal 1983, Smith 1980, and others[2]). Researchers have tended to focus on effects of variables within programs such as competency (Hofstetter 1979a), branching (Hullfish 1969), lesson length (Kuhn 1974, Humphries 1978) and lesson frequency (Humphries 1978) on student achievement. Much research has been conducted which concentrates on student aural perception and learning styles (Hofstetter 1978a, 1980, 1981b, Kuhn and Lorton 1981, Killam, Lorton and Schuber 1975, Deal 1985). Comparative studies between computer-assisted instruction (CAI) in ear training and programmed instruction in music have been extensively researched (Deal 1985, Hofstetter 1975, Canelos et al 1980, Garton 1981). Yet relatively little research has been conducted in the comparison of CAI with traditional instruction in music ear training (Watanabe 1981, Vaughn 1978). Furthermore, these studies have been conducted with students at a tertiary level of music education. In addition, relatively little is known about the effect of variables such as student age, sex and extent of music education of school-going students exposed to computer-assisted music instruction (Lee 1975).

---

[1] A program is a series of coded instructions to control the operation of a computer.

[2] A comprehensive survey of developments in computer-assisted music education is undertaken in Chapter 2.

1.2 AIM AND RATIONALE

The purpose of this study was to determine the effectiveness of CAI in developing music aural-perception skills amongst school- going students in SWA. The aim of the research was, primarily, to inform decision-makers within the sphere of music education at a primary and secondary level in SWA in determining whether or not the computer provides a feasible alternative to traditional methodology in certain areas of music education. A secondary aim was to consider the influence of variables such as age, sex and extent of music education of school-going students exposed to CAI in music ear training on student improvement in aural skills.

1.3 SPECIFIC AREAS TO BE INVESTIGATED

1.3.1 A SURVEY OF THE LITERATURE

The purpose of this survey was to provide an historical perspective of developments in computer-assisted instruction and to assess the current state of computer-assisted music education. A critical review of the literature regarding research connected with applications of computers to music education was undertaken with particular emphasis on comparative studies using CAI systems.

1.3.2 COMPARATIVE STUDY BETWEEN CAI AND TRADITIONAL INSTRUCTION

The methodology and design sections of this dissertation (Chapters 4 and 5) contrast these two methods of instruction in a controlled ex-

periment within the conventional research tradition. The computer-based aural training program for music education developed by Prof. F.T. Hofstetter and marketed as the Micro GUIDO Ear Training System was used in this study. For this research, it was necessary to reconfigure lessons to conform with the requirements of the University of South Africa (UNISA) Practical Musicianship syllabus, since the competency tables provided with the GUIDO system are designed for use at a tertiary level of music education (this adaptation is described in Chapter 3.3). The proposed curriculum was validated using a pilot group representative of the population under study. The reconfigured lessons, syllabus and tests used in this research were submitted to various music authorities for validation.

1.4 PROPOSED RESEARCH STATEMENTS

This research focused primarily on student achievement in its comparison of CAI and conventional group-class instruction in aspects of music aural training. The hypotheses proposed for investigation were stated as follows:

1.4.1 HYPOTHESIS 1

It is expected that music students, aged between eleven and fifteen years, selected from the Windhoek Conservatoire, SWA, who receive CAI in interval recognition and rhythm dictation over a six-month period, using the reconfigured Micro GUIDO Ear Training System will show greater proficiency in these aural skills, as measured on a test of ability in interval recognition and rhythm dictation based on the UNISA Practical Musicianship grade examinations, than music students of the same age group (chosen from the Windhoek Conservatoire), receiving the conventional method of group-class instruction in interval recognition and rhythm dictation for the same length of time.

1.4.1.1 Definitions of the variables for Hypothesis 1

1. The independent variable is defined as that factor which is measured, manipulated or selected by the experimenter to determine its relationship to an observed phenomenon (Tuckman 1978, pp. 58- 59). The independent variable in Hypothesis 1 therefore refers to the type of instruction: CAI and the conventional method of group- class instruction. This study therefore has a single independent variable or factor with two levels.

2. The dependent variable is that factor which is observed and measured to determine the effect of the independent variable (Tuckman 1978, p. 59). In Hypothesis 1 this refers to the degree of skill proficiency in the stated aural-perception tasks.

3. Since this study seeks to explore the relationship between instructional approach (independent variable) and skill proficiency (dependent variable) without singling out a third factor which may modify this relationship, there is no moderator variable in Hypothesis 1.

4. Control variables are those factors which are controlled by the experimenter to cancel out or neutralise any effects they might otherwise have on the observed phenomenon (Tuckman 1978, pp. 65-66). In Hypothesis 1, an attempt is made to control for certain variables, namely, the selection procedure of participants according to race, age group and initial level of proficiency in the aural-perception skills under consideration as well as lesson content in the two modes of instruction. The universal variables controlled by routine design procedures such as history, maturation, testing, instrumentation, selection and attrition are discussed fully in Chapter 4.7.

5. The intervening variable is that factor which theoretically affects the observed phenomenon but cannot be seen, measured or manipulated; its effect must be inferred from the effects of the independent and moderator variables on the observed phenomenon

1.4.1.1 Definitions of the variables for Hypothesis 1

1. The independent variable is defined as that factor which is measured, manipulated or selected by the experimenter to determine its relationship to an observed phenomenon (Tuckman 1978, pp. 58- 59). The independent variable in Hypothesis 1 therefore refers to the type of instruction: CAI and the conventional method of group- class instruction. This study therefore has a single independent variable or factor with two levels.

2. The dependent variable is that factor which is observed and measured to determine the effect of the independent variable (Tuckman 1978, p. 59). In Hypothesis 1 this refers to the degree of skill proficiency in the stated aural-perception tasks.

3. Since this study seeks to explore the relationship between instructional approach (independent variable) and skill proficiency (dependent variable) without singling out a third factor which may modify this relationship, there is no moderator variable in Hypothesis 1.

4. Control variables are those factors which are controlled by the experimenter to cancel out or neutralise any effects they might otherwise have on the observed phenomenon (Tuckman 1978, pp. 65-66). In Hypothesis 1, an attempt is made to control for certain variables, namely, the selection procedure of participants according to race, age group and initial level of proficiency in the aural-perception skills under consideration as well as lesson content in the two modes of instruction. The universal variables controlled by routine design procedures such as history, maturation, testing, instrumentation, selection and attrition are discussed fully in Chapter 4.7.

5. The intervening variable is that factor which theoretically affects the observed phenomenon but cannot be seen, measured or manipulated; its effect must be inferred from the effects of the independent and moderator variables on the observed phenomenon

(Tuckman 1978, p.67). Since the intervening variable always refers to a conceptual variable, its identification in Hypothesis 1 is neither clear-cut nor as easy to define as the other variables. In this study an attempt was made to hold constant as many factors as possible such as the content, structure and order of presentation of the course material as well as time spent in each mode of instruction. It is the mode of presentation of material that is crucial to this research. One must therefore postulate: "What is it about the two modes of presentation (CAI and traditional classroom instruction) that might lead one to be more effective than the other?" Since Hypothesis 1 predicts that students receiving CAI will perform better than their counterparts receiving traditional instruction, it is necessary to postulate probable reasons for this assumption. Possible answers may be attention as well as amount of information presented. CAI is likely to demand more active participation than classroom learning, more concentration from students, and the degree of structure of the CAI program may have a bearing on its effectiveness.

1.4.1.2 Definition of concepts

Computer-assisted instruction (CAI)

This term refers to the process of teaching by computer, a technique for individualising instruction. The term is considered synonymous with computer-aided instruction, computer-aided learning (CAL) and computer-based learning or instruction (CBL or CBI).

Conventional instruction

This refers to the teaching of aural-perception skills in a classroom situation. Although it is often referred to as the teacher/learner method of instruction, it is pointed out that aural classes are usually conducted (at the Windhoek Conservatoire) in small groups of

students, and not in a one-on- one situation, as the term 'teacher/learner' would appear to imply.

Degree of skill proficiency in ear training

Ear training has been defined as an important field of elementary instruction designed to teach the student to recognise and write down musical intervals and rhythms (Apel 1970, p. 250). The term is synonymous with aural training which is defined as follows: "the purpose of aural training is to teach pupils to recognise the sounds and rhythms they hear and to write them down on paper" (Westrup and Harrison 1984, p. 47). The facility in this action and the development of student ability in aural training is generally regarded as a skill or acquisition of a skill (Colwell 1970, p. 118). The degree of skill proficiency refers to the extent to which a student elicits the desired behaviour in terms of the educational objectives of the learning experience. In terms of this study it is assumed that an increase in skill proficiency in specific aural tasks will be reflected by an increase in the score on a test designed to measure these skills.

Interval recognition

A musical interval refers to the distance in pitch between two notes, which is expressed in terms of the number of notes of the diatonic scale which they comprise (e.g., third, fifth, ninth) along with a qualifying word (perfect, major, minor, augmented or diminished). Interval recognition refers to the aural perception of an interval in terms of its distance and quality. This term 'interval' must not be confused with the statistical level of measurement - the interval scale. This is characterised by a common and constant unit of measurement which assigns a real number to all pairs of objects in the ordered set (Siegel 1956, p.26).

Rhythm dictation

This refers to the process of notating a rhythm after hearing it played. This is an auditory-visual skill since the student must visualise the note symbols for the rhythm he/she is hearing.

1.4.1.3 Rationale for Hypothesis 1

Magidson (1978, pp. 5-8) observed that, in a comparison of CAI with traditional instruction within a wide spectrum of educational fields, fifty-five per cent of studies reported that CAI was as effective as traditional instruction, while in forty-five per cent, CAI was more effective than traditional instruction. In these studies the CAI involved only the modes of tutorial and drill and practice. Similarly, a report by Kulik, Kulik and Cohen (1980) suggests equal or superior efficacy of computer-based instruction from a meta-analysis of findings. In the field of music education, studies by Deal (1985), Cooper (1975), Canelos et al (1980), Garton (1981) and others support these findings. Furthermore, Hofstetter (1975) has observed significant improvement in student aural ability in a comparison of the GUIDO CAI system with tape-laboratory instruction. Although many comparative studies between CAI and alternate forms of instruction have been conducted to date, it should be pointed out that there are many educationalists who are critical of this research strategy. Writing in 1981, Gleason observed that, in his opinion, "few serious researchers are now interested in comparative studies, i.e., studies which attempt to compare the results of computer-assisted instruction with the results of other strategies, either unique or 'conventional'" (1981, p. 7). Serfontein concurs with this point of view and regards the role of research as one which must focus on the optimal use of the computer in education (1982, p. 218).

However, it is this writer's opinion that Hypothesis 1 of the present study is worthy of 'serious' investigation, primarily because of the paucity of precedent studies in this particular field. It is argued that the present study makes a significant contribution to the literature by adding to the body of knowledge and understanding of this specific application of computers to an aspect of music education. Hypothesis 1 is justified as one derived from many precedent comparative studies, yet one that is unique in many respects because of the particular time, place and circumstances in which it is tested.

1.4.2 HYPOTHESIS 2

A comparison of achievement scores was made between students who receive CAI of different sex and age group, and between students who attended regular music theory classes and students who did not, to determine if any of these independent variables had an influence on results. Therefore, this study examined the hypothesis that certain independent variables, namely, sex, age group and presence/absence of theory classes, influence the degree of student improvement in the development of aural-perception skills amongst school-going students attending the Windhoek Conservatoire who receive CAI in interval recognition and rhythm dictation.

1.4.2.1 Definition of the variables for Hypothesis 2

This study examines the relationship between participants of different sex, age group and participants who attend regular theory classes and those who do not (the independent variables), and the degree of proficiency obtained in certain aural-perception tasks (the dependent variable). Each independent variable is considered separately. The control variables in Hypothesis 2 include the type of instruction (CAI), initial grade level of participants, as well as lesson content and order of presentation of material. The intervening variable may refer to interest level in the mode of instruction, level of understanding of the subject matter and attention level of students of different ages.

1.4.2.2 Rationale for Hypothesis 2

Justification on empirical grounds is difficult because of the lack of relevant research in this area. However, Lee (1975) and Lorton

and Killam (1976) have observed differences in aural- perception abilities of male and female students using CAI. More research on aural perception has been conducted which does not use a computer as an instructional medium, but which supports the contention that sex and age influence the degree of this ability (Schleuter and Schleuter 1985, Petzold 1966, Thackray 1972). However, in this study, the researcher considered it likely that, since a computer was being used to administer the ear training instruction, there might be a difference between attitude of males and females in the degree of interest in the instruction medium and that this might affect achievement (boys might be better predisposed to computers than girls). Furt' the younger students in the sample (aged 11-12) might have more d.' alty in operating the computer than their older counterparts (aged 13-15) since there exists a difference in the degree of understanding and level of attention in students of different ages. It could also be postulated that students who attend regular theory classes have an advantage over students who do not, since the former have reinforced their understanding and grasp of musical concepts. The theoretical background which theory classes provide (such as a knowledge of scale construction, note-values, time signatures, note-groupings, etc.,) might influence the degree of student improvement in interval recognition and rhythm dictation. Hypothesis 2 is justified because it makes a relevant and significant contribution to the literature by analysing differences in aural-perception ability among students in the sample of different sex, age and musical background.

1.4.3 HYPOTHESIS 3

It is evident that the main emphasis of this research is the comparison of alternative instructional methods, namely CAI and traditional instruction. The comparison of gross differences in student scores (in Hypothesis 1) would reflect the relative degree of efficacy of the two modes of instruction. However, it would not reflect the size of the difference in student scores. Furthermore, the researcher wished to determine not only whether one form of instruction was more

effective than another, but whether or not the increase in student improvement was as great as that anticipated. This would be possible if student scores were examined in terms of a pre-set, expected level of proficiency in the aural skills under consideration, to determine whether or not students had achieved a desired goal after a six-month treatment period. The following hypothesis was formulated:

It is expected that students (from the selected sample) receiving CAI in interval recognition and rhythm dictation will show a greater improvement in these aural-perception skills, as measured in the Computer-assisted Music Ear Training Study (CAMETS)[3] tests, than students receiving conventional, group-class instruction in the same skills, when skill proficiency is determined in terms of pre-set competency levels for each skill: interval recognition and rhythm dictation.

1.4.3.1 Definition of the variables for Hypothesis 3

The variables in Hypothesis 3 are identical to those identified in Hypothesis 1 with the exception that an expected proficiency level is added as a primary control variable.

---

[3] Computer-assisted Music Ear Training Study (CAMETS). This was the title given to the present research project; the comparative study between CAI and traditional instruction in music ear training. The acronym refers to the syllabus and programs, as well as the tests used in this study.

1.4.3.2 Rationale for Hypothesis 3

Logical justification is provided in support of this hypothesis. It is argued that, since students were to receive intensive instruction in specific aural skills over a six-month period, an expected proficiency level of three grades higher than the starting level was reasonable, and expected competency could be set at a high level of mastery. This line of reasoning is expanded below.

At present, aural training is a minor aspect of primary and secondary music education in both SWA and the Republic of South Africa (RSA). Although an aural test is conducted as part of the grade level examination, this constitutes between ten and fifteen per cent of the practical music examination of all examining bodies in SWA (UNISA, Trinity College of Music and the internal Windhoek Conservatoire examinations). Due to this lack of emphasis by examining bodies on aural training, less time is devoted to developing aural skills, while more time is spent on the practical skills of playing an instrument. Music teachers generally direct their efforts towards practical preparation of pieces to be played by students, as well as the preparation of scales and arpeggios. In the light of this, it is reasonable to assume that music lecturers at the Windhoek Conservatoire spend a limited part of the practical music lesson on ear training. Furthermore, it is likely that lecturers devote very little time to preparation of students for aural tests during the course of the year, and most of this training is administered a few weeks before the practical examination is conducted. Empirical support for these assumptions was obtained during the course of the present study (see student questionnaire, Ch. 7.1). If efforts of music teachers are viewed in the best possible light, it would be reasonable to assume that music lecturers at the Windhoek Conservatoire spend a maximum of ten minutes out of each hour-long practical lesson on aural training. Furthermore, this training is generally administered by lecturers in preparation of students for music examinations at one particular grade level. It is therefore evident that a student would receive between three and five hours of instruction (at most) in ear training during the course of a year, in preparation for one grade

of a music examination. Now, during the course of the CAMETS project, students would receive instruction in two specific aural skills. This training would be administered by both computer and teacher, in two half-hour lessons per week, and would continue for a six-month period. Therefore, each student participating in this study would receive approximately fourteen to eighteen hours of concentrated training in these aural skills. It is therefore argued that it would be reasonable to expect students participating in the study to attain proficiency in these aural skills at a grade level of three grades higher than their present level. It must be emphasised that this choice of expectancy level was purely arbitrary, in that any level may have sufficed. However, the researcher wishes to argue that the chosen level was governed by a reasonable expectation.

In the CAMETS tests which were to be administered at this higher grade level, proficiency in the specific aural skill is represented as a percentage. This percentage gives an indication of a student's aural-perception ability at certain tasks. A mark of fifty per cent on the test would indicate that a student has correctly recognised or identified half of the sounds in questions presented. It would also mean that the student was unable to aurally identify half of what he/she had heard. It was therefore determined that student proficiency in certain aural tasks should be set at a high level of mastery. The competency levels set for the post-tests were therefore given as eighty per cent for music interval recognition and sixty per cent for rhythm dictation. This means that, by the end of the six-month instruction period, it was expected that students would attain this level of competency. The competency level set for rhythm dictation was lower than that for interval recognition because it was expected that students would find it more difficult to acquire this skill, since it is not part of the practical examination at a grade level, whereas interval recognition is part of the examination. Precedents of a high expected level of competency are to be found in studies by Kuhn and Lorton (1981) where eighty per cent proficiency was required and Hofstetter (1980) where ninety per cent competency was required. It is further noted that the competency levels set for the standard GUIDO program is seventy- five per cent.

Finally, it was expected that the hypothesised difference in degree of proficiency at the pre-set competency level would result from the increased practice that the CAI group would receive in these skills, the gradual increase in difficulty level built into the computer programs and the self-paced nature of the computer programs. In addition, research conducted by Vaughn (1978), Hofstetter (1975), Canelos et al (1980) and Garton (1981) have indicated, in comparative studies between CAI and alternative music instructional methods, that CAI has produced statistically significant results in favour of CAI, although studies by Deal (1985), Cooper (1975) and Watanabe (1981) have yielded contrary evidence.

1.4.4 BRIEF OUTLINE OF METHODOLOGY

1.4.4.1 Design of the Comparative Study

Forty-three students attending the Windhoek Conservatoire, aged between eleven and fifteen years, volunteered to participate in this study. A modified pre-test/post-test control group design was used. A researcher-built pre-test was administered and students were matched according to interval recognition scores and grade level. Thereafter, each pair was randomly assigned to either the experimental (CAI) or the control (teacher) group in interval recognition. An inverse assignment of these intact groups was made, so that the control group now became an experimental group (CAI: Rhythms), while the pre-defined experimental group was treated as its control (teacher: Rhythms). Each student received CAI and group-class instruction for two half-hour sessions per week. Treatment continued for six-months (14-18 hours of instruction). CAI was administered by means of the Micro GUIDO Ear Training System, specially adapted by the researcher to suit study at a grade level. Two lecturers in aural training at the Windhoek Conservatoire volunteered to administer instruction to the control groups. Control groups were divided

into students aged between eleven and twelve years, and students aged between thirteen and fifteen years. Each lecturer taught half of these sub-groups, determined randomly. A post-test was administered at the end of the treatment period and scores obtained on pre- and post-tests were subjected to statistical analysis.

1.4.5 CONTROL OF VARIABLES

1. Students were matched according to grade level and pre-test scores and then randomly assigned to an experimental or control group.

2. In addition to traditional group-class instruction, each student received CAI to counteract the so-called 'Hawthorne' or novelty effect of receiving CAI.

3. The 'teacher-effect' (that is, level of teacher's motivation, interest in the subject of aural training and ability to impart knowledge) was evenly spread amongst the sample, since each instructor taught half of the participants in each of the two specified age groups (11-12 years; 13-15 years). 'Teacher-effect' was therefore controlled.

4. Time spent in each form of instruction (CAI and traditional) was equal and therefore controlled.

5. The post-test administered to each student was identical to the pre-test administered to that student.

Therefore it is argued that any significant change between pre- and post-test scores could be directly attributed to the method of instruction.

1.4.6 REPRESENTATIVENESS OF THE SAMPLE TO THE POPULATION

Forty-three students aged between eleven and fifteen years were chosen at random from the Windhoek Conservatoire to participate in this study. Since the total population of students of this age group attending the Windhoek Conservatoire was 142 students, the chosen sample represented more than thirty-one per cent of this total population. It is argued that the chosen sample adequately represented this age group at the Windhoek Conservatoire since the total population was identified before commencement of this study and since an acceptable form of probability sampling (random sampling) was employed in the selection procedure. Furthermore, it is pointed out that students attending the Windhoek Conservatoire are drawn from all White schools in SWA and therefore the sample is representative to some degree of the entire population of White music students within the specific age group of the sample. However, external validity of this study can only be reaffirmed when the study is replicated with different sample groups.

1.4.7 DATA ANALYSIS

Nonparametric statistical tests were selected for analysis of data generated by the comparative study. These provided a method for comparing gain scores as a way to determine the effects of the treatment. Selection of the appropriate statistical tests is presented in Chapter 4.6 and their utilisation is described in Chapter 6.

1.4.8 QUESTIONNAIRES, INTERVIEWS AND OBSERVATION

It is noted that questionnaires and interviews were intended only to supplement the above quantitative research design and to comprehensively determine the process variables. Therefore questionnaire results were not subjected to statistical analysis. Information gleaned from questionnaires, interviews and observation was intended to inform the comparative study, to interpret results and to determine the shades and nuances of the experimental study.

1. Researcher-built questionnaires were administered to:

   a. students participating in the study to determine their attitudes toward CAI, difficulties encountered in operating the GUIDO system, evaluation of the computer-assisted instructional program and preference of instructional methods;

   b. music lecturers at the Windhoek Conservatoire and music teachers at schools in Windhoek, SWA to determine their opinions of the CAI system used, as well as their evaluation of the computer-assisted instructional program;

   c. music authorities at six universities in South Africa for a face-validation of the CAMETS syllabus and tests used in the comparative study.

2. Interviews were conducted with:

   a. the two lecturers from the Windhoek Conservatoire who administered group-class instruction to the control group in the comparative study;

   b. students of the same age group who did not participate in the experimental study but were chosen for a pilot study in determining the concurrent validity of the CAMETS tests. This procedure, which involves multiple measurement of the same concept, was carried out by relating the performance of the

pilot group on the CAMETS tests with their performance on another well- reputed test, namely the UNISA examination in Practical Musicianship.

3. Observation

On the spot observation by the researcher of both methods of instruction was carried out to describe the learning milieu, conventional group-class teaching methods and student approach to working with the computer.

1.4.9 INTERPRETATION OF RESULTS OF THE COMPARATIVE STUDY

It is argued that this study will assist decision-makers in determining the feasibility of CAI and its effectiveness as a tool to aid music teachers in certain areas of music education in SWA. Recommendations made to administrators, educational planners and teachers are based on an analysis of statistical data and the interpretation of these results by the researcher. Conclusions drawn from the present study are intended to permit these decision-makers to make value judgements concerning the worth of the GUIDO system and to evaluate the researcher's recommendation that this system be used in school-music education. Obviously the cost of this CAI system is a determining factor in assessing its feasibility.

1.5 SIGNIFICANCE OF THE STUDY

As will be seen from the review of the literature (Chapter 2), the present research is neither a replication of a previous study nor one that is entirely original. Although based on similar studies conducted in the United States of America (USA), the present study is,

to this writer's knowledge, the first of its kind to be made in SWA in which CAI in music ear training is compared with traditional instruction. In addition, it is the first to make use of the Micro GUIDO Ear Training System, the first to adapt this system to conform with music educational requirements in SWA and the first to determine the effectiveness of this technological tool at a primary and secondary level of music education.

It is therefore hoped that this study may begin to answer some of the questions music educators may have regarding the use of CAI within the context of music education in SWA, its relevance and its benefits to music education.

2.0 SURVEY : DEVELOPMENTS OF CAI IN MUSIC EDUCATION

This survey assesses the current state of computer-assisted music education and provides some perspective for the context of the comparative study undertaken. Although primarily intended to provide a background and frame of reference for the present study, this survey has an additional purpose. Since 1980, computers have been gradually incorporated into the educational experience in South Africa. Most major universities, recognising the benefits of CAI, have implemented CAI learning centres to some degree. Yet in SWA, CAI is a relatively new phenomenon. It is the researcher's opinion that many educators, especially those not directly connected with CAI at an educational institution, remain sceptical of this educational aid. Furthermore, many educational planners may still regard CAI as a sophisticated, fashionable plaything or technological toy, currently fulfilling a material world's obsession for something new. By showing the extent of development of CAI and the extent of its acceptance by leading American universities, it is hoped to dispel such notions.

2.1 HISTORY

This outline of historical development, although not exhaustive, provides some indication of the development and applications of computers to education. Attention is given to research undertaken since 1970 in the application of computers to aspects of music education.

2.1.1 GENERAL

Although the development of computers in the twentieth century was adumbrated by the calculating devices of Blaise Pascal and Gottfried

Wilhelm Leibniz in the seventeenth century as well as Charles Babbages' 'Analytical Engine' in 1834, it was not until the 1930's that researchers in the USA, Britain and Germany independently developed calculating devices which used the binary system of numbers, the standard internal language of today's digital computers[4]. However, it is generally acknowledged that the birth of the modern computer age dates from February, 1946 when ENIAC (for Electronic Numerical Integrator and Computer) was unveiled at the University of Pennsylvania (Elmer-DeWitt 1986, p. 53).

In 1809 patents were issued by the U.S. Patent Office for devices which aided teaching. However, the first device labelled 'teaching machine' was patented by Sidney L. Pressey in 1926 (Gore 1969, p.84) and was used for grading multiple-choice questions and keeping student records[5].

Programmed instruction (PI)[6] or programmed learning, which has evolved since the 1950's, may be seen to be closely related to the

---

[4] A more comprehensive historical outline is given in Mach. e of the year (1983, pp. 20-22).

[5] The date of this invention is given as 1924 by Frenzel (1980, p. 86).

[6] Programmed instruction (PI), synonymous with programmed learning (PL), refers to a teaching method whereby matter to be learned is arranged in a coherent sequence of small, clear steps and presented in such a way that the student is able to instruct, test and, if necessary, correct himself at each step. There are two basic kinds of programs:

1. the 'linear program' which obliges the student to compare his own response at each step with the correct response;

2. the 'intrinsic (or branching) program' which offers a limited

development of teaching machines. CAI is its logical and natural extension, since programmed learning materials may be presented with greater flexibility by computers. Criticism leveled at CAI denigrating computers as "high speed page turners" (Blacquiere 1982, p. 415 and Osgood 1984b, p. 161) will be discussed in Chapter 10. In the early 1960's PI teaching programs were implemented on computers. Although considered impractical because of cost and size, the development of mini-computers in the mid- 1960's led to renewed interest and research in this application of computers to education. Of paramount importance was the conception and implementation of the PLATO Project in the early 1970's. PLATO is a CAI system implemented on a large and powerful time-sharing computer. A considerable library of educational courseware[7] has been developed and PLATO is today the most successful CAI project in existence[8].

With the introduction of low-cost microcomputers in 1975, CAI became an affordable and feasible alternative to PI. Its bold acceptance by universities and schools in the USA and, to a lesser extent, in Europe, has assured the computer of a place in the educational proc-

---

choice of responses at each step. The correct response is immediately reinforced; an incorrect response obliges the student to follow a corrective sub-program leading back to the point at which the error occurred. Most CAI is essentially PI on a computer.

7 Courseware: A combination of the terms course and software. The term 'software' refers to the programs of instructions that tell computers what to do, whereas 'hardware' is the machinery that makes up a computer. Therefore 'courseware' is the material to be learned, written with a computer language to form a program or a special piece of application software.

8 This opinion has been corroborated by Frenzel (1980, p.88), Gaede (1982, p.28), Lomax (1982, p.321) and others.

ess. The extent of acceptance of computers in education should not be underestimated. This point is emphasised by the following facts:

1. By 1984 Control Data had invested more than one billion dollars into its PLATO series of educational programs.

2. By October 1985 computers were considered mandatory or strongly recommended at more than two dozen educational institutions in the USA, including Drexel, Stevens Institute, Clarkson, Dallas Baptist, Carnegie-Mellon, Colby, Dartmouth, Drew, Franklin and Marshall, Lehigh, LeTourneau, Sweet Braer, Massachusetts Institute of Technology, Rochester Institute of Technology, Rensselaer Polytechnic, Case Western Reserve, Stanford, Michigan, Brown and Reed College. None have integrated computers into the curriculum more than Drexel University where there are at present eight thousand microcomputers and the total student population is thirteen thousand.

3. In 1984 the Apple University Consortium was established in which the participating members[9] purchase Apple Macintosh microcomputers at greatly reduced prices (approx. $1 000) and agree to share software developed. By 1984, fifty thousand computers had been purchased.

4. In 1982 Apple Inc. offered free computers to each elementary and secondary school in the USA provided that tax concessions would be granted. By 1984 Apple Inc. had donated ten thousand Apple

---

[9] Apple University Consortium members are Boston College, Brigham Young, Brown, Carnegie-Mellon, City University of New York, Columbia, Cornell, Dartmouth, Drexel, Harvard, Northwestern, Princeton, Reed, Rice, Stanford, University of Chicago, University of Michigan, University of Notre Dame, University of Pennsylvania, University of Rochester, University of Utah, University of Washington, and Yale (source: Osgood (1984a, p. 184).

IIe microcomputers (total value: $ 21 million) to schools in California.

5. A survey conducted in 1982 by Market Data Retrieval Inc. indicated that 130 000 microcomputers were being used in the 82 000 public schools in the USA, although the wealthier schools had significantly more computers than the poorer schools. By 1984, a survey conducted by the same company indicated that the average grade school owned 3.6 microcomputers and the average high school owned ten. These figures were expected to double annually.

6. During 1983 Control Data donated $1 million worth of equipment to Forest City, Iowa, to computerise its school system.

7. In 1970 a plan to implement CAI in French secondary schools was implemented. The cost of the 1970-1976 project was $ 20 million. With the advent of microcomputers, a ten-year plan was conceived by the French government to install ten thousand microcomputers by 1985. Yet CAI is still a scarce resource as there are 730 000 students between the ages of eleven and eighteen in France[18].

---

[18] This information was taken from the following sources:

a. Osgood (1984a,b, pp. 161-184). This provides an in-depth survey of fifteen colleges and universities in the USA where computers have been extensively incorporated into the educational experience;

b. Elmer-DeWitt (1985, p. 70);

c. Suflick (1982, p. 53);

d. Elmer-DeWitt (1984, pp. 51-53);

e. Machine of the year, (1983, pp. 6-24);

2.2 APPLICATIONS OF COMPUTERS TO MUSIC EDUCATION

In the field of music education many teaching machines and PI systems are presently in use[11]. Although adequate for cognitive learning in music, many do not suffice for developing music skills such as ear training and dictation. For these, a sound source is needed, that is, the primary learning stimulus should be provided by sound. It is acknowledged that some PI ear training courses do provide a sound source, via recordings or tape. The relative benefits of these and comparison with CAI will be considered in Chapter 10.

The need for individualisation in instruction - the individual reinforcement of desired behaviour as a necessary concomitant of learning - has been encouraged by behavioural psychologists since the early 1950's (Skinner 1960 and Deterline 1962). It would appear that researchers in the early 1970's considered the development of computer-assisted music instruction as a means of fulfilling these two primary needs.

In the late 1960's, Diehl developed an instructional program at Penn State University using an IBM 1500 computer to display music notation, play pre-recorded music examples and ask questions about the articulation, phrasing and rhythm. His subsequent research indicated that CAI assisted in improving these musical skills of participating students (Diehl 1973, pp. 1-11). Similarly, in mid- 1971, development of an interface between an electronic organ and a digital computer

---

f. Hebenstreit (1980, pp. 17-21);

g. A survey of CAI in primary schools in the UA, Alaska, England, Tasmania and South Africa is given by Baker (1982, pp. 526-528).

11 Refer to Gore (1969, pp. 85-87) for description and evaluation of these programmes.

was begun at Stanford University, allowing the organ to be played under computer control. Over the next ten years a CAI music system was developed to supplement Stanford's Music Theory curriculum[12]. The Stanford project used a linear program with appropriate branching to teach sight singing and ear training. The unique technology involved the development by IBM of an automatic pitch discriminator for training in tone production, which could extract the fundamental pitches from a musical tone, played or sung (Allvin 1971 p. 138).

The subsequent development of large CAI systems like PLATO provided the tools for implementation of music instruction methodology, with special emphasis on ear training. The installation of the first PLATO terminal on March 14, 1975 marks the beginning of the University of Delaware PLATO project and the university's Office of Computer-Based Instruction. By 1983 Delaware had 220 PLATO terminals on campus. The more recent utilisation of microcomputers (since 1980) by Delaware has resulted in an even more impressive integration of computers with education[13].

By 1979 nine National Association of Schools of Music (NASM) schools had developed learning system applications for large-scale computers, concentrating on one of five music applications. These are performance (Pennsylvania State University), teacher training (University of Illinois), music fundamentals (State University College - Potsdam, New York; Ohio State, Iowa and Georgia), ear training (Delaware and Stanford), and set-theory (Indiana) (Hofstetter 1979b, p. 41). Jones (1975) has also indicated that twenty-three institutions affiliated to NASM were involved in music applications of CAI as at 1975.

---

[12] This evolution is documented in Kuhn and Lorton (1981, pp.207-214).

[13] The extent of this integration is documented in Summative reports of the Office of Computer-Based Instruction. Historical development is outlined in the Eighth Summative Report. F.T. Hofstetter (1983a, pp. 2-6).

In 1976 the music department at California State University, Northridge, acquired the Music Education/Composition System which had been developed over a six-year period at Dartmouth College by J. Appleton, S. Alonso and C. Jones (Grigsby 1978, pp. 355-308).

It is obvious from the above historical outline that the USA is at the forefront of technological development in the educational applications of computers. Further, it should be stated that the contribution of developers and researchers in the USA constitutes, for all practical purposes, the entire body of knowledge of computer applications to education. This statement has particular relevance with regard to computer-assisted music education and is borne out by the paucity of research conducted in Western Europe[14]. It is further apparent, from a review of the literature, that the majority of published research is by developers and scholars closely connected with computer-music systems at universities in the USA.

2.3 SURVEY OF THE LITERATURE

The purpose of this review of the literature is to expand upon the context and background of the present study, to help further define the problem and to provide an empirical basis for the proposed hypotheses. Attention will be given to research regarding computer applications to aspects of music education such as performing skills, composition, music theory and ear training. From a detailed perusal of the relevant literature, it is the researcher's intention to show how the proposed hypotheses have been derived from precedent studies.

---

[14] A perusal of European Abstracts International since 1970 under Computers, Music education and Education gives credence to this observation.

2.3.1 PERFORMANCE

The concept of teaching the playing of a musical instrument by means of a computer would not seem to be feasible to most practicing musicians and results borne out by research appear to corroborate this. In his study Higgins (1981) notes that, while attempts to teach basic clarinet to seventeen students over an eight-week period using a microcomputer were moderately successful, none of the subjects would choose CAI over the traditional form of instruction. Part of a study begun in 1970 in Kansas developed improvisation skills at the keyboard amongst children by supplying a computer-driven accompaniment while students improvised (Hegarty 1970, p. 261). Similar to today's electronic organs, applications such as this should be discounted as fields for serious research. Similarly, software marketed today to 'teach' guitar[15] or other instruments may be viewed as novel applications of printed material.

Yet Diehl (1971, pp. 299-306) has stated that CAI offers the potential for meaningful research in instrumental performance. In a study conducted at Pennsylvania State University, emphasis was placed on aural-visual discrimination tasks to develop performance related skills on the clarinet, such as phrasing, articulation and interpretation. Various researchers have developed studies along similar lines where CAI in aural-visual perception skills has been compared with traditional instruction. Sanders (1980) reports no significant differences between student achievement scores, as does Asselin (1972) in part of her research study.

In an inconclusive study involving eight university students, Peters (1974) developed an interface so that a computer could be used to judge student pitch and rhythm performance accuracy on the trumpet. In 1975 he reported on the success of a PLATO project aimed at reviewing material learned by wood- and brass-wind performers regarding

---

[15] A recent example is Guitar Studio marketed by Micro Music.

intonation, articulation and tone production. This was simply an adaptation of PLATO's tutorial mode capability to present information, test it using a multiple-choice format and use corrective or appropriate branching techniques (Peters 1975 pp. 46-47).

By far the most ambitious application of computers to performance would seem to be that being developed at the University of Waterloo. Writing in 1981, Steele and Wills report on the development of a Keyboard Computer Music System where music examples performed by students on the piano are judged by a computer (1981, pp. 199-205). In this way, unevenness of touch, rhythm inaccuracies, unspecified note-retention, dynamic inaccuracies and other problems can be detected and brought to the student's attention. However, it would seem that this development is in its infancy at present.

2.3.2 COMPOSITION

Today, a wide variety of computer systems are available for music composers as an aid to composition. Digital sound synthesisers interfaced with a computer allow composers to 'write' music on the computer and hear the results immediately. A brief survey of the more sophisticated synthesisers would include the Portable Digital Sound Synthesis System developed by Harold G. Alles, Synclavier developed by J. Appleton, S. Alonso and C. Jones, the Fairlight Computer Musical Instrument designed by P. Vogel, K. Ryrie and T.Furse, and the Polyphonic POD System developed by B. Truax. Commercially available music composition systems controlled by microcomputers include the Music System by Mountain Computer, the Atari Music Composer, Music Maker Module manufactured by Texas Instruments, the Yamaha CX5M music computer and the Alpha Syntauri synthesiser developed by L.Spiegel[16]. Of recent interest is Muse, designed by L. Vollum, which

---

[16] The following articles provide more detail and historical back-

is a small computer grafted onto a high-technology music stand. It is the equivalent of a word processor for composers with a play-back facility[17].

However, relatively little research is being conducted on the use of computers as aids to teaching composition. The LASSO computer- based tutorial in sixteenth century counterpoint was developed by Newcomb (1983). It simulates the role of the teacher and provides individualised instruction. Using the PLATO system, it has been tested at Florida State University as an aid in teaching counterpoint. Jones et al (1981, pp. 215-222) report on the development of a program for teaching traditional four-part harmony composition using a microcomputer. The computer supplies the bass and first chord. The student enters the upper voices and the computer checks for errors such as parallel fifths, octaves, incorrect voice-leading and overlapping. The student may hear his composition and compare it with the suggested answer.

In addition, programs developed by P. Nye for use on the Synclavier at California State University are being used to teach creative compositional techniques while students learn to perceive structure, form and notation (Grigsby 1978, pp. 366-368). The title of the program is 'Play' and, since no basic skills such as notation are necessary, this application would appear rather limited.

As early as 1972, Smoliar (1973, pp. 121-125) predicted possible applications of computers to music composition. He visualised programs which would perform harmonic analysis of any given piece of music as well as the chronological synthesis of styles. Although valuable contributions have been made to this field by Jackson (1981), Blombach

---

ground of these systems: Hofstetter (1979b, pp. 38-45); Munford (1982, pp. 52-54); Truax (1980, pp. 40-53); DeFord (1982, pp. 90-93).

17 See Andersen (1986, p. 53);

(1976), Gross (1975), Stech (1976) and others, these predictions have yet to be realised.

2.3.3 THEORY

Much research has been conducted in developing theory programs for presentation by computer. These lessons include rudiments, notation, fundamentals, key signature, scale construction, terms and basic harmonic progressions. Kuyper (1981), Cooper (1975), Arenson (1976), Wilson (1981), Hullfish (1969), Thieme (1976), Grigsby (1978), Von Feldt (1971), Dangelo (1985) and others have reported on the development of CAI theory programs. Some of these studies simply document programs that have been developed (Kuyper, Arenson, Wilson), although it is acknowledged that student trials were conducted during program development by Arenson. Other researchers, in addition to program development and documentation, have undertaken comparative studies of the effectiveness of CAI, either in comparison with traditional instruction (Cooper 1975, Thieme 1976, Grigsby 1978, Von Feldt 1971, Dangelo 1985), other methods of instruction (Cooper 1975), or in comparison with CAI programs of different structural design (Hullfish 1969, 1972).

In evaluation of the efficacy of CAI in comparison with traditional instruction, Cooper, Thieme, Grigsby, Von Feldt and Dangelo report that there was no significant difference between the results of students receiving the different forms of instruction. Must conclude that CAI is as effective in administering instruction in music theory as the traditional form of instruction. It should be pointed out that results of evaluation studies cannot be considered superficially in terms of the computer being 'better' or 'worse' than alternate forms of instruction and that conclusions drawn by researchers should be approached with caution. It is necessary to consider each evaluation in terms of the relative merits of the research design. Flaws in the above design will be considered later.

Various music theory packages are commercially available for use with microcomputers. These include Apple Music Theory, Music Master developed by W. Kuhn and P. Lorton and marketed by Syntauri, Music Tutor developed by C. Boody and marketed by Soundchaser, and others.

2.3.4 EAR TRAINING

This critical survey of the literature of applications of computers to ear training instruction is intended as a review of major research studies undertaken to date, as well as a means of defining the context of the present research project. It is primarily intended as a justification for this project in view of the large body of research already completed in this field.

Pioneers in applications of music ear training to computers include Diehl (1971, 1973), Placek (1972, 1974), Kuhn (1974), Peters (1974, 1975), Herrold (1973), Lorton (1975) and Hofstetter (1975), although it should be observed that this research was only possible because of earlier and concurrent developments of computer-controlled sound synthesisers. Extensive developmental work carried out by M. Matthews, L.A. Hiller, G.M. Koenig and others during the 1960's as well as L. Alonso, J. Appleton, C. Jones, H. Alles and B. Truax in the early 1970's contributed to making computer-assisted ear training instruction a reality by providing a sound source[18].

Research since 1970 has taken many directions, all connected with music ear training. Researchers have focused on the development of listening skills (Smith, H 1972), instrument-identification skills (Watanabe 1981, Turk 1984) and sight-singing skills (Platte 1981, Thompson 1973, Lemons 1984, Kolb 1984). Allvin (1971, p.138) and

---

[18] For a more comprehensive report on earlier developments, refer to Truax (1980, pp. 40-53).

Hofstetter (1979b, pp. 40-41) report on the development of pitch-discrimination devices for use in training students to sing music at sight at Stanford and Delaware. Similarly, Kolb (1984) has developed a computer system which can extract the fundamental frequency of vocal tones and display these in music notation. Other researchers have examined computer applications to develop aural-visual discrimination skills (Deal 1983, 1985; Shannon, 1982). Here the student is asked to identify differences between printed music notation on the screen and the aural input from the synthesiser. As early as 1971, Diehl reported on program development at Pennsylvania State University which incorporated aural training in visual-aural discrimination tasks in conjunction with CAI for instrumentalists (1971, p. 303). It is pointed out that this skill forms part of the present UNISA Practical Musicianship examinations where candidates are required to identify rhythm and pitch inaccuracies between the printed score and music played (from Grade 6 onwards). Further, this skill is tested, albeit implicitly, in sections of UNISA examinations such as visualisation (Grade 2 onwards) and sight reading. Still other researchers have explored CAI as a means of developing tonal memory (Robinson 1984) and to teach verbal-descriptive skills upon an aural sensation of music (Lee 1975).

During the 1970's, nine NASM schools developed learning system applications for large-scale computers. By 1980 two educational institutions had developed comprehensive ear training computer programs. The concurrent research undertaken by developers of the CAI programs - W. Kuhn and P.Lorton at Stanford and F.T. Hofstetter at Delaware - provides the foundation for study of the use of computers to teach aural training in aspects of interval identification, melodic dictation, chord-quality recognition, rhythm dictation and harmonic dictation. It is acknowledged that similar developmental research has been conducted at Minnesota (Boody) and California State Universities (Nye et al). The relative merits of these and other CAI systems will be discussed later.

Although there has been considerable research directed at computer-assisted music instruction in ear training, the primary focus of attention has been on program development and program evalu-

ation. Deal (1983, 1985) developed a CAI program in pitch and rhythm error detection which was evaluated in comparison with Ramsay's conventional program. Placek (1972, 1974) concentrated on the development and design of his CAI lesson called 'Rhythm', as well as evaluations of the lessons by students following a two- week trial period. Kuhn (1974) reported on curriculum design, development and usage of the CAI ear training program at Stanford. Extensive data has been collected on student usage at Stanford and has been used primarily for evaluation of program content and improvement (Kuhn and Lorton 1981). Grigsby (1978) has detailed the capabilities of the 'Play, Teach and Sing' music programs developed by P. Nye and adapted for use at California State University. Usage of the programs is described and evaluations by students considered as part of the process to improve content. Finally, I. Smith (1980) has presented designs for two computer- based music instruction systems where only informal pilot studies were conducted.

Researchers have developed various types of similar programs with alternate designs, methods of presentation, ordering of program content, etc., to determine the effect of these variables on student achievement scores. Hullfish (1969, 1972) designed a study which compared two methods of programming instructional materials in music theory for computer presentation, to determine the effect of different types of branching: response-sensitive (br ..ching based upon a history of student responses) and response-insensitive (based upon the last response) branching. Similarly, Hofstetter (1979a) has investigated the effect of competency-based[19] branching when compared

---

[19] This refers to a predetermined criterion level of mastery before branching to a more difficult level is permitted. In Hofstetter's research (1979a), students in the experimental group had to achieve scores of ninety per cent accuracy before being allowed to proceed to the next unit (lesson), whereas their counterparts in the control group would have to complete a controlled number of exercises in each unit before proceeding (sequential ordering).

with a sequential approach to student achievement scores and the relative merits of these approaches on student learning time and amount of learning achieved. The benefits of the competency-based approach to teaching a' 'nterval identification is comprehensively documented. Studies have been made to determine the effects of computer-assisted ear training lesson time on student achievement. Data collected at Stanford (Kuhn 1974, p. 99) has been used to determine optimum length of lesson time before saturation point is reached, while Humphries (1978) has also considered the effect of lesson frequency (number of drill sessions per week) as well as the length of each computer lesson.

Much research has been conducted which concentrates on student perception and learning styles using computer-assisted music instruction. Students perceive stimuli in different ways and these studies categorise student responses by pinpointing problem areas. Hofstetter has made valuable contributions in this field. Because of the unique capability of computers to store information regarding student responses (number of incorrect/correct responses, number of trials, time for student response, etc.,), Hofstetter has been able to categorise these into "confusion tendencies" (1978a, p. 111) from analysis of student response 'matrices' or patterns. Hofstetter identifies seven such confusions in student aural perception of harmonic dictation exercises (1978a, pp. 113-117), five principles of chord-quality confusions (1980, pp. 87-91) and four such principles relating to student perception in rhythm dictation (1981b, pp. 270-277). Hofstetter has also analysed student learning styles by collecting data on exercises completed, average response time and number of repetitions requested in these studies. Similarly, research conducted at Stanford has concentrated on student learning patterns and perception problems. Kuhn and Lorton (1981, pp. 219-210) have documented the effect of transposition, length of melody, student repetition requests, rhythm complexity and size of interval (step or leap) on student ability in melodic dictation. Student accuracy in chord recognition exercises has been closely monitored and confusions analysed. Killam, Lorton and Schubert (1975) have investigated the effect of note length in student perception of intervals.

Deal has also observed the influence of the number of repetitions of an aural exercise on student achievement (1985).

Recent studies of student aural perception, although not related to CAI, have a direct bearing on computer ear training program design and future development. These include Boisen (1981), Shatzkin (1984), Schleuter and Schleuter (1985), Schmidt (1984), Sisk (1984) and Sterling (1984). Relevant observations to aural training in interval and rhythm perception from these studies will be discussed in Chapter 10. Relatively few research studies have been undertaken to determine the impact of variables such as student age and sex on achievement scores in applications of CAI to music ear training, and therefore Hypothesis 2 of the present study has significance. Lee (1975) reports on the differences in perception skills between male and female subjects using a CAI program designed to teach verbal-descriptive skills upon an aural sensation of music. In a comparison of interval and triad perception (using CAI), Lorton and Killam (1976) have reported that female accuracy was greater than male accuracy in perception of intervals whereas female accuracy was lower than males in perception of triads with notes sounded simultaneously (reported in Kuhn and Lorton 1981, p. 211).

Much research has focused on student attitude towards CAI in music education. This is evident in Arenson (1976), Placek (1972, 1974), Garton (1981), Platte (1981), Higgins (1981), Sanders (1980), Lemons (1984), Shannon (1982), Turk (1984), Hofstetter (1975), Kuhn (1974), Thieme (1976), Peters (1975), Grigsby (1978), Lindeman (1979), I. Smith (1980), Vaughn (1978), Thompson (1973), Canelos et al (1980) and others. It is interesting to note that students exposed to computer-assisted music education in the above studies generally reacted favourably towards this method of instruction. Only Higgins (1981) and Shannon (1982) report on a negative student attitude. It is noted that Higgins contrasted CAI with traditional instruction in teaching applied clarinet: none of the participants preferred the computer to traditional practical instruction (cf. Performance: 2.3.1). In a comparison of CAI and the traditional in-class approach to develop aural- visual perception skills, Shannon (1982) reports that the two groups did not differ in degree of positive or negative

attitude towards the two instructional methods. Further, student attitude, although measured by Arenson (1976) and Lemons (1984), is not indicated in Dissertation Abstracts International. The investigation of student attitude towards CAI in the present study by means of a questionnaire (q.v. Ch. 7.1) therefore contributes to the above-mentioned literature.

Comparison of CAI with alternate instructional methods such as PI and self-taught instruction in music has been extensively researched. Deal (1985) concludes that CAI in pitch and rhythm error detection appears to be a successful method of teaching this skill to college music education students and that it was no more or less effective than Ramsay's programmed materials in error detection (p. 164). This finding is consistent with that of Cooper (1975) where a comparison of teacher-taught, self-taught and CAI in teaching initial music theory yielded no significant differences in student achievement between the selected methods of instruction. However, Hofstetter (1975), Canelos et al (1980) and Garton (1981) reported contrary evidence. Hofstetter conducted a research study to determine the effect of the GUIDO CAI system in harmonic dictation. Student scores, when compared to a control group receiving instruction in a tape laboratory, were higher at the .05 level of significance. Similarly, in an evaluation of three types of instructional strategy for learner acquisition of intervals (mastery learning using CAI, programmed- and self-instruction), results obtained by Canelos et al indicated a significantly higher performance score for CAI mastery-learning and PI over self-practice. In addition, more relevant information from the instruction was acquired by learners receiving mastery learning using CAI than the PI strategy. Garton's results indicate that the CAI harmonic dictation program was more effective than tape-recorded assistance administered in the ear training laboratory at Louisiana State University. Mean gain scores of the experimental (computer) group were significant (at .01) in a comparison of difference scores (pre- and post- test) with the control (tape) group.

2.3.5 COMPARATIVE STUDIES : CAI AND TRADITIONAL INSTRUCTION

Relatively little research has been conducted specifically in this area. Of relevance are studies by Watanabe (1981) and Vaughn (1978). As stated previously, Watanabe's study was concerned with the effectiveness of CAI in developing aural skills in instrument identification. He concluded that there was no significant difference between the group exposed to the computer-assisted aural drill programs and the group receiving traditional instruction in instrument identification. Since Vaughn's study is the only research (to this author's knowledge) which relates directly to the present study, it warrants close scrutiny. Vaughn contrasted the effectiveness of computer-assisted ear training instruction with the traditional style of ear training instruction in a controlled experimental setting. The study was conducted with eighty students attending Basic Musicianship classes at Oregon State University. Students were randomly assigned to either the experimental (CAI) group or the control (traditional) group. The experimental group received the traditional classroom instruction including the theoretical instruction necessary for understanding the concepts of ear training in melodic, harmonic and rhythm dictation. This group used computer-assisted programs to reinforce the classroom learning. Eight hours of CAI was administered to this group. The control group received the same theoretical background as the experimental group, "but were free to reinforce this learning in any manner found satisfactory to each student" (1978). In the analysis of data obtained from pre- and post-tests scores, results indicated that there was a statistically significant difference favouring the experimental group in the comparison of mean scores with the control group (at the .05 level of confidence). Vaughn concludes that significantly greater academic growth in ear training occurred when students utilised the computer for this study than when they did not.

It would appear that Vaughn has avoided the most common defects in an attempt to establish internal validity of the above research design. He has controlled for various extraneous variables such as

history, maturation, testing, instrumentation, instability, selection, attrition and statistical regression[20] which might jeopardise the validity of experimental studies in education. These variables are defined in Chapter 4. Vaughn's method of control has important implications for the present research. 'History' and 'maturation' were adequately controlled since Vaughn selected students attending the same course at the same university. Therefore external factors affecting student perrormance as well as natural growth occurring in the learners was likely to be evenly spread amongst the sample. In addition, the random selection procedures used and random assignment of students to experimental and control groups ensured that the effect of 'selection', 'testing' and 'statistical regression' was minimised. It is noted that similar procedures of sample selection and random allocation to groups were used in the present study. Control for 'instrumentation', 'instability' and 'attrition' was ensured by the use of a standardised testing apparatus (Aliferis Music Achievement Test) and choice of design (Solomon Four-Group Design) in Vaughn's study.

However, there would appear to be two possible sources of invalidity in this design, although one of these is a relatively minor consideration. Vaughn does not specify the form of the alternative treatment (in the control group) or whether this treatment was monitored. It is reasonable to assume that unless the control group also received eight hours of alternative instruction, or if alternative instruction was not strictly enforced, that an imbalance in the treatments would result. Therefore, it may be possible to ascribe student improvement not to the effect of CAI, but to the lack of suitable instruction for the control group[21]. More important, however, is the observation that

---

[20] Observation and explanation of these design factors is attributed to Campbell and Stanley (1963) and are extensively replicated in educational-research literature.

[21] This information was taken from Dissertation Abstracts International, 38 1977-78, p. 3357-A.

Vaughn's study does not appear to acknowledge the so-called 'Hawthorne effect'[22] as an extraneous variable which may have had a strong bearing on results of the research. As Wolf (1979, p. 138) has observed:

"If one treatment is an innovative program involving new materials and equipment while the other is a conventional one involving used text-books, run-of-the-mill materials and the like, it is possible that learners in the first program might outperform learners in the second because they feel they are part of something 'special'".

This phenomenon is particularly apparent in research studies where CAI is compared with alternative forms of instruction or traditional instruction. Yet, in research studies using CAI in music education, many scholars appear to have overlooked or ignored the relevance of this factor.

Niemiec (1984) has observed that, when study methodology is considered, stronger studies produce different results than weaker studies. It is beyond the scope of this survey to attempt an evaluation of studies which compare CAI with traditional instruction by determining the validity of the findings in relation to the strengths and weaknesses of each design. Yet it was important in establishing the research design of the present study to consider the relevant precedent models by researchers and, hopefully, to avoid some of their weaknesses.

The Hawthorne factor appears not to have been adequately controlled in research conducted by Cooper (1975), Grigsby (1978), Thieme (1976), Sanders (1980), Dangelo (1985) Thompson (1973), Vaughn

---

[22] This has been defined as "an improvement in performance consequent upon participation in an experiment and independent of other factors. It is presumed to be mediated by motivational changes". Downing and Jones in Downing (1967) quoted in Pilliner (1973, p. 44).

(1978), Von Feldt (1971) and Canelos et al (1980). It is noted that in CAI evaluation studies by Hofstetter (1975), Garton (1981) and Watanabe (1981) the alternative treatment made use of a tape laboratory. This may be seen as an attempt to equalise treatments under study with respect to a possible Hawthorne effect. Also, Robinson (1984), Deal (1983), Shannon (1982) and Lemons (1984) chose control groups which were from different locations from CAI treatment groups. Isolation of the experimental and control groups may have proved effective in counteracting the Hawthorne effect, although this may have created additional problems of comparability of the two groups. Although Thompson (1973) noted that students in the experimental group admitted to a "wearing off of the novelty" (in a questionnaire), this does not dismiss the Hawthorne effect. Finally, Canelos et al (1980, p.247) claim that "it is doubtful that technology had anything to do with the significant differences in test performance ... The particular instructional technology [CAI] served only to deliver the instructional strategy and had relatively little effect upon learner acquisition of information". Unless one is prepared to believe that CAI was commonplace when this study was conducted in 1980, one may discard this argument as untenable.

In a study not related to computer-assisted music instruction, but conducted to determine the effects of computer programming on the problem solving abilities of sixth grade students, Ford (1984) negated the Hawthorne effect by permitting the control group to receive an 'irrelevant' treatment (word processing) via the identical technological medium used by the experimental group (the computer). Although Ford's method of control might have been effectively used in the present comparative study, an attempt to negate the Hawthorne factor was made by providing a 'relevant' treatment for the control group. This was achieved by administering CAI to both experimental and control groups with each group receiving instruction material in separate aspects of ear training. This research design is elaborated in Chapters 4.5 and 5.5. A precedent for this design was to be found in a study by Perkins (1985, q.v. Ch. 4).

It is noted that, while Hypotheses 1 and 3 of the present project have obviously been derived from the studies mentioned above, this study

does not seek to replicate any previous research in order to confirm the findings of a specific study. Instead, this study may lend support to precedent studies if its results corroborate with the findings of earlier research.

A further rationale for the present study exists: of the nineteen comparative studies of computer-assisted music instruction detailed above[23], only four have been conducted with school-going students (Asselin 1972, Dangelo 1985, Von Feldt 1971, and Robinson 1984). Also, the CAI instruction period was limited in most of these studies to the relatively short term, usually only a few hours over a short period[24].

From the foregoing extensive survey of the literature regarding music educational applications of computers, it is apparent that the raison d'être for the present research is that, simply stated, it has not previously been conducted. Certainly, the present study is the first of its kind to be conducted in SWA and RSA. Further, it is the only research (to this author's knowledge) to use the GUIDO ear training computer system in a controlled experimental setting with students at a primary and secondary level of music education, conducted over six-month period.

---

[23] Deal, Cooper, Garton, Watanabe, Platte, Sanders, Lemons, Robinson, Shannon, Hofstetter (1978a), Grigsby, Vaughn, Lee, Thompson, Von Feldt, Dangelo, Canelos et al, Asselin, Thieme.

[24] Deal: 6 weeks; Cooper: 4 lessons; Garton: 5 weeks; Watanabe: 4 weeks; Platte: 8 weeks; Lemons: 40 minutes p.w. for 10 weeks; Robinson: 1 hour p.w. for 8 weeks; Shannon: 8 weeks; Hofstetter: 7 weeks; Vaughn: 8 hours; Lee: 6 weeks; Thompson: 3 weeks; Canelos et al: one and a half hours; Asselin: 6 weeks; Thieme: 2 lessons.

3.0 OVERVIEW OF THE MICRO GUIDO EAR TRAINING SYSTEM

This chapter provides information about the CAI system used in this study. Description of its operating procedure is given from both the perspective of the student working with the system and the instructor wishing to modify the lesson content. This process of modification is comprehensively described. Finally, reasons for the choice of the CAI system used in this research are given.

3.1 BACKGROUND AND APPARATUS

In 1974 a computer-based dictation system called GUIDO® [25] was developed at the University of Delaware. GUIDO is an acronym for Graded Units for Interactive Dictation Operations, named after Guido d' Arezzo[26] (c. 990 - c. 1050), an Italian Benedictine monk and music theorist. This music education ear training tem has been extensively used at the University of Delaware. Initially intended for use on the PLATO System, the GUIDO system was adapted for use on a micro PLATO learning station in the late 1970's. The micro GUIDO learning station consists of a micro PLATO display terminal, a Uni-

---

[25] Registered trademark and service mark of the University of Delaware.

[26] Born in Arezzo, Guido d' Arezzo greatly advanced Solmization and Mutation by adapting the syllables Ut, Re, Mi, Fa, Sol, La to the Hexachord and by demonstrating the hexachordal positions on the fingers by the use of the 'Guidonian hand'. He is also, rather doubtfully, credited with the invention of the musical stave, the use of which he certainly encouraged. His chief theoretical work is entitled Micrologus de Musica.

versity of Delaware Sound Synthesiser, a set of earphones through which the student listens to the music and a single disk drive. The Micro GUIDO Ear Training System program is written on a single 8-inch floppy diskette and contains both student and instructor options[27].

3.2 STUDENT OPTIONS

Having loaded the GUIDO lessons diskette, a title page appears on the screen (see Figure 1 on page 44). This menu provides a number of options. To access any of these sections, the student must type the number preceding each section title. For example, the student wishing to proceed with Interval Dictation (i.e., interval recognition) would type '1' on the keyset. Alternatively, a student wishing to proceed with Rhythm Dictation would press '5' on the keyset.

The Micro GUIDO Ear Training System contains a complete course in music ear training which is presented in five separate programs,

---

[27] The exact specifications of the Micro GUIDO Ear Training System are given below. It consists of:

1. one Micro PLATO Student Station 110GC-002 consisting of 1 Viking Terminal with 64K Random Access Memory (RAM);

2. one primary disk drive with built-in controller including 64K RAM and featuring 1,2 megabytes of flexible disk storage;

3. one University of Delaware Sound Synthesiser;

4. the Micro GUIDO Ear Training program written on an 8-inch floppy disk.

GUIDO DICTATION LESSONS

1. Interval Dictation Drill
2. Melodic Dictation Drill
3. Chord Quality Drill
4. Harmonic Dictation Drill
5. Rhythmic Dictation Drill
6. Orchestration for the UDSS

Copyright 1982, 1984 by the University of Delaware.
All rights reserved.
GUIDO® is a registered trademark of the University of Delaware.

Figure 1. Title Page of Micro GUIDO Ear Training System

namely, interval recognition, melodic dictation, chord recognition, rhythm dictation and harmonic dictation. As noted later, it was decided to limit the field of the comparative study to aural training in interval recognition and rhythm dictation. Therefore, the following overview deals only with these two programs of the Micro GUIDO Ear Training System. The operating and descriptive procedure that follows is given from the point of view of the student working with these programs. The procedures for determining lesson content and reconfiguration (i.e., the perspective of the instructor) is given in 3.3.

3.2.1 INTERVAL RECOGNITION

---

[28] The GUIDO Interval Dictation program was developed by F.T. Hofstetter, programmed for mainframe by W.H. Lynch, and converted

```
INTERVAL DICTATION DRILL

Is your synthesiser on?  If it isn't, please turn it on now, and
plug in your headphones or speaker.  Then, press one of these
keys:

NEXT:        to see the list of interval units.
SHIFT-NEXT:  to continue working on unit 1, P1, P5, (P1 = Perfect
             1st, P5 = Perfect 5th).
LAB:         to choose an instrument for the music in the drill.
HELP:        for more information on this lesson.
BACK:        to return to your index.
```

Figure 2. Key options for GUIDO Interval Dictation Drill

Having selected this program[28] (by pressing '1' on the keyset), the student is directed to an introductory page which reminds him/her to switch the University of Delaware Sound Synthesiser on and to plug in the earphones. This page provides the student with a number of key options which are given in Figure 2.

For example, if a student wants to begin with unit no. 1 (i.e., lesson no. 1), he/she presses the NEXT key, types the number of the unit (1) and presses NEXT. Thereafter the student is taken to this lesson (see Figure 3 on page 46).

The unit title 'P1,P5' indicates that intervals of a perfect first and perfect fifth are presented in the first unit. 'Goal 4 out of 5' indicates that the student must answer four intervals correctly out of a series of five questions in order to pass a unit and continue with the next unit. For each correct answer one point will be added to the student's total. If the student answers one interval incor-

---

for micro PLATO usage by D.V. Wiley and R. Garton; copyright 1982, 1983 by the University of Delaware.

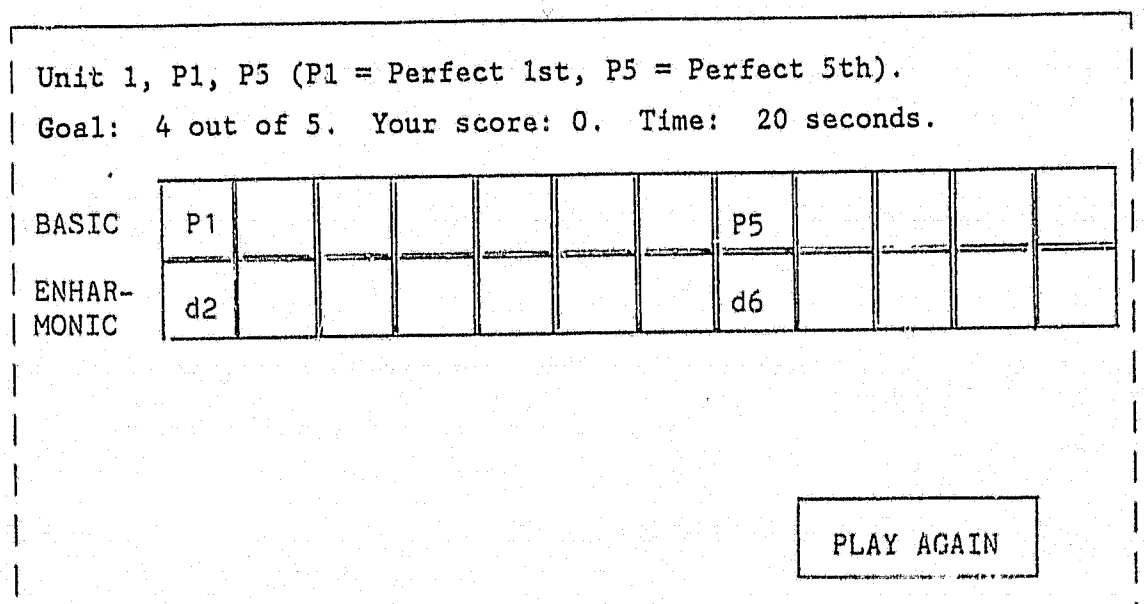
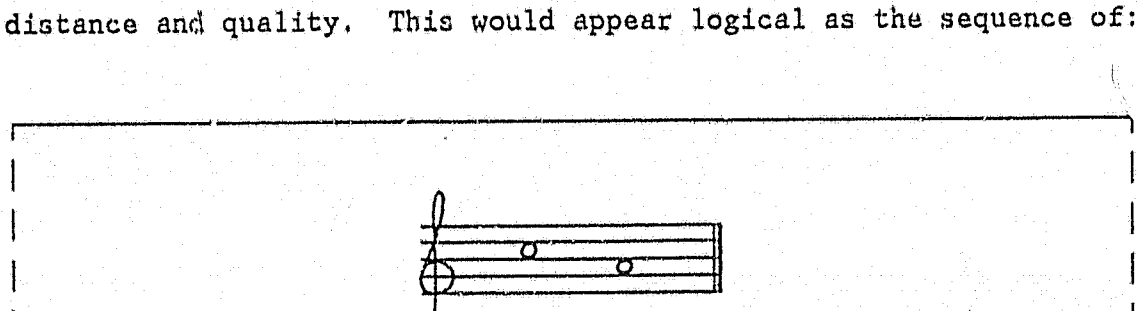


Figure 3. Reconfigured GUIDO lesson in Interval Recognition: note - message in parenthesis appears when time limit has elapsed.

rectly, his/her score remains unchanged. However, if two consecutive incorrect answers are given, the student's score drops to zero. Therefore the goal of '4 out of 5' means that four consecutively correct answers must be given out of a series of five questions. 'Your score = 0' indicates the student's score at the moment. 'Time = 20 seconds' indicates the time allowed to answer each interval. The student may answer after the time allowed has elapsed (a message indicating this will appear on the screen). However, no points will be awarded for a correct answer in this instance.

The student listens to the interval played through the earphones. The unit title indicates the interval options in each particular lesson and it is important to note that the computer selects an interval at random from these options. Therefore a student cannot 'learn' the order of questions and anticipate an answer. In the case

of ascending intervals, the first note heard by the student is the tonic (doh) of a scale and the student is required to identify the second note heard in relation to this first note. In the case of descending intervals, the second note heard is the tonic and the student is required to 'work backwards' in obtaining the interval distance and quality. This would appear logical as the sequence of:



produces an interval of a minor third. However, as observed later, in the UNISA syllabus for Practical Musicianship, the interval is always named in relation to the first note, whether the interval is ascending or descending. In the above example, the candidate sitting for a UNISA examination is expected to identify the interval as a major sixth, that is, the A note is the sixth degree of the major scale of C heard below the tonic.

In the first reconfigured GUIDO Interval Dictation unit, music intervals of a perfect first and perfect fifth are asked in ascending form only and in each instance the first note or tonic moves about within preset limits. If the student thinks that the second note heard is a perfect fifth above the first note, for example, he/she actually touches the box marked 'P5' on the screen. If the answer is in fact 'P5', this box lights up and the message 'Correct' is displayed. The student's score moves to '1' and the next interval is played. If the answer is not P5 (in this example), an arrow appears below the box 'P5' (pointing to the left) indicating the direction of the correct answer. The student may play the interval again and, having identified the correct box, the message 'Right' is displayed and his/her score remains stationary (or drops to zero if the previous interval was also answered incorrectly). When the student achieves his/her goal (as set for the unit) the message 'Con-

gratulations! You have completed this unit. Press NEXT' is displayed. The student presses the NEXT key and proceeds to the next unit.

Whenever the message 'HELP is available' is displayed on the screen, the student may press the 'HELP' key and is then directed to a list of HELP topics. Each of these provide information on what the interval dictation drill does, how to identify the intervals in the drill, how the score is calculated and keys that may be used in the drill.

This information was contained in the instructions given to each student at the start of the research project (see Appendix A).

3.2.2 RHYTHM DICTATION

Having selected this program[29] (by pressing '5' on the keyset), the student is directed to an introductory page containing the same information as presented in the interval program (see Figure 2 on page 45). The 'LAB' function key permits the student to choose an instrument for the music in the lessons. Here the student must select 'Sound for Rhythm Drill'. If this is not selected, the notes played in the rhythm lessons will not be clearly defined and the note values will be indistinct, difficult to hear and consequently difficult to notate. Thereafter, the student selects the unit (lesson) he/she wishes to begin with by pressing the number of the unit on the keyset. If 'unit 1' is selected, the following information is presented on the screen (Figure 4 on page 49). The title indicates the time

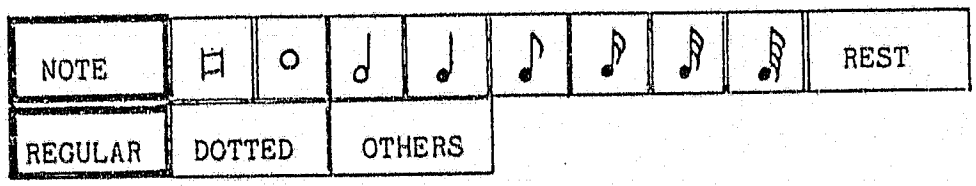
---

[29] This program was developed by F.T. Hofstetter, programmed for PLATO by W.H. Lynch and converted for micro PLATO usage by D.V. Wiley; copyright 1982, 1983 by the University of Delaware.

Unit 1 Simple time signature: 2/4 (simple duple).

2
4 

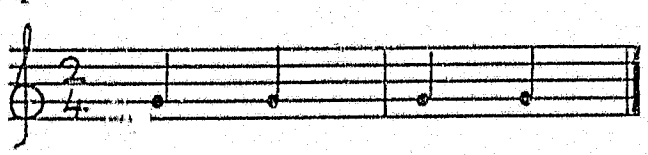
Touch the notes you hear on the boxes below



PLAY AGAIN METRONOME

HELP is available

Notes: The message 'Please wait .. exercise is being composed' appears at first. After a second or two this changes to 'Touch the notes you hear on the boxes below'. The message 'Sorry! You time is up. Finish the rhythm or press NEXT' appears when time limit has elapsed. If the correct answer is entered:

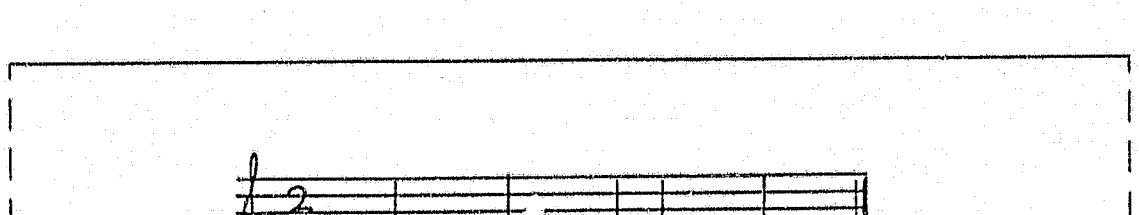


the following message appears: '100% right. Your score: 1. Goal 4 out of 5. Press NEXT'.

Figure 4. Reconfigured GUIDO lesson in Rhythm Dictation.

signature(s) of rhythms presented in a particular lesson. The time signature as well as the first note (or beat) is always given in rhythm dictation exercises. The student listens to the rhythm played and then answers the question by selecting the note-values required from the row of boxes. Unit 1 may serve as an example. This message first appears: 'Please wait - Composing new exercise'. After a second or two, this changes to: 'Touch the notes you hear on the boxes below'. Printed on the screen is the time signature, the first note

of the rhythm played and an arrow. The arrow indicates that the computer is awaiting a response. In this instance, the first note heard was a quarter note (crotchet) and this is the first note of the rhythm heard. This is followed by three more beats, each beat of the same length as the first given note. Therefore the answer to this lesson must be:



The student answers by touching the box marked ' ♩ ' on the screen. At each touch, a quarter-note appears on the screen, completing two bars (measures) of rhythm. It is noted that bar- lines appear automatically at the end of a correctly completed measure and a double bar-line appears at the end of the rhythm. If the rhythm has been answered correctly, the message: 'Your score 1; Goal 4 out of 5. Press NEXT' is displayed.

Rests may be selected by touching the box marked 'REST'. Thereafter, rests of equivalent value to the notes in each box will be displayed. If a dotted note is required, the student first presses the box marked 'DOTTED' and then the note value required. All rhythms are played on a single repeated pitch. Comprehensive operating instructions were given to each student (see Appendix A).

3.3 RECONFIGURATION OF THE MICRO GUIDO EAR TRAINING SYSTEM

The programs in ear training that ac ...e GUIDO system are primarily intended for use by music stud... a tertiary level of

education (Hofstetter 1975, p. 100). This is immediately apparent from an examination of the lesson contents of any of the GUIDO programs. For example, in the Interval Dictation Drill, the first lesson includes intervals of P1, M2, P4, M7 (P = Perfect; M= Major). By unit no. 6, all twelve chromatic ascending music intervals are presented and tested. By unit no. 10, all ascending and descending intervals of the chromatic scale are presented and tested. Similarly, in the GUIDO Rhythm Dictation Drill, half-beat values are introduced using simple-, duple-, triple- and quadruple time signatures by unit no. 3, quarter-beat values by unit no. 9, and ties and triplets are introduced in unit nos. 7 and 15 respectively.

In contrast, a perusal of the UNISA syllabus for Practical Musicianship Grade examinations (Appendix E) reveals far more modest expectations from music students at the primary and secondary level of music education. It is noted that the UNISA grade examinations have been extensively adopted both in SWA and the RSA and provide an accepted context for music education in these countries at this level. For example, regarding interval recognition, a UNISA Grade 1 student is required to identify one of the first five notes of a major scale sounded after the tonic. Intervals of the harmonic minor scale are presented in Grade 6 for the first time (either ascending or descending).

It is obvious that, since the present comparative study was to be conducted at this primary and secondary level of music education, the standard GUIDO programs would not be suitable. Fortunately, developers of the GUIDO system have allowed for this by providing a table-driven lesson design, whereby the lesson content may be changed. Each GUIDO program reads a set of instructional variables from a master table. These variables specify the questions to be asked, how to ask them and what actions to take based on student performance (Arenson & Hofstetter 1983, p. 47). Therefore the term 'reconfiguration' refers not to a re-writing of the GUIDO programs, but to an adaptation of lesson content. The format for lessons is predetermined in the GUIDO program and cannot be changed, yet all other variables such as lesson title, content, time limit, expected student proficiency, etc., may be specified.

This facility, which permitted adaptation of instructional variables, was extensively used in the formulation of the CAMETS programs, using the capabilities of the GUIDO system. It was previously observed that each GUIDO diskette contains both student and instructor options. In order to change the variables of GUIDO lessons, the instructor enters a code-word. This prevents students from accessing the instructor option.

3.3.1 CAMETS PROGRAM IN INTERVAL RECOGNITION

Method of Reconfiguration

An 'Interval Parameter Editor'[30] has been designed for the Micro GUIDO system whereby the content of lessons may be edited. Editing is carried out by first specifying titles which are to be assigned to any of the units (lessons). Next, the editor 'constructs' lessons by entering the specification of the content and scoring constraints for each instructional unit. An example of this is given in Figure 5 on page 53.

Thereafter, the editor specifies the order in which units are to be presented by entering their number-sequence on a table. Finally the editor specifies the table to be used.

The complete CAMETS program in Interval Recognition is given in Appendix B.

Sequence of CAMETS Interval Recognition units

---

[30] This was developed by F.T. Hofstetter. The original PLATO version was written by W.H. Lynch; Micro PLATO version written by R. Garton and J. Conrad; copyright 1981, 1983 by the University of Delaware.

```
Unit 1.  P1, P5, (P1 = Perfect 1st, P5 = Perfect 5th).
Title:  1                              >
Direction:  up
Range:  bottom for C4 to C4
Length:  2.6 seconds
Time Limit:  20 seconds
Advancement:  4 out of 5
Plays:  unlimited
Spelling:  no

P1, P5 : yes ;          All other intervals : no

Type the NUMBER of the title you want assigned to this unit.
Press:  NEXT or BACK to move the arrow down or up.
        SHIFT-DATA to save changes when done with this unit!
        SHIFT-LAB  to copy another unit into this one.
        SHIFT-HELP to delete this unit,
        SHIFT-NEXT for the next unit,
        SHIFT-BACK to return to the unit list.
```

Figure 5. Interval unit editing program of GUIDO system: note - the researcher has specified all the information after each colon.

Four hundred and thirty-seven units were created which cover the requirements of the CAMETS syllabus (see Appendix D) from beginner to a grade 8 level. Units 1-60 present the first five notes of the major scale (ascending). These are presented in the following order: P5; M3; M2; P4 (P = Perfect; M = Major).

This material covers the requirements for Grade 1. The justification for the particular order in which intervals are introduced is derived from the principle that notes of the tonic triad should be presented before the dominant and subdominant triads (Ulster 1956, p. 105). Ulster recommends that soh (or the Perfect 5th) is best introduced

after doh, rather than me (Major 3rd) after doh, because it "affords an easier interval after doh, for small children to grasp, than would me" (p. 105). Thereafter, units 61-126 present the eight notes of the major scale as ascending intervals in concordance with requirements of the CAMETS syllabus for Grades 3 and 4. The sequence is again based on Ulster's principle (see above) and notes are introduced in the following order: P5; P8; M3; M7; M2; P4; M6.

Ulster observes that, after the introduction of P5, the interval of a perfect octave (doh^{1}) is introduced because P8 is easier to grasp than M3: "Some music teachers maintain that me should be introduced before doh^{1}, but there is no real reason for this and doh^{1} does afford a greater interval and hence is preferred after soh (1956, pp. 105-106). Ulster then suggests the addition of notes of the dominant triad (that is, M7 and M2, since P5 has already been introduced) and then notes of the sub-dominant triad (that is, P4 and M6).

Descending intervals of the major scale are then presented in the same order as ascending intervals (units 127-192). Thereafter both ascending and descending intervals of the major scale are presented (units 193-210). Units 211-248 cover the notes of the harmonic minor scale in ascending form (only m3 and m6 are 'new' intervals; m = minor). Next, the notes of the descending harmonic minor scale are presented (units 249-288) and then combined with ascending intervals of the same scale (units 289- 300). After this, both major and harmonic minor scale intervals are combined, first ascending, then descending, then both ascending and descending (units 301-330). Thereafter, intervals of the tritone, minor second and minor seventh are introduced in ascending form, then in combination with all intervals previously presented, and finally in descending form (units 331-437).

The CAMETS Interval Recognition program is intended as a precursor to the standard GUIDO program. The linear sequence is very much more gradual and incremental since the 437 units of CAMETS represent the first ten units of GUIDO.

3.3.2 CAMETS PROGRAM IN RHYTHM DICTATION

Method of Reconfiguration

A 'Rhythm Parameter Editor'[31] has been designed for the Micro GUIDO system whereby the contents of lessons may be edited. Editing is effected in a similar manner to that described for the Interval Recognition lessons. An example of the editing of rhythm units is given in Figure 6 on page 56. The complete program is given in Appendix C.

Sequence of CAMETS Rhythm Dictation units

This comprehensive program comprising 339 units (lessons) was designed by the researcher to conform exactly with requirements of the CAMETS syllabus (see Appendix D) from a beginner to a grade 8 level. The order of presentation of lessons conforms with the syllabus. It is noted that, whereas the process of entering variables for the CAMETS Interval Recognition program was merely time-consuming, the process of entering variables for the CAMETS Rhythm Dictation program was problematic as well. This was so because it was this researcher's intention to present rhythm questions with correct groupings of notes and rests. Two examples from the standard GUIDO program serve to explain this. In unit no. 1 of the original program entitled 'Undivided Beat Values in 2/4, 3/4 and 4/4', the list specified is:

List 1

1 (4.00 : 4.00) 4/4 1 (i.e., 𝅝)
2 (2.00 : 2.00) 1/2 1 (i.e., 𝅗𝅥)

---

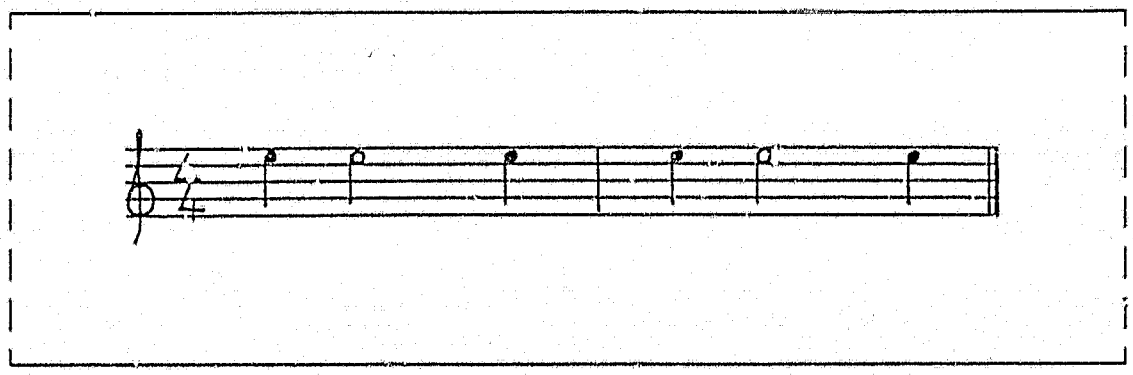
[31] Developed by F.T. Hofstetter; mainframe PLATO version by W.H. Lynch; micro PLATO version by D.V. Wiley and J. Conrad; copyright 1982, 1983 by the University of Delaware.

```
Unit 1.  Simple time signature: 2/4 (simple duple).
Title :                                  >
Measures : 2 to 2
Speed : 75
Pitch : C4 to C4
Simple-Compound Ratio : 1 : 0
Time Limit : 10 seconds
Plays : unlimited
Percent: 80%
Advancement:  4 out of 5
Metronome : choice
Simple Lists  : 1, 0, 0, 0, 0    Compound Lists  : 0, 0, 0, 0, 0
Simple Values : 1, 0, 0, 0, 0    Compound Values : 0, 0, 0, 0, 0
Ties : 0%
Simple Time Signatures
Top     2   :  99    (all other choices specified as zero)
Bottom  4   :  99    (all other choices specified as zero)

Type the number of the title you want for this unit.

SHIFT-DATA to save changes (unit must have a title; NEXT/BACK
moves arrow; SHIFT-HELP deletes unit; SHIFT-BACK - unit list;
SHIFT-LAB - copy a unit into this one; SHIFT-NEXT - next unit
```

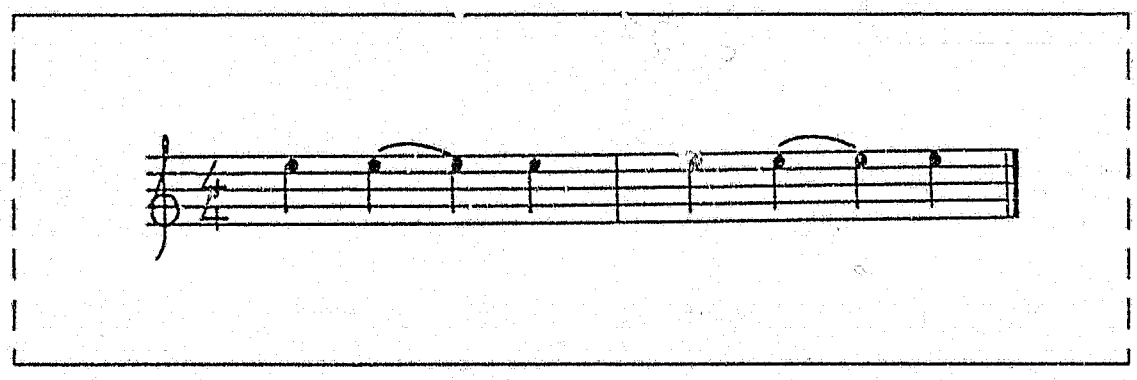
Figure 6. Rhythm unit editing program of GUIDO system: note - the researcher has specified all information after [illegible] colon.

3 (3 [illegible] : 3.00) 3/4 1 (i.e., 𝅗𝅥.)
4 ([illegible] : 1.00) 1/[illegible] 1 (i.e., ♩)

As explained in Appendix C, this means that the computer may select either a semibreve, minim, dotted minim, crotchet, or any combination of these in the construction of rhythms in the specified time signatures. Therefore, the following rhythm is possible :



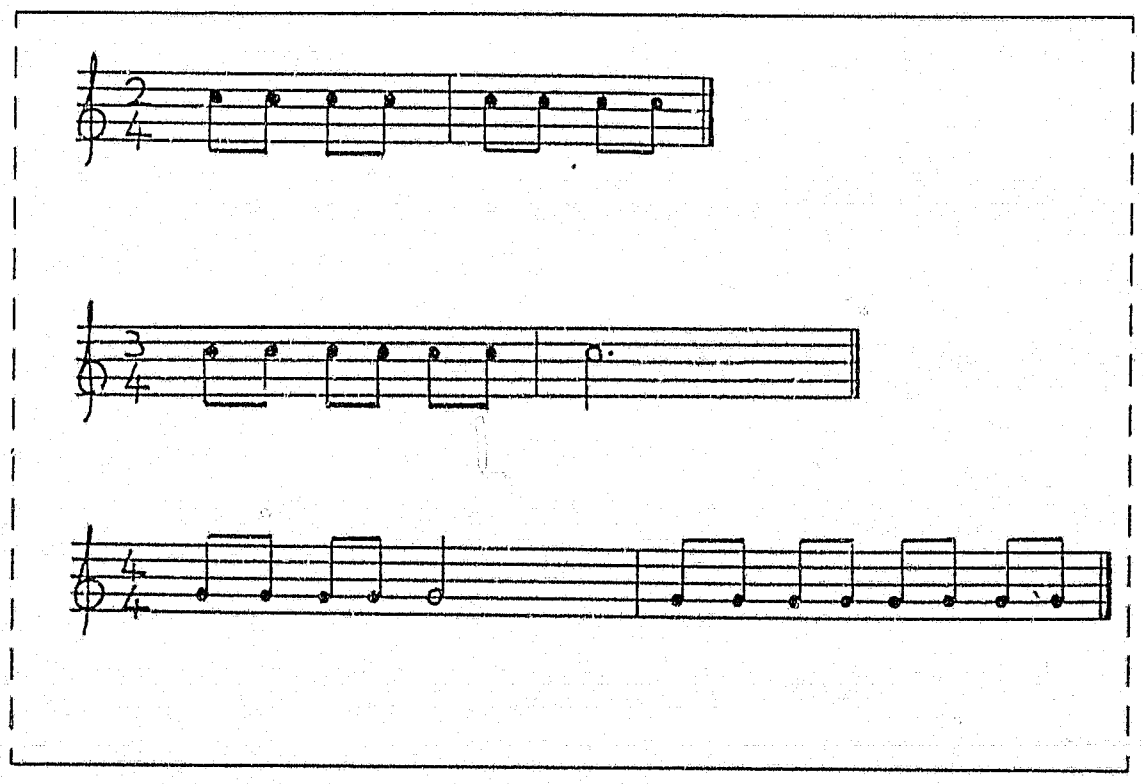
Although not critical, it was considered preferable to avoid such syncopations, especially in the lower grades. Also, purists may argue that it would be better to notate the above rhythm as:



so that the division of each bar is maintained. In a later lesson (unit 3 : 'Half-Beat Values in 2/4, 3/4 and 4/4') the following pattern is added to the above list (List 1):

5 (1.00 : 1.00) 1/8 1/8 2 (i.e., ♪♪)

Now, the computer may construct and present rhythms such as:



It is noted that this is <u>exactly</u> how student answers would appear on the screen. Since young children were being taught to notate rhythms in this study, it was considered imperative that they be taught to group notes correctly according the the specified time signature. The rules regarding grouping of notes and rests, as stated in any standard text of rudiments of music[32], were strictly enforced in the preparation of the CAMETS Rhythm Dictation program. This was achieved by 'blocking' all possibilities for incorrect groupings.

Unit no.3 of the standard GUIDO program (see above) may serve as an example. To ensure correct grouping of notes, unit no. 3 would have been broken down into two lessons. In the first, time signatures of 2/4 and 4/4 would be presented. The list of note patterns would be constructed as follows:

List

---

[32] Macpherson (1970, pp. 21-25) and <u>Rudiments and Theory of Music</u> (1958, pp 41-43).

1 (4.00 : 4.00) 4/4 1 (i.e., )
2 (2.00 : 2.00) 1/2 1 (i.e., )
3 (2 00 : 2.00) 1/4 1/4 2 (i.e., )
4 (2.00 : 2.00) 1/8 1/8 1/8 1/8 4 (i.e., )
5 (2.00 : 2.00) 1/4 1/8 1/8 3 (i.e., )
6 (2.00 : 2.00) 1/8 1/8 1/4 3 (i.e., )

Now correct grouping of notes is ensured. Similarly, a unit would be created for rhythms in simple triple time signature 3/4. The list for these rhythms would be constructed as follows:

List

1 (3.00 : 3.00) 3/4 1 (i.e., )
2 (1.00 : 1.00) 1/4 1 (i.e., )
3 (2.00 : 2.00) 1/2 1 (i.e., )
4 (3.00 : 3.00) 1/8 1/8 1/8 1/8 1/8 1/8 6 (i.e., )
5 (3.00 : 3.00) 1/2 1/8 1/8 3 (i.e., )
6 (3.00 : 3.00) 1/8 1/8 1/4 1/4 4 (i.e., )

It is noted that, in the CAMETS program, the addition of note- patterns is far more gradual than that given in the above example. Each new pattern is introduced on its own and only later combined with previous patterns. It should be evident that the problem of ensuring correct note-groupings was compounded as smaller note- values were introduced, both in simple time signatures and when compound time signatures were presented. Nevertheless, it was considered desirable to create an acceptable program for use by students at a primary and secondary level of music education.

3.4 THE CAMETS SYLLABUS

The CAMETS syllabus is based on the UNISA Practical Musicianship syllabus for graded examinations in music. As noted earlier, the UNISA syllabus is widely accepted in SWA and RSA. It was therefore used as a model of music educational requirements at a primary and secondary level of education. Since this study was concerned with aural training in interval recognition and rhythm dictation, only these sections of the UNISA syllabus were considered. The relevant portions are given in Appendix E and the CAMETS syllabus in both Interval Recognition and Rhythm Dictation is given in Appendix D.

A number of differences between the two syllabi are acknowledged at the outset and are considered below. It was necessary to modify the CAMETS syllabus because of the nature of the computer instruction program.

3.4.1 CAMETS SYLLABUS IN INTERVAL RECOGNITION

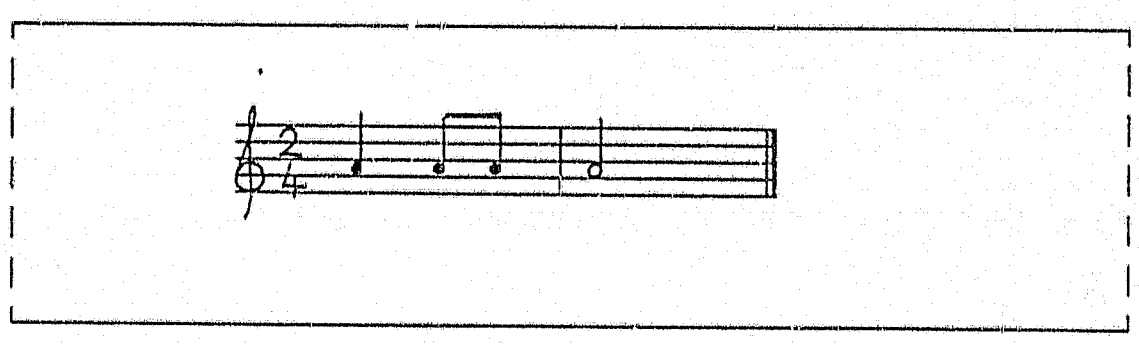
It will be seen that this syllabus closely follows that of UNISA. However, the computer system used could not test a student's ability to sing an interval. So the requirement that students must 'hum, sing or whistle' an interval is not included in the CAMETS syllabus or tests. It was necessary to devise the CAMETS syllabus for Grades 7 and 8 because interval recognition is no longer tested as such in the corresponding UNISA grades. The CAMETS Grades 7 and 8 syllabus is justified as a logical hierarchical extension of the previous grades, so that the remaining chromatic intervals are covered, first ascending, then descending.

3.4.2 CAMETS SYLLABUS IN RHYTHM DICTATION

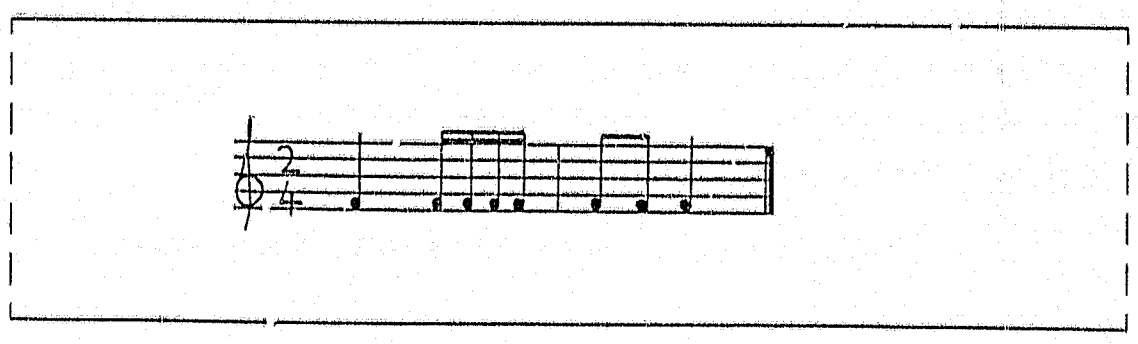
As will be seen from the UNISA syllabus, it is only from Grade 5 onwards that the student is required to 'name the note values' of a passage. Therefore, it was necessary to devise the CAMETS syllabus for preceding grades and to take into account the capabilities of the CAI program. The CAMETS syllabus in Rhythm Dictation (Appendix D) indicates which time signatures are required for a particular grade and the rhythmic patterns with which a student is expected to be familiar in these particular time signatures. Each grade is accumulative, i.e., the student is expected to know the rhythmic patterns given in time signatures for <u>all</u> previous grades.

For example, at a grade 2 level, the student must be able to notate rhythms in 2/4 using different configurations of the following rhythm patterns:

𝅗𝅥 , ♩ and ♫ . Therefore one possible rhythm might be:



In Grade 3 the pattern ♫♩♩ is added so that one possible rhythm might be:



Author Zolkov A M
Name of thesis The use of Computers in Music Education in South West Africa 01163

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2013

LEGAL NOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed, or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page) for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.