THE INFLUENCE OF
SELF-REGULATION ON INSTRUMENTAL PRACTICE

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for the degree
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October 1996
PLEASE NOTE

The greatest amount of care has been taken while scanning this thesis,

and the best possible result has been obtained.
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No other person's work has been used without due acknowledgment in the main text of the thesis.

This thesis has not been submitted for the award of any other degree or diploma in any other tertiary institution.

..........................................................

Dated: 31st October 1996

Vanda G. Weidenbach
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ABSTRACT

The main purpose of this dissertation was to explore the psychomotor and cognitive characteristics of the practice behaviours of a group of novice keyboard instrumentalists and to identify those factors which had most significant influence on performance achievement. The pivotal question guiding the study was “How can one characterise the effects of practice strategies on the performance outcomes of this group of novice performers?” Six research questions were examined. The first three concerned student predisposition, practice procedures, and performance achievement. The second three questions examined the relationships between personal characteristics, practice behaviours and performance outcomes.

To answer these questions, the practice behaviours of twenty-one young adults training to be primary teachers, who were enrolled in a keyboard elective, were investigated. The study was conducted in a microtechnology-based environment. Students’ explanations of how they thought about, planned and implemented practice, as well as other issues related to cognitive engagement, were documented via individual journals, questionnaires, problem solving activities and tests. The physical behaviours demonstrated by students during private practice were recorded and saved to computer disk and audio tapes across the period of the study to provide evidence of psychomotor conduct.

The results of the study indicate that some beginners are capable of cognitive engagement in the execution of practice. Students who planned, analysed, and evaluated practice strategies, both mentally and physically, were identified as self-regulated learners. These students were the more successful achievers. Students who made use of the technology, specifically for instructional purposes, made more gains than those who did not. Accumulated practice was not found to influence performance achievement. Implications for future research on this little explored subject were included.
TABLE OF CONTENTS

Statement of Authorship................................................................. i
Acknowledgments........................................................................... ii
Abstract............................................................................................ iii
Table of Contents........................................................................... iv
List of Tables...................................................................................... xiii
List of Figures..................................................................................... xiv

CHAPTER ONE

NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION............................................................................. 1

1.2 THE IMPORTANCE OF PRACTICE............................................... 2
1.2.1 Self-Regulated Learning......................................................... 3
1.2.2 Technology Applications....................................................... 4

1.3 DELINEATION AND JUSTIFICATION FOR THE STUDY.......... 6
1.3.1 Aims of the study................................................................. 7
1.3.2 Intended format of this study............................................... 9

1.4 KEY TERMS RELATED TO THE STUDY................................. 10
1.4.1 Practice- Routine practice, planned practice, deliberate practice........................................... 10
1.4.2 Sight Reading........................................................................ 11
1.4.3 Metacognition...................................................................... 11
1.4.4 Self-Regulation.................................................................... 12
CHAPTER TWO
OVERVIEW OF INSTRUMENTAL PRAXIS: PAST AND PRESENT

2.1 INTRODUCTION.................................................................15

2.2 INSTRUMENTAL PERFORMANCE.........................................16
2.2.1 Musical ability............................................................16
2.2.2 Cognitive ability........................................................19
2.2.3 Musical achievement....................................................20
2.2.4 The nature and development of expertise.........................22
2.2.5 The development of instrumental skills............................25
2.2.6 Environmental influences..............................................28

2.3 INSTRUMENTAL INSTRUCTION..........................................29
2.3.1 Traditional approaches to teaching.................................29
2.3.2 Contemporary approaches to teaching.............................30

2.4 SUMMARY........................................................................30
CHAPTER THREE

REVIEW OF THE LITERATURE: PRACTICE AND FACTORS WHICH INFLUENCE PERFORMANCE OUTCOMES

3.1 INTRODUCTION.................................................................33

3.2 PRACTICE...........................................................................34
  3.2.1 The influence of practice on skill development...........34
  3.2.2 The development of performance expertise through practice.................................................37
  3.2.3 Early investigations of practice........................................38

3.3 FACTORS BELIEVED TO AFFECT PRACTICE.................40
  3.3.1 Sight reading...............................................................40
  3.3.2 Modelling......................................................................42
  3.3.3 Feedback........................................................................44
  3.3.4 Motivation......................................................................45

3.4 TEACHERS' INFLUENCE ON PRACTICE.........................48
  3.4.1 Teachers' attitudes to practice.................................48
  3.4.2 Teachers' recommended strategies.........................49
  3.4.3 Teaching practice as a skill........................................50
  3.4.4 Summary........................................................................50

3.5 PSYCHOMOTOR ASPECTS OF INSTRUMENTAL PRACTICE...........51
  3.5.1 Physical practice.........................................................51
3.6 COGNITIVE ASPECTS OF INSTRUMENTAL PRACTICE.......54
3.6.1 Self-regulated learning.................................................55
3.6.2 The application of metacognitive thinking to instrumental
learning...........................................................................60
3.6.3 Mental practice..............................................................61
3.6.4 Characteristics of deliberate practice.............................64

3.7 COMPUTER TECHNOLOGY IN INSTRUMENTAL
PRACTICE.................................................................69
3.7.1 Cognitive apprenticeship...............................................69
3.7.2 Computer aided practice..............................................70

3.8 IMPLICATIONS FOR THIS STUDY.................................71

CHAPTER FOUR
RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION............................................................73
4.1.1 Research questions.....................................................75

4.2 DESIGN OF THE STUDY..................................................76
4.2.1 Description of the sample.............................................76
4.2.2 Setting and equipment ................................................77
4.2.3 Procedures.................................................................78
4.2.4 Instrumentation.........................................................82

4.3 RESEARCH QUESTIONS..................................................82
4.3.1 Question 1
What entry behaviours did students bring to the study?.........82
4.3.2 Question 2
Were students metacognitively engaged in the planning and implementation of practice?..............................85
Planned Practice.........................................................85
Self-Regulated Learning Strategies...............................86
Independent Learning..................................................88
Deliberate Practice......................................................89
Self-Directed Physical Practice.....................................89
Instructional and Motivational use of the MT100..............91
Specific Instructional Applications of the MT100..............92

4.3.3 Question 3
What level of performance outcomes did students achieve at the conclusion of the study?..............................93
Performance Achievement..........................................93
Repertoire Progress....................................................94
Sight Reading Ability..................................................94
Scanning Ability.........................................................94

4.3.4 Students attitudes to practice..................................95
Practice .................................................................95
Computer Aided Practice.............................................95

CHAPTER 5
PRESENTATION AND INTERPRETATION OF THE DATA
5.1 INTRODUCTION..........................................................97
### 5.2 QUESTION 1
WHAT ENTRY BEHAVIOURS DID STUDENTS BRING TO THE STUDY?

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2.1 Ability to use Computers</td>
<td>99</td>
</tr>
<tr>
<td>5.2.2 Attitude to Computers</td>
<td>99</td>
</tr>
<tr>
<td>5.2.3 Aural Aptitude</td>
<td>100</td>
</tr>
<tr>
<td>5.2.4 Music Experience</td>
<td>101</td>
</tr>
<tr>
<td>5.2.5 Summary of Entry Skills measures</td>
<td>102</td>
</tr>
</tbody>
</table>

### 5.3 QUESTION 2
WERE STUDENTS METACOGNITIVELY ENGAGED IN THE PLANNING AND IMPLEMENTATION OF PRACTICE?

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3.1 Planned Practice</td>
<td>104</td>
</tr>
<tr>
<td>5.3.2 Self-Regulated Learning Strategies</td>
<td>105</td>
</tr>
<tr>
<td>5.3.3 Independent Learning</td>
<td>118</td>
</tr>
<tr>
<td>5.3.4 Deliberate Practice</td>
<td>120</td>
</tr>
<tr>
<td>5.3.5 Self-Directed Physical Practice</td>
<td>122</td>
</tr>
<tr>
<td>5.3.6 Instructional use of the MT100</td>
<td>125</td>
</tr>
<tr>
<td>5.3.7 Motivational use of the MT100</td>
<td>128</td>
</tr>
<tr>
<td>5.3.8 Specific instructional applications of the MT100</td>
<td>130</td>
</tr>
</tbody>
</table>

### 5.4 QUESTION 3
WHAT LEVEL OF PERFORMANCE OUTCOMES DID STUDENTS ACHIEVE AT THE CONCLUSION OF THE STUDY?

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4.1 Performance Achievement</td>
<td>132</td>
</tr>
<tr>
<td>5.4.2 Repertoire Progress</td>
<td>133</td>
</tr>
<tr>
<td>5.4.3 Sight Reading Ability</td>
<td>134</td>
</tr>
<tr>
<td>5.4.4 Scanning Ability</td>
<td>135</td>
</tr>
</tbody>
</table>
CHAPTER SIX
DISCUSSION AND ANALYSIS OF RESULTS

6.1 INTRODUCTION ................................................................. 141

6.2 ENTRY STATUS ................................................................. 142
6.2.1 Interrelationship of Entry Status variables ......................... 143

6.3 QUESTION 4
WAS PRACTICE INFLUENCED BY PERSONAL
CHARACTERISTICS EXHIBITED BY STUDENTS AT THE
COMMENCEMENT OF THE STUDY? ........................................ 144
6.3.1 Ability to use Computers ............................................. 145
6.3.2 Attitude to Computers .............................................. 146
6.3.3 Aural Aptitude ......................................................... 146
6.3.4 Music Experience ................................................... 147

6.4 PRACTICE BEHAVIOURS ................................................ 149
6.4.1 Interrelationship of Practice Behaviour variables ............... 149
6.5 QUESTION 5
WERE PERFORMANCE OUTCOMES AFFECTED BY
PARTICULAR PRACTICE STRATEGIES? 

6.5.1 Metacognitive aspects of Practice
6.5.2 Psychomotor Behaviours
6.5.3 Computer Aided Learning
6.5.4 Practice
6.5.5 Computer Aided Practice

6.6 OUTCOMES

6.6.1 Interrelationship of outcomes variables

6.7 QUESTION 6
WAS THE RELATIONSHIP BETWEEN PRACTICE STRATEGIES
AND PERFORMANCE OUTCOMES MODERATED BY THE
INFLUENCE OF STUDENT PREDISPOSITION?

CHAPTER SEVEN
SUMMARY, DISCUSSION AND IMPLICATIONS

7.1 INTRODUCTION

7.2 MAJOR OUTCOMES OF THE STUDY

7.2.1 Student pre-disposition
7.2.2 Metacognitive Practice
7.2.3 Influence of Metacognitive Practice on Performance
    Achievement
7.2.4 Sight Reading
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Ability to use Computer</td>
<td>83</td>
</tr>
<tr>
<td>4.2</td>
<td>Kuder-Richardson Reliability MEK</td>
<td>84</td>
</tr>
<tr>
<td>4.3</td>
<td>Music Experience</td>
<td>85</td>
</tr>
<tr>
<td>4.4</td>
<td>Planned Practice</td>
<td>86</td>
</tr>
<tr>
<td>4.5</td>
<td>Self-Regulated Learning Strategies</td>
<td>87</td>
</tr>
<tr>
<td>4.6</td>
<td>Level of Independent Learning</td>
<td>88</td>
</tr>
<tr>
<td>4.7</td>
<td>Level of Deliberate Practice</td>
<td>89</td>
</tr>
<tr>
<td>4.8</td>
<td>Self-Directed Physical Practice</td>
<td>90</td>
</tr>
<tr>
<td>4.9</td>
<td>Level of Self-Directed Physical Practice</td>
<td>90</td>
</tr>
<tr>
<td>4.10</td>
<td>Instructional Applications of the MT100</td>
<td>91</td>
</tr>
<tr>
<td>4.11</td>
<td>Motivational Applications of the MT100</td>
<td>92</td>
</tr>
<tr>
<td>4.12</td>
<td>Specific Instructional Applications of the MT100</td>
<td>92</td>
</tr>
<tr>
<td>4.13</td>
<td>Assessment of Performance Achievement</td>
<td>94</td>
</tr>
<tr>
<td>4.14</td>
<td>Attitude to MT100 as an aid</td>
<td>96</td>
</tr>
<tr>
<td>5.1</td>
<td>Analysis of Self-Regulated Learning Strategies</td>
<td>107</td>
</tr>
<tr>
<td>5.2</td>
<td>Level of Independent Learning</td>
<td>119</td>
</tr>
<tr>
<td>5.3</td>
<td>Level of Deliberate Practice</td>
<td>122</td>
</tr>
<tr>
<td>5.4</td>
<td>Level of Self-Directed Physical Practice</td>
<td>125</td>
</tr>
<tr>
<td>5.5</td>
<td>Specific Instructional Applications of the MT100</td>
<td>131</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure

3.1 A model of self-regulated learning ......................................................... 56

4.1 Framework of the study................................................................. 81

5.1 Elaborated framework of the study.................................................. 97
5.2 Attitude to computers scale.......................................................... 100
5.3 Aural aptitude................................................................................... 101
5.4 Music experience scale................................................................. 102
5.5 Planned practice scale..................................................................... 105
5.6 Identification of self-regulated learner by items.............................. 117
5.7 Identification of self-regulated learner by categories...................... 117
5.8 Observed instructional use of the MT100........................................ 127
5.9 Self-reported instructional use of the MT100................................. 128
5.10 Observed motivational use of the MT100....................................... 129
5.11 Self-reported motivational use of the MT100................................. 130
5.12 Performance achievement............................................................ 133
5.13 Repertoire progress....................................................................... 134
5.14 Sight reading ability....................................................................... 135
5.15 Scanning ability............................................................................... 136
5.16 Accumulated practice time............................................................. 138
5.17 Computer aided practice............................................................... 139

6.1 Framework and variables of the study.............................................. 141
6.2 Entry status variables..................................................................... 143
6.3 Relationship between entry status and practice behaviours............ 145
6.4 Self-regulating practice model for novice instrumentalists............. 148
6.5 Interrelationship of practice behaviours and metacognition............ 149
6.6 Interrelationship of practice behaviours and psychomotor behaviour................................................................. 152
6.7 Interrelationship of practice behaviours including computer aided learning.................................................. 154
6.8 Practice behaviours and outcomes variables............................................. 155
6.9 Relationship between metacognition, practice behaviours and outcomes............................................................ 156
6.10 Relationship between psychomotor practice behaviours and outcomes............................................................... 161
6.11 Relationship between computer aided learning practice behaviours and outcomes........................................ 164
6.12 Interrelationship of outcomes variables................................................. 168
6.13 The moderating influence of entry skills through practice behaviours on outcomes........................................ 170

7.1 Influence of predisposition on self-regulation............................. 174
7.2 Influence of student practice behaviours on performance achievement............................................................ 178
CHAPTER ONE
NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION

Although learning to play a musical instrument is an activity begun by large numbers of children and adults, few become expert performers and even fewer attain the level of elite performer. Despite the universal search by teachers to find effective teaching methods, the provision of considerable financial outlay by guardians, and the efforts made by instrumental students themselves, many students discontinue their studies before attaining skilled performance status. Currently, it appears impossible to foresee which students will become successful performers.

Learning to play a musical instrument traditionally begins following the “master apprentice” model: instruction is one-to-one, the teacher demonstrates performance and the student is required to perfect performance skills using modelling procedures during private practice sessions. This usually occurs outside the teacher's supervision. Although teachers place considerable emphasis on the need for students to practise to gain performance proficiency, the process of practice is not clearly defined nor well understood by either teacher or student. The majority of teachers place emphasis on the psychomotor and socio-environmental conditions while ignoring the cognitive processes, frequently leaving students to devise their own practice strategies (Barry & McArthur, 1994; Weidenbach, 1995a).

In the past, the generally accepted view was that instrumental success depended primarily on musical giftedness and to a lesser degree on amount of practice. Recent research (Sosniak, 1985; Ericsson, Krampe, & Tesch-Romer, 1993; Sloboda, 1993)
has led to major shifts away from an emphasis on musical ability and its impact on performance, to increased focus on the effects of practice and other mediating variables, both innate and environmental. If practice is a more significant issue than previously thought, there is a need to know more about it, particularly as it relates to beginners.

1.2 THE IMPORTANCE OF PRACTICE

Practice is generally accepted as being important to performance outcomes, particularly amount undertaken. However, little is known about the diversity of strategies used by instrumentalists and their impact on performance outcomes. Internationally, there are performers who can be identified as experts from whom information might be sought on their current practice behaviours. However, how experienced instrumentalists practise currently may have few similarities to how they practised as beginners.

Although the work of Gruson (1988), Miklaszewski (1989), and Hallam (1995) has increased our knowledge of some aspects of practice, these studies were not conducted with beginners. Furthermore, accomplished musicians may have practised differently during their early development from at present. Whether these instrumentalists were taught, or individually acquired for themselves, as they became more expert, specific strategies is unknown. In addition, the extent to which other particular factors impinged on their instrumental achievement is also unclear although some emphasis has been given to accumulated early practice.

What is known about practice might be termed the “mythology of practice”. There appear to be commonly held beliefs concerning appropriate practice strategies which have been passed on through successive generations of teachers to their students (Minahan, 1986; Hinson, 1996). These writers ignore issues of cognitive engagement
during practice and, although Pace (1992:17) suggests “piano practice is musical problem solving that combines thinking and physical coordination”, opinions such as his are rare. Despite the doctrines of teachers, few strategies have been subjected to scrutiny through substantive investigations.

If students are to benefit from practice, they need to learn early which strategies are personally the most effective. There is, therefore, a need for teachers as well as students to understand practice and what makes it productive.

1.2.1 Self-Regulated Learning

Despite its omission from the body of existing literature on instrumental learning, it is clear that self-regulated learning has implications for music as much as for other academic subjects. Recent identification of the processes which lead students to become self-regulated, and subsequently successful academic achievers, by cognitive and social psychologists (Paris & Winograd, 1990; Zimmerman, 1990; White & Baird, 1991; Zimmerman, Greenberg & Weinstein, 1994) suggests that self-regulated learning has implications for instrumental teachers.

In instrumental learning, considerable performance skills acquisition occurs in the absence of teachers. Being self-regulated - that is, assuming personal self-control for achievement - may be the distinctive feature which accounts more for instrumental achievement success than previously mentioned factors such as ability or amount of practice. Researchers (Corno, 1989; Zimmerman, 1990) have identified skills that characterise self-regulated learners including planning, setting goals, organising, self-monitoring and self-evaluating (Zimmerman, 1986) all of which demand metacognitive engagement. Additionally, these students report high levels of self-efficacy, self-attribution, task interest and higher academic achievement.
All learners possess some of these skills to different degrees but to date little research has been conducted with instrumental learners to determine how self-regulation affects instrumental outcomes. Metacognition - that is, the ability to think about one's thinking - was defined by Flavell (1979:906) as "any conscious cognitive or affective experiences that accompany and pertain to any intellectual enterprise." Despite continued growth in the literature on metacognition (Flavell, 1979; Boyatzis & Kolb, 1991; Flavell, 1992), it has only comparatively recently entered the music literature (Boardman, 1989). While little is known about how students practise, even less is understood about whether they think about it.

The extent to which beginner instrumentalists call on metacognitive skills during practice is unknown. The writer suggests that self-regulated learning procedures, as described in general classroom praxis, if applied to music learning skills, would result in comparable improvements in instrumental learning outcomes.

Recent shifts in learning theory place increased emphasis on the potential of students to take greater control of their own learning through increasing self-reliance (Boardman, 1989; Corno, 1989; Zimmerman, 1990; Collins, 1991; Flavell, 1992). Diminishing emphasis on innate musical ability and increasing emphasis on self-directed learning point to practice as a variable which warrants more significant attention than it has received in the past. Investigating how a group of novice instrumentalists practise would contribute to a greater understanding of the processes and effects of practice.

1.2.2 Technology Applications
Another recent interest in education concerns cognitive apprenticeship in which computer-mediated learning facilitates students' independence through increasing use of the computer with concomitant decreasing input from the teacher (Collins, 1991).
Computers have already impacted on music learning in various contexts. Given the potential of the music keyboard to be interfaced with MIDI (Musical Instrument Digital Interface) devices, investigating the extent to which one specifically dedicated music computer (the MT100 Sequencer) can provide support for students during private practice would add to this literature.

It is clear from the writer’s discussions with students and teachers that practice is frequently not discussed and generally left to the student to plan. Another reason why so little is known and understood about how beginner students practise is because, generally, instrumental teachers are not present to monitor their students’ private practice. They are, therefore, unaware of the strategies which are used even when they have made recommendations. Student practice could be monitored by the investigator if it were recorded on a sequencer. This would provide the opportunity of analysing the practice schema of individuals.

There is, therefore, a need to know how beginner instrumentalists practise, particularly when they are not provided with guidelines or procedures to follow. 

Questions which will contribute to a greater understanding of practice are:

- Do students focus primarily on physical drill?
- What facets of drill and practice are effective?
- Do students use feedback to modify their strategies?
- Do they pre-plan practice and self-monitor performance?
- Are their strategies modified according to outcomes or do they use fixed strategies?
- Are they able to determine which strategies have been successful and then apply them for deliberate practice?
- To what extent do they think about and cognitively plan practice?
Exploration of how a group of beginner students practise would provide knowledge of the schemata these students use during private practice, including their use of the technology. The identification of strategies found to be effective for students who exhibit particular characteristics would lead to increased understanding of practice processes.

1.3 DELINEATION AND JUSTIFICATION FOR THIS STUDY

The aim of this study is to investigate the practice behaviours of a group of beginner instrumentalists. It seeks to determine whether any students demonstrate self-regulated learning strategies and if these strategies influence performance outcomes.

A group of young adult novice instrumentalists, learning to play keyboard in an interactive microtechnology keyboard laboratory environment, is the focus for the investigation which will explore various factors which could potentially influence the acquisition of performance skills.

Although considerable research has been conducted concerning the acquisition of musical instrument performance skills, only a few studies have investigated practice \textit{per se} (Gruson, 1988; Lippman & Lim, 1988; Coffman, 1990; Lim & Lippman, 1991; Barry & McArthur, 1994; Hallam, 1995). Of these, none used beginner students as their subjects. Investigations concerned with the application of computer technology have addressed issues related to teaching various music skills. However, exploration of interactive use of computers for the purpose of aiding and monitoring practice has not appeared in the literature. Of the few studies investigating practice behaviours, none has probed the thinking behaviours of students.
1.3.1 Aims of the study

The three significant focal points in this study are practice planning, psychomotor behaviour during practice, and computer-aided learning. The central elements of this investigation include the extent to which thinking and planning processes accompany practice, the particular physical strategies students use, and the use of computers to aid practice. Other potentially moderating factors which students demonstrate at the commencement of the study such as ability to use computers, attitude to computers, auditory aptitude and prior music skills also form part of the investigation.

This study will track students' use of metacognitive strategies in the planning and implementation of practice to provide an understanding of how this group of beginners think about practice. Emphasis in the past, particularly for beginners, has been on time spent practising and repetitious drill rather than strategy planning. Whether hours of mechanical practice are as effective as practice which is self-monitored, self-directed and self-regulated has not previously been investigated. Deliberate practice - that is, the means by which strategies are deliberately contrived to overcome specific performance problems - has been described by expert performers in different fields including music (Ericsson, Krampe & Tesch-Romer, 1993). The results of their investigations suggest that a significant level of metacognitive engagement is required for performance achievement.

Students in this study will have access to the MT100 Sequencer to use as an aid to practice. However, using it because it is available, without understanding how it can be an effective teaching tool, might be wasted use of the resource. The MT100 has the potential to be used as an instructional device to aid learning by providing demonstration models and feedback. It might also be used for motivational purposes. The extent to which these purposes influence performance outcomes is to be explored.
If students are to benefit from hours of practice trying to develop instrumental skills, there is a need to identify and explain the elements of effective practice. These then need to be located within a model for a practice schema from which all students will be able to draw. Knowing whether beginners call on thinking abilities during practice rather than concentrating more on repetitious drill is a key element. Discovering whether a connection exists between thinking processes and performance achievement levels will increase current understanding of the nature of effective practice.

This study is designed to examine qualitatively the application of self-regulatory behaviours of novice keyboard instrumentalists by probing their practice procedures. Data on the extent to which students intellectually plan their strategies and reflect on practice outcomes will be gathered from personal journals and through questionnaires. Verification of how students physically practise will be provided by recorded audio and computer private practice sessions; how they use the computer is to be evaluated by observational data collected during practice and self-report questionnaires. The collection of different forms of data acknowledge the potential disparity between personal recollection and chronical reality.

The primary purpose of the study is to investigate the relationship, if any, between student predispositions, practice planning, physical practice behaviours, computer application during practice, and performance outcomes.

The following research questions were designed to guide the study:

Question 1 What entry behaviours (predispositions) did students bring to the study?

Question 2 What practice behaviours were demonstrated by students during the study?
Question 3  What level of performance outcomes did students achieve at the conclusion of the study?

Question 4  Was practice influenced by personal characteristics (predispositions) exhibited by students at the commencement of the study?

Question 5  Were performance outcomes affected by particular practice strategies?

Question 6  Was the relationship between practice strategies and performance outcomes moderated by the influence of students' predispositions?

How these questions are used as the framework of the study will be explained in Chapter Four.

1.3.2 Intended format of this study

Chapter One introduces the reader to the nature and scope of the study, pointing to the key issues to be explored in this thesis. In Chapter Two, the theoretical framework on which the study stands - the background to instrumental teaching and learning - is described. It will justify the need to look further than musical ability as the primary explanation for performance achievement and will explore other factors which may be more influential in light of both past and present attitudes to performance proficiency.

An extensive review of the literature relating to instrumental performance and practice is presented in Chapter Three. Relevant research concerning metacognition, practice, technology issues, and other factors believed to affect practice, are detailed. Chapter Four describes the research design and methodology. In Chapter Five the results are reported through presentation of the data. Discussion and analysis of the results are provided in Chapter Six while Chapter Seven presents the summary, discussion, and recommendations for future research.
1.4 KEY TERMS RELATED TO THE STUDY

An explanation of the following terms, as they are used in this thesis, is provided.

1.4.1 Practice

Not all instrumental playing can be considered practice. Playing once, for example, would generally not be defined as practice. Although no definition of practice appears in Grove's Dictionary of Music and Musicians (1975), according to the Oxford English Dictionary (1973:1645), the term means “to exercise oneself in the performance of music with the view of acquiring skill.” Physically performing technical exercises and musical repertoire, following the presentation of models which the player sets out to imitate through repeated performances, meets this definition. Following conversations which the researcher has had with students and teachers, it appears that this description reflects their understanding of the term. The implied emphasis is on physical drill.

Routine practice and planned practice

“Routine practice” describes the foregoing activity. Routine practice is intentionally playing music with the aim of improving performance but without systematic cognitive planning. Throughout the study, the terms practice and rehearsal will be used interchangeably reflecting the usage in the literature.

An alternative definition of practice (Oxford, 1973:1645), places greater emphasis on the notion of practice as an intellectual behaviour, that is, “to devise plans to bring about a result” in which cognitive planning is indicated. Intellectual processing in various forms may occur throughout instrumental practice, before, during and
following the activity. The term “planned practice” is used in this study to describe students' practice when they applied metacognitive behaviours to their learning.

**Deliberate practice**

“Deliberate practice”, a term used by Ericsson, Krampe, and Tesch-Romer (1993), refers to purposeful practice which is significantly different from other music related activities. Deliberate practice is highly structured, probably the result of prior performance analysis, when the player pays particular attention to critical aspects of performance in need of remediation. Ericsson et al. (p. 368) suggest that the explicit goal of deliberate practice is to improve performance. “Specific tasks are invented to overcome weaknesses, and performance is carefully monitored to provide cues for ways to improve it further”.

Deliberate practice is a distinct activity “in which the level of difficulty is adjusted to maximise improvement” (Ericsson et al., 1993:114).

1.4.2 Sight reading

Sight reading is defined as “unpremeditated performance” (Sloboda, 1993:67) and occurs when a performer, after seeing the musical score for the first time, translates the signs into information which leads to performance realisation (Apel, 1972; Wolf, 1976). When this performance is repeated, after the initial trial, it becomes rehearsal or practice and it is generally thought that the extent to which one is a capable sight reader significantly influences practice (McPherson, 1994).

1.4.3 Metacognition

Metacognition refers to a person’s ability to think about his/her cognitive processes during the process of learning. “Metacognitive experiences are any conscious cognitive
or affective experiences that accompany and pertain to any intellectual enterprise” (Flavell, 1979:906).

1.4.4 Self-Regulation
Self-regulated learners are those who are “metacognitively, motivationally, and behaviorally [sic] active participants in their own learning” (Zimmerman, 1989: 329). The skills of self-regulation include the ability to evaluate one’s own capabilities to organise and plan specific learning strategies which will lead to the achievement of specified goals. Self-observation, self-judgement, and self-reaction are the three subprocesses which define self-regulation, according to Bandura (1986).

1.4.5 Instrumental Performance
The general term “instrumental performance” may be applied to the efforts of a novice sight reading a composition or to the other end of the spectrum, the eminent, world renowned instrumentalist performing for an audience. Artists may be referred to as “elite”, “expert”, or “novice”. The term “expert” within the literature is generally understood to mean individuals who have undergone intensive and extensive training, having mastered essential knowledge and skills to become independent performers. Their professional involvement generally results in full-time commitment. The “elite” performer is one who has met the criteria of the expert and, additionally, demonstrates levels of excellence which contribute uniquely to the art by bringing new interpretations or innovations to performances.

In some studies, the term “beginner” is used to describe students in their early years of learning, that is, the developing instrumentalist whereas in this study, the subjects had no prior experience of playing the keyboard. They were categorised as novices or beginners. Although this study is essentially concerned with beginners, reference to
experts is made in order to explore and clarify structures and schema which might be relevant to beginners.

1.4.6 Keyboard

This study was undertaken with a focus on the development of keyboard performance skills. The term keyboard can have the musical meanings: the piano, or instruments whose sounds are synthetically produced, or both. In the mid-eighteenth century, keyboard meant any similar-looking instruments to the piano, such as clavichord, spinet, harpsichord, or organ. The term keyboard in this study will refer to synthesisers in a laboratory while any reference to piano will be specific in its application. Keyboard does not refer to an alpha-numeric computer in this study.

1.4.7 Computer Technology

As with keyboard, the term computer has broad usage and, since computers are used in this study, clarification is required. The use of computer technology in this study refers to a sequencer, specifically the Roland MT100 Sound Module Sequencer (MT100), which provides auditory feedback rather than the visual feedback more commonly associated with computers having a VDU (visual display unit). Through the sequencer, students may also access demonstration models of the music from their texts, with or without enhanced backgrounds. The specific features and uses of the MT100 in this study will be described later.

1.4.8 Praxis

This study is concerned with practice, that is, the repeated rehearsal of performance to improve instrumental skill. Praxis is used to mean customary behaviour, for example, pedagogical praxis, to differentiate it from practice meaning rehearsal.
1.4.9 Spelling conventions

This study was conducted in Australia and in this thesis there may be grammatical and spelling conventions which are different in other countries. “Practice” is used as a noun and “practise” when it is a verb. “Behaviour” is spelt with a “u” in this environment.

1.5 SUMMARY

This chapter has identified the importance of practice and pointed briefly to the increased attention it has received in recent literature. Many instrumental teachers place emphasis on amount of practice, routine psychomotor skills, and socio-environmental conditions while ignoring the metacognitive aspects of practice. Although there is a body of research showing a connection between accumulated practice and expert performers, little is known about the particular procedures used during practice.

It is generally accepted that, although most instrumental teachers make recommendations to their students regarding practice, the effectiveness of their advice is unsubstantiated because they do not monitor actual practice processes. Teachers are rarely present when students practise. While acknowledging various other factors which may also influence performance achievement, this study will focus on metacognitive planning, physical practice, and the use of technology for specific purposes to enhance practice.

Chapter One has provided an introduction to the nature and scope of the study, pointing to the key issues to be explored in this thesis. In Chapter Two, an overview of what is generally known and accepted concerning instrumental praxis, both past and present, will be presented.
CHAPTER TWO

OVERVIEW OF INSTRUMENTAL PRAXIS:

PAST AND PRESENT

In Chapter One, the nature and scope of the study was outlined. In this chapter, the background of practice and its relationship to instrumental learning within current theory on which this study is founded, are discussed. The following holistic description of instrumental performance will identify issues thought to relate to the development of this complex skill and clarify current praxis and attitudes towards practice as an integral element of performance development.

2.1 INTRODUCTION

In the past, it was believed that the primary influence on instrumental performance achievement was musical ability, implying some inner, innate predisposition. More recent views suggest that instrumental skills are the result of a number of diverse factors which include genetic potential, maturation, musical ability, cognitive ability, enculturation, environmental conditions, training and practice. In contemporary parlance the term “musical ability” is used increasingly as a more generic term to indicate demonstrated facility in a musical task that is tested (Farnsworth, 1969; Shuter-Dyson & Gabriel, 1981). According to Shuter-Dyson and Gabriel (1981:7), “all aptitude tests are to some extent achievement tests” and vice versa so musical ability is taken to mean what a person is able to do musically. Despite this, the view of the general population and many instrumental teachers remains in conflict with this more recent perspective.

The following discussion will demonstrate that none of the items mentioned has satisfactorily accounted for performance achievement and in general, practice, as an independent construct, has not been treated as one of the most significant factors.
The topics to be overviewed provide the current contextual framework for practice and include performance, cognitive and musical ability, the nature and development of expertise, performance skills, the environment, and instrumental teaching and learning.

2.2 INSTRUMENTAL PERFORMANCE

2.2.1 Musical ability

Past views of innate musical ability as the primary determinant of music performance excellence continue, despite the lack of evidence to support this belief (Ericsson, Krampe, & Tesch-Romer, 1993). Perhaps the idea originated from known examples of prodigies such as Mozart who demonstrated exceptional feats of musical achievements at an early age.

Another assumption has been that familial connections for prowess in music are the result of genetic influences. However, this ignores the impact of environmental influences such as availability of pertinent information, exposure to the domain, and encouragement to begin to learn and therefore to practise. Consider being exposed to the intensity of music found in the household of J. S. Bach, for example. Such enculturation through environmental influences might account more for the music success of several of his children than genetic influence.

If genetic factors were the primary influence in determining exceptional performance in any domain, performance would remain stable notwithstanding effort and practice, and this is not supported in the literature. As one example, the measurement of Intelligent Quotient (I.Q.) has been shown to be influenced by practice effects (Gibson, 1969) leading to the conclusion that cognitive ability is not fixed. In the broadest sense, education has been based on the notion of practice as a means of improving academic skills. In sports, the influence of practice on physical
skills has been extensively investigated (Bloom, 1985) providing specific knowledge which has been put to beneficial use in that domain.

Contemporary literature places less emphasis on innate ability as the primary precursor to performance expertise. It is acknowledged that without some pre-determined disposition it is unlikely that elite levels of musical performance achievement will be reached. What one would wish to contradict is the notion that there are those in society who are “musical” and those who are not, since considerable research has shown that even without musical training, certain musical behaviours are evident in all children.

According to Hargreaves (1986), even individuals classified as "non-musical" do possess a range of musical skills, and most children acquire the basic skills needed for musical engagement relatively early. In what has been termed “generative process development” (Sloboda, 1988, 1994; Boardman, 1988), young children appear to absorb the general structures of music through environmental exposure and are able to make sense of what could be considered complex musical associations. Sloboda (1994:350) states:

> even without any prior musical instruction, most children are capable by the age of ten of reaching the same level of performance as musically trained adults at judging which of two musical passages conforms to the rules of tonal harmony.

This supports the notion that there are generative forces at work through which children develop functional understandings of musical structures without specific musical ability or musical training. This may have significance as to how some individuals rehearse.

Based on extensive research by Sloboda (1993), several well-supported conclusions have emerged in relation to performance achievement including the belief that musical ability develops in most individuals in the first decade of life
through normal enculturation. More specifically, he considers several other factors which contribute to the development of a musical performer:

i. lengthy periods of engagement with music through practice and exploration
ii. high levels of material and emotional support from parents and other adults
iii. relationships with early teachers characterised by warmth and mutual liking
iv. early experiences with music that promote, rather than inhibit, intense, sensuous/affective experiences (p. 106).

It is the first of these factors with which this study is primarily concerned as this researcher attempts to discover more about practice and its effects on beginners.

Sosniak (1985) supports the notion that innate musical ability is irreconcilable with instrumental success because the majority of instrumentalists in her study had reached the level of exceptional performer without showing signs of early promise. Five or six years of formal instruction had taken place before any indication of a promising future was observed and, additionally, Sosniak was able to identify factors other than musical ability as being influential. For example that;

- young children lived in environments in which music was highly valued
- music formed an integral part of their daily lives
- lessons were imposed on the children as part of normal experience
- first instrumental experiences were positive
- children were made to feel important by their teachers
- they spent more time rehearsing than any other activities aside from television
- lessons and practice regimes were established early and other activities built around music
- students were continually reminded of their musical potential.

This suggests that taking tests of musical ability as an indicator of instrumental potential may be of limited value, so making assumptions based on tests should be made with caution. Although atomistic tests exist which measure discrete skills (Seashore, Lewis & Saetveit, 1960; Wing, 1961; Bentley, 1966; Gordon, 1965,
1979, 1982), none provides an overall measure of general musical ability. Even if there were such tests, their value is questionable so to encourage or discourage potential instrumental students on the basis of any test of musical ability is insupportable. Identifying other indicators which explain the reasons for instrumental achievement, in addition to those identified by Sosniak, is therefore warranted. These changing views point to instrumental achievement being a consequence of factors other than some innate musical pre-disposition.

2.2.2 Cognitive ability

Research on the effect of cognition in the development of expertise in sport suggests that superior physiological and bio-mechanical systems may not be entirely responsible for excellence (Garland & Barry, 1987). Regardless of cognitive ability, students can succeed academically provided individual learning styles are identified and accommodated by determining in which channel - visual, kinaesthetic or auditory - perceptual strength lies. Although investigations into the learning style of school drop-outs (Griggs & Dunn, 1988), and in sports (Hill, 1992) have supported this assertion, no similar studies have been undertaken on unsuccessful instrumentalists.

Whether cognitive ability has influence on music expertise has been the subject of previous studies. In an early review, Manor (1950) concluded that low achievers in instrumental music differed significantly from middle and high achievers on Intelligent Quotient scores, and since then some studies have shown these to be a useful predictor of instrumental music competence (Gordon, 1967; Hufstader, 1974; McCarthy, 1974; Young, 1976; Schleuter, 1978; Delzell, 1989; Klindehinst, 1991). However, other studies have contradicted these findings showing I.Q. to have a weak relationship with music ability (Shuter-Dyson, 1982) as well as a range of other skills (Ericsson, Krampe, & Tesch-Romer, 1993).
Gordon (1968), Young (1971), Hufstader (1974), and McCarthy (1980) suggest that intelligence, musical aptitude and academic achievement test scores are valid predictors for beginner instrumentalists but may not be reflected in final achievement levels. This suggests the influence of other factors.

One confounding exception to the relevance of intellectual capacity in instrumental performance is the “idiot savants” who, by normal measures of intelligence, performs subnormally but demonstrates exceptional piano performance skills (Viscott, 1970; Sloboda, 1985). One might conclude that these individuals possess exceptional intelligence in one particular facet of cognitive functioning. The work of Gardner (1983), for example, suggests music as one of seven discrete intelligences. However, the crucial issue here is that their musical performance development is characterised by a phenomenal memory and by practice without instruction.

It appears that learning style has more potential to impact on successful learning, including instrumental performance, than cognitive ability. This appears not to have been considered by teachers who have, in the past, focussed on drill and practice.

2.2.3 Musical achievement

The measurement of musical achievement has also attracted attention and both norm-referenced and criterion-referenced measures have been devised. Although not of primary influence on this study, other than in measuring performance outcomes of the subjects, it is relevant to note that all these tests measure a restricted set of behaviours which do not necessarily reflect general music capacity. The question, therefore, is what is it that contributes in a major way to instrumental success if not musical ability? It is clear from other research that any form of musical engagement is complex, so there is a need for investigations which explore how musical expertise develops. Therefore, evaluating the critical thinking
processes of novice instrumental students might be of considerably more value than attempting to measure musical ability.

Perhaps consulting research in critical thinking, how it functions, and whether skills can be learned would be more productive than investigating research on musical ability, despite the fact that currently “no single conception of critical thinking has emerged as the best definition of critical thinking in music” (Richardson & Whitaker, 1992: 553). Earlier emphasis on thinking and how it could be promoted by questioning was suggested by Ritterman (1987:5).

The crucial importance of encouraging pupils to develop the ability to think and reason for themselves and to be able to articulate the results of these processes has become widely recognised as a cross-curricular priority.

The task of mastering the performance of repertoire requires students to analyse performance, determine whether difficulties exist, find a solution to any difficulty, and rehearse to overcome it. Studies in this area to date are limited and first it would need to be recognised that learning repertoire is in itself a problem solving activity which might best be put in the hands of the student rather than the teacher.

While it may be that some individuals achieve musical skills more easily than others, research has found that even for the “talented”, progress is unlikely to occur without effort (practice). In a study of seventy-six major composers, Hayes (1981) concluded that at least ten years of intensive musical training and skill development occurred prior to the composition of significant works. Other studies to be mentioned later suggest this ten year time frame as essential for the achievement of expertise across a range of skills. It is therefore concluded that practice, over time, is more influential than musical ability.

Some studies have attempted to identify other precursors of musical excellence. The assumption that to achieve high levels of competence as a musician required having access to learning opportunities, among other things, was investigated by Sloboda
and Howe (1991). Students attending a school for musically gifted children were studied to identify potentially contributing factors. Most students had not shown any particular signs of early music promise nor had they been identified early as musically gifted. Many of the students had come from families in which musical expertise was not evident although, clearly, musical encouragement was.

A critical factor appeared to be the development of strong rapport with the first instrumental teacher and strong encouragement from parents. Also, more than 90% of the parents took an active role in practice, even if only at the level of ensuring it was done. In terms of amount of practice, it appeared that the most able students actually rehearsed less as children than their less able peers. This is contradicted in other studies (Anderson, 1982; Ericsson, Tesch-Romer & Krampe, 1990). However, in the study by Sloboda and Howe (1991), the best of the children had played more than one instrument. These findings generally corroborated those of Sosniak's (1985) earlier study which demonstrated that performance achievement does not appear to be primarily the result of innate musical ability.

2.2.4 The nature and development of expertise

Existing knowledge of performance achievement has been largely acquired through the investigation of the achievements of experts but explanations of how they reached that standard are often as vague as the reasons given for students discontinuing instrumental learning. Across a range of disciplines, a period approximating ten years is required before exceptional performance is achieved (Simon & Chase, 1973; Krogius, 1976; Hayes, 1981; Gustin, 1985; Monsaas, 1985; Sosniak, 1985) so it appears that skills evolve over time. Other factors which are thought to have influenced the development of expertise include early recognition of interest, parental support, teacher influence, training, and practice, and in the case of athletics, certain physical characteristics.
The assessment of expertise differs across domains and the limits of upper levels of achievement have been shown to increase over time. Records of athletes, number of titles for world chess masters, numerical speed of typists or morse code operators, are measures which can be reliably reported. Chronologically, records are regularly broken as skill levels increase, frequently as a result of improved training as is amply demonstrated through past records of the Olympic Games.

According to Bloom (1985) there are three phases which lead to expert performance. The first occurs when the individual shows interest leading to instruction and the beginning of practice. During the second phase, extended and intensive training and practice occur as a form of preparation for full-time involvement in the domain. The third phase is full-time commitment and performance engagement which results in the performer achieving the level of professional employment. Usually from this point, instrumentalists, for example, become independent of their teachers, often surpassing them in knowledge and skills. It is generally acknowledged that practice is essential to maintain expert levels.

Performance in music can also be measured, albeit in a different way from other skills. Measuring music performance may be considered less objective than the definite outcome of a race. However, music competitions produce winners - those whose performance is deemed the most exceptional - while other analytical criteria also determine elite music behaviour. Musical compositions once considered playable only by experts, are now commonly found in the repertoire of young, developing artists, possibly as a result of more refined practice skills.

According to Roth (1982, cited in Ericsson, Kampe, & Tesch-Romer, 1993:23), "the improvement in music training is so great that the violin virtuoso Paganini 'would indeed cut a sorry figure if placed upon the modern concert stage' ."
It appears that skills in music performance have increased over time as has been evidenced in sport and other skill domains. This may well be attributed to the result of better practice techniques.

Although Sloboda (1993) acknowledges that the literature on expert performance is sparse, he maintains that there are general comparisons to be made between expert and inexpert performance. He suggests that experts have knowledge of large-scale grouping or patterns within the music which control performance. Some of these groupings or patterns are hierarchical. Non-experts, on the other hand, are more concerned with fundamental aspects which Sloboda refers to as musical “foreground” (p.101).

Experts are able to monitor musical performance using problem solving strategies which operate at fast speed and function in automatic mode, possibly operating at an unconscious level. Non-experts, on the other hand, work at the conscious level trying to negotiate all the complexities included in the realisation of a performance. These differences suggest that practice techniques will also differ.

In monitoring their own performance, it appears that experts are able to make decisions quickly enabling them to rectify difficulties because they are listening selectively to the outcomes. Sloboda (1993:101) states that experts are capable of monitoring motor performance functions “relatively independently of conscious feedback” because of the knowledge held in the subconscious. Some aspects of performance are therefore left to occur automatically to enable other aspects to be drawn to the foreground of conscious attention for closer monitoring.

As one explores the nature of performance expertise by asking what it is and what is known about it, the conception that practice is an essential part of the process of becoming an expert becomes increasingly likely.
2.2.5 The development of instrumental skills

Learning to play a musical instrument is a complex process involving the application of various cognitive activities to facilitate the acquisition of knowledge, as well as extensive practice to develop essential psychomotor skills. The development of performance skills is thought to occur through enculturation, training and practice. Current cognitive psychology suggests that musical enculturation dominates musical development up to the age of about ten but, after that time, musical training becomes the controlling influence (Sloboda, 1993: 196).

The execution of instrumental performance may be at a simple level such as with novices playing their first melodies, or at the complex level of concert performers whom one would identify as experts. The writer has categorised four levels of performer: the novice at the very beginning stages of learning; the developing instrumentalist who continues to build skills, knowledge, repertoire and technique; the expert, who is an independent learner and who may be functioning as a professional teacher/performer; and finally the elite instrumentalist, who is usually a concert artist and whose skills bring to performance unique and highly individualised interpretations. It is generally thought that at each of these levels, practice is essential if skills are to be maintained or improved.

The act of performance demands both speed and precision in neural/motor responses whether one is decoding and processing the symbols of music notation, playing from memory or improvising. Long chains of motor activity are constantly monitored by the performer through the auditory channels during practice. In addition, the performer is expected to play with technical subtlety, incorporating phrasing and other music specific techniques, to evoke a sense of aesthetic response by performing with emotion, and to perform quite complex, often extended compositions from memory. When the performance elicits satisfying emotional
responses from the listening audience, the goals of the performer are generally considered to have been achieved.

Published interviews with elite piano players which follow disclose a diversity of attitudes and behaviours the performers below say they use during practice (Uszler, Gordon & Mach, 1991:359-370). Individual recommendations of how to rehearse include:

- do not analyse the music (Brendel, p.360)
- carefully analyse the music (de Larrocha, p.360)
- rehearse slowly (Firkusny), rehearse softly (Egorov, p.360)
- think about the elements (Fleisher, p.369)
- alter the rhythms (Hough, p.363)
- rehearse technical exercises (Kocsis, p.363)
- mentally practise (Bolet, p.365)
- concentrate on touch (Turek, p.366)
- develop your own techniques (Horowitz, p.366).

From the same text, pianists’ recommendations on the memorising of works include the following:

- mental practice away from the piano (Ashkenazy, p.367)
- slow practice, place less reliance on visual memory (de Larrocha, p.368)
- find the structural elements of the music (Dichter, p.368)
- simply repeat the work (Browning, p.370).

From these comments it is concluded that the practice schemata used by expert performers are diverse and comprehensively complex. The question is whether any behaviours acquired in the beginning stages of learning to rehearse facilitate this path to complexity.
In the beginning stages of instrumental learning, performance is primarily imitative, being modelled on the demonstration of the teacher who monitors the student's attempt and gives feedback on accuracy. Practice during the lesson is teacher directed. This behaviourist model is feasible throughout the lesson but demonstration and feedback are generally unavailable during private practice sessions in the absence of the instructor.

Some use has been made of audio and video tapes to provide demonstrations of the music to be performed with positive results but, because external feedback and reinforcement are generally not available during private practice sessions, inaccurate performance frequently results (Hodges, 1975; Anderson, 1981). This suggests that students may need to be taught analytical and reflective skills to provide internalised accurate feedback.

As will be discussed in the subsequent review of the literature, in traditional western pedagogy, the general elements of instrumental performance include music reading, practice, and skilled realisation of the music, while more specific skills essential to the task include sight reading, scanning, analytical listening, motor programming and memorisation.

The purpose of sight reading is to reproduce the composer's original intentions in much the same manner as one reads language symbols and translates the words into speech concurrently. Having completed this original translation, the performer proceeds to rehearse while simultaneously following the score to produce a fluent musical performance. This behaviour, often described as rehearsal, necessitates repeated exposure to the score and is thought to be a significant element of expert performance (Sloboda, 1993). A final stage, after which the instrumentalist may present the work for public performance, is memorisation of the music.
Although there are various means by which instrumentalists learn and perform music, the writer's experience suggests that the majority follow this sequence of sight-reading, rehearsal and memorising in which the emphasis is on visual cues. However, an opposing view of visual memory is offered by Larrocha (Uszler, Gordon & Mach, 1991:368) who is reported as saying "I don't believe much in visual memory. It seems unsure and leaves me rather insecure." If, through some form of backward chaining of procedures used by experts, the metamorphosis through which practice strategies progressed could be identified, then the processes by which the novice becomes expert, might be illuminated.

This current study is concerned with the development of instrumental skills in novice keyboard players. Because of their beginner status, issues related to finer points of musicianship, including expert technique, individual style, and legitimate interpretation will not be emphasised although these are acknowledged as higher order skills that one would consider requisite in expert performers. However, the justification for including discussion on expert performance in this chapter is to identify any elements of expert performers' praxis which may be connected with that of novices.

2.2.6 Environmental influences
The effects of environment on musical development have been investigated. Parental influence (Sosniak, 1985; Manturszewska, 1990; Sloboda & Howe, 1991), and socio-economic status (Mitcham, 1969; McCarthy, 1980) have highlighted differences which contribute to success. Stevens' (1989:3) study of group keyboard learning in a laboratory demonstrated the positive "catalytic effects of interaction" on subjects' social and cognitive outcomes. Whether the physical environment plays any part, particularly in terms of where practice takes place, has received little attention by researchers, although this is one topic addressed by teachers in general discussion. It is suggested that beginning students may discuss
and discover practice strategies from one another if they are not discussed by the teacher.

2.3 INSTRUMENTAL INSTRUCTION

2.3.1 Traditional approaches to teaching

Most instrumental teaching follows a traditional paradigm. Despite the obvious use of cognition in any musical activity, past emphasis on instrumental teaching has concentrated on psychomotor aspects and many teachers follow the same methods by which they were taught. Teachers still hold locus of control. Motor skill development and remedial techniques, detailed in texts concerned with the psychology of musical performance which are to be identified in the literature review, are still generally written from the perspective of the teacher rather than the learner. Instrumental teachers expect that students will rehearse but it appears that, other than general directions to “learn the piece by next lesson”, “practise at least 30 minutes every day”, or “keep a time practice diary” (Weidenbach, 1995a), students are given few instructions on practice technique.

An extensive review of piano methods covering 200 years (Uszler, 1982, 1983, 1984, 1985) detailed instructional methods and materials without alluding to practice once, the emphasis being on pedagogical issues and content, both from the teacher's perspective. Music tutors - that is, texts of musical scores - frequently give directions on basic piano technique and explanations of musical terminology, but none of those reviewed recommend how one might conduct practice sessions, nor do they suggest that thinking about how one practises should be one important feature.

Teaching instrumental skills is still based on a model centred around a set of curriculum materials in which outcomes are explicit and evaluated either informally by the teacher or formally through some recognised public examinations body. The
teaching process is teacher centred and has largely remained unchanged for the past 200 years, relying primarily on the imitative facility of the student. Kohut (1985) asks whether this over-reliance on imitation is outdated, given the advances in technology, although others involved in sports training may not agree.

2.3.2 Contemporary approaches to teaching

Although individualised teaching is preferred by the majority of piano teachers, reference to group teaching can be found from the early 1800s (Rainbow, 1990). It reached its height in the 1930s. At that time classroom teaching of keyboard skills was used as a means of developing general musicianship in children. Whether group interaction between students has any influence on practice in either quality or quantity is unknown although peer motivation has been shown to be stimulated through competition in similar learning environments.

Despite the expansion of group teaching facilitated by keyboard laboratories since the 1950s, little attention has been paid to how students in these environments rehearse and opportunities to use the sequencer to monitor practice have been overlooked. As well as group learning and individualised personal teacher instruction, software is currently available for students wishing to teach themselves to play keyboard instruments. Whichever mode of learning individuals elect, private practice is still a crucial variable. A greater understanding of the influence of self-regulation on all of these students is therefore warranted.

2.4 SUMMARY

It appears that factors other than innate musical ability are responsible for instrumental success. Whether any of these factors have more significant impact than others is unknown and, despite the diversity of investigations concerning practice outcomes, few have addressed performance itself.
Studies of expert performers have provided some understanding of the background leading to musical excellence (Sosniak, 1985; Ericsson, Krampe & Tesch-Romer, 1991; Sloboda & Howe, 1991). These include factors such as musical and cognitive abilities, environment, and motivation. They highlight the diverse influences on the developing instrumentalist and place genetic influence in perspective.

In an attempt to explain the diverse influences on performance achievement, a number of explored factors have provided new knowledge and at the same time dispelled past beliefs, while practice per se, as a potential influence, has been all but ignored. The following summarises the writer's understanding of current praxis:

i there is no clear definition of musical ability;

ii existing tests are outdated and none measure musical ability to the satisfaction of contemporary researchers;

iii genetic influences appear to have indirect influence on performance, operating primarily as mediating factors;

iv familial connections appear to be weak for many exceptional instrumentalists, as both parents and siblings demonstrate no instrumental expertise;

v performers in the elite/expert categories often show no particular promise as children;

vi some children who demonstrate outstanding abilities fail to meet early expectations;

vii several aspects of environment appear to contribute to successful instrumental achievement;

viii there is currently no means of predicting instrumental success;

ix practice as a construct is not well understood due to lack of investigation; and
x generally, instrumental teachers appear not to teach students how to practise.

Practice, the focus of this dissertation, does not occur in a vacuum or without a purpose. The aim of this chapter was to provide a general description of practice and its sub-components as they relate to instrumental performance, to form a bridge between the nature and scope of the study detailed in Chapter One and the literature review in Chapter Three which more specifically addresses research into practice and its related components. None of the issues raised has satisfactorily accounted for performance achievement alone. Although practice, as an independent construct, has been cited generally as one of the significant factors in performance achievement, the actual processes of practice have not been extensively explored. This chapter has placed practice within a framework of other connecting factors relating to musical performance providing the theoretical foundations of this study.
CHAPTER THREE

REVIEW OF THE LITERATURE:

PRACTICE AND FACTORS WHICH INFLUENCE PERFORMANCE OUTCOMES

3.1 INTRODUCTION

While the literature is rich in studies which have investigated a wide range of variables which have the potential to impact on the development of performance skills, from both teacher and learner perspectives, few have addressed the issue of practice.

Past beliefs have credited factors other than practice as the primary determinants of performance achievement, the most significant of these having been identified in the previous chapter. Recent views on skills development in academic work and sports skills have supported the place of practice as a key variable in the development of performance skills although this has not yet been explored to the same degree in instrumental learning. Practice itself is inextricably entwined with music performance and some of the previously discussed factors are thought to influence performance outcomes.

The following literature review addresses practice and factors thought to influence it including teachers' influence, psychomotor behaviours, and cognitive engagement. The application of computers as an aid to learning is also addressed.

As stated in Chapter One, there is a dearth of research literature concerning practice specifically. This literature review will place practice within the general context of performance and current views on performance achievement.
Klinedinst (1991:236) sought to identify variables which would predict performance success and recommended that “all students be tested with a valid and reliable music aptitude test and the results used in conjunction with academic ability and achievement test scores.” Practice was not listed even as a potential variable so it is concluded from this that a bias towards ability, despite changing attitudes from other directions, still exists. Practice is taken for granted - seen as an integral part of instrumental development - which may explain why it has been rarely investigated and the complexity of its process has not yet been comprehensively understood. This investigation aims to make the invisible, visible by exploring a ritual that is routine and taken for granted (Delamont, 1992).

3.2 PRACTICE

In the development of instrumental skills, there are several factors whose influences have been established through investigations with both professional and developing musicians. Although these vary across individuals, one influence which is unquestionably ubiquitous, though not extensively addressed, is practice.

Child prodigies who demonstrate skills prior to training often receive instruction earlier than their peers which increases their opportunities to acquire high levels of skills through accumulated practice. However, not all children identified as having exceptional musical ability achieve elite performer status as adults (Bamberger, 1986). Retrospectively, it has been found that many elite performers gave no indications of exceptional ability at an early age. For the achievers in one study, a variable which set them apart from less successful performers was amount of practice (Sosniak, 1985).

3.2.1 The influence of practice on skill development

It is generally acknowledged that practice is an essential element in the development of instrumental performance skills (Wagner, 1975; Rosenthal, 1984; Wolfe, 1984;
Rosenthal, Wilson, Evans, & Greenwalt, 1988; Price, 1990; Barry, 1992). Despite this, according to Sloboda (1993:90), “almost nothing” is known "about the precise ways in which musicians of differing skill go about their rehearsal.” Buck (1944), an early music psychologist, concluded that novices generally do not rehearse productively because they rehearse by simply repeating music from beginning to end without any strategic plan. Currently, although some teachers and expert performers insist there is much more to practice than simple repetition, many teachers fail to introduce their students to strategies other than physical drill. This investigation will demonstrate whether Buck’s assertion is upheld for this group of students.

A small number of teachers consider that for practice to be effective it needs to be "deliberate" rather than "routine" but it appears that specific strategies which would facilitate deliberate practice are not generally taught. This leads one to conclude that expert performers, at some time during their instrumental apprenticeship, were either taught or developed specific, focussed practice themselves. However, little is known about the practice strategies they used when they were beginners to facilitate their development.

The adage “practice makes perfect” might be more appropriately replaced with "perfect practice makes perfect” but what makes practice “perfect” for individuals has not previously attracted investigation. Research across a range of disciplines has shown that successful practice is achieved through rigorous concentration and deliberate attention to specific outcomes. Practice strategies, therefore, need to include these aims if results are to be productive (Barry, 1992; Ericsson, Krampe & Tesch-Romer, 1993).

When one considers the newness of the experience for beginners and the need to acquire a basic set of different but interrelated skills, practice for the novice differs
considerably from that of the expert. The well-established partnership between sports psychology and physiology which has led to a comprehensive understanding of skill development and performance in sports and other skills has not yet transferred to music practice nor been applied to beginners.

Time spent on rehearsing does not in itself determine performance success (Wagner, 1975; Anderson, 1981). Wagner (1975) demonstrated that not all practice is productive. When students provided a written report on practice time and performance, although practice time increased, this did not lead to increased performance proficiency. Leonard and House (1972) confirmed that students frequently rehearsed without objectives and therefore unproductively. According to Barry (1990), when practice is structured and systematic, rather than left to follow a free course, it leads to more accurate performance. However, what constitutes structured, systematic practice is unexplained in the literature. Quality practice appears to be more important than quantity.

In contrast to Barry's (1990) findings, Sloboda and Howe (1991), investigating the differences between the best and the average students, detected that the former had done less formal practice, though not less practice overall, in their early years than the latter, and spent more time on improvisation and other activities. McPherson's (1993) investigation demonstrated that students who, in addition to rehearsing specific compositions, also incorporated more varied activities during practice such as improvisation, memorisation and playing by ear demonstrated higher levels of these types of performance skills. Qualitative differences, therefore, appear to hold the key to effective practice.

Some teachers understand that repetition alone will not necessarily produce learning outcomes because students' behaviour needs constant monitoring, a view supported by LaFosse (1973). In the absence of supervision and feedback, mistakes may be
learned, and students may not progress because they do not understand which skills need to be improved. Beginners, in particular, may not have the ability to be self-regulatory in their practice sessions because of lack of self-analysis skills or because of their limited capacity for accurate aural discrimination.

Research has provided insight into other applications of practice. For example, the acquisition of skills develops over time. This contention is supported by research studies in chess (Simon & Chase, 1973; Krogius, 1976), mathematics (Gustin, 1985), tennis (Monsaas, 1985), swimming (Kalinowski, 1985) and music (Sosniak, 1985). Other studies reported in Ericcson, Krampe and Tesch-Romer (1993) indicate that skill development may not progress at an even rate with periods in which the level of skills remains relatively stable until some intervention occurs. Is it when students reach such a plateau that they discontinue learning? Without restructuring practice procedures, individuals may be unable to move beyond these plateaux.

The lack of studies concerning beginners' practice behaviours led to the exploration of literature concerned with the practice behaviours of experts.

3.2.2 The development of performance expertise through practice

Emphasis on practice as a primary influence on skills development has appeared in literature unconnected with music. Results of these studies suggest the effects of practice are more significant than previously considered. Early investigations into the acquisition of complex skills including morse code (Keller, 1958), chess (de Grout, 1965; Chase & Simon, 1973), typing (Thomas & Jones, 1970), bridge (Charness, 1979), and various sports, have resulted in an increased understanding of how expertise is developed through practice rather than pre-disposition.
Studies of expert musical performers provide some understanding of the processes which lead to excellence (Sosniak, 1985; Ericsson, Krampe & Tesch-Romer, 1991; Sloboda & Howe, 1991). Expertise appears to be germane to particular domains, for example, athletes may excel in one particular sport but not in another and, similarly, musicians who excel on more than one instrument are rare. Conclusions from these and other studies suggest that expertise is domain-specific, that skills do not transfer readily, and that prolonged engagement in a skill has significant influence over its development.

Contemporary literature points to the crucial nature of practice across a range of skills including music.

Current level of practice is highly correlated with current level of performance, but there are many findings showing that the accumulated amount of past practice influences current performances (Sloboda, 1993: 115).

Interviews with elite performers (Uzler, Gordon & Mach, 1991) and a small number of studies (Gruson, 1988; Hallam, 1995) have shed light on the multiple approaches adopted by experts during practice, and their amount of practice, but little is known about the practice strategies they employed as novices. Even less is known about the practice procedures adopted by beginner instrumentalists.

Teachers appear to recommend strategies they were taught by their own teachers, or techniques they discovered to be effective through their own learning. Whether these can be generally applied to all individuals is questionable. To what extent students follow these recommendations or are encouraged to analyse the effectiveness of them is unknown since most teachers do not monitor students' private practice sessions.

3.2.3 Early investigations of practice

Rubin-Rabson's (1939:321) findings that "many music students are handicapped by an ignorance of learning techniques" and "the efficient learner obviously does
not depend on repetition alone for learning, but on a skilful organisation of the materials” (p. 341), appear to hold true today. Rubin-Rabson's work in the 1930s concerned several related topics: memorising music, unilateral versus coordinated rehearsal, massed versus distributed practice, whole versus part method, incentive versus non incentive, extended versus short passages for pre-study away from the piano, and mental practice prior to piano playing. From her summary, the writer concludes that:

i  rehearsing hands separately produces "greater stability and clarity in the learning of piano material" (p.343)

ii distributed practice is more effective than concentrated practice for less able learners

iii whole learning is as effective as part learning

iv incentives do not cause a reduction in the number of trials necessary to perfect a performance

v pre-practice times reach an optimal level beyond which increased times produce minimal improvement

vi mental practice prior to keyboard playing is more effective than keyboard learning alone

vii learning is more efficient under conditions of over-learning.

Although this work provides some understanding of the effects of different practice strategies on instrumental outcomes, few studies have added to these early investigations. On the issue of rehearsing hands together or separately, one other related study (Brown, 1933) found the former to be more interesting and efficient than the latter.

The process of practice is complex, as much a function of the brain as of physical drill, and just as in need of investigation today as it was in the 1940s. Sight reading, modelling, feedback, motivation, motor skills, mental practice and skill
development have been investigated since then in an attempt to identify factors which contribute to effective practice strategies. A review of these issues follows.

3.3 FACTORS BELIEVED TO AFFECT PRACTICE

3.3.1 Sight reading

Sight reading is thought to have a significant influence on both practice and performance outcomes. Music sight reading can be likened to literary sight reading when one reads an unfamiliar passage. For both language and music reading, the ability to take in psychological units as well as the complexity of the text will mediate the performance outcomes.

There are two significant differences between sight reading words and sight reading music. Firstly, children generally learn to use language in spoken form long before they learn to read the printed word whereas most instrumentalists learn to read music and play simultaneously. The second difference is how the skills are rehearsed. In literary reading, verbal and silent reading (mental practice) is encouraged thereby increasing practice opportunities. Silent reading of a musical score is problematic for novice instrumentalists as it requires an ability to audiate, a skill generally lacking in beginners.

Many musicians become accomplished sight readers, while others perform with expert skill but without being able to sight read music fluently. Similarly there are fluent readers of language as well as those who have not attained the skill of reading and are only speakers of the language. For some musicians, instrumental sight reading is a burden they overcome by memorising the music as soon as possible. This has the effect of reducing sight reading opportunities. Others abandon instrumental tuition altogether because of music reading difficulties (Rees, 1978).
The development of good sight reading skills is an important aspect of performance because it creates a cycle which enhances instrumental proficiency. The more able the sight reader, the more fluent the performance which leads to the introduction of more repertoire and more sight reading, enabling the cycle to continue. The ability to sight read may also affect motivation to rehearse because new repertoire provides stimulation through variety and creates interest. A considerable body of research on sight reading has led to two important conclusions. Firstly, sight reading is a skill that can be taught and secondly, specific rhythm training is essential to its development (Boyle, 1970). Given the importance of sight reading to performance, it is difficult to explain why it is generally not specifically taught by instrumental teachers.

Practice itself is affected by sight reading ability, at a more complex level, according to Sloboda (1984). He concludes that musical features of a score, recognised prior to performance, control it in some systematic way. Other studies on music reading suggest the need for it to be introduced from the earliest stages so that integration of the use of eye, hands and brain can be fully developed (Trupin, 1986). In contradiction, Suzuki (1983) maintains that reading of notation should only be introduced after the student has reached a prescribed level of practical instrumental proficiency. Suzuki’s aid to practice, recorded tapes, relies on auditory cues rather than the visual (Suzuki, 1983).

According to McPherson (1994), sight reading, in the beginning stages of instrumental learning, does not correlate significantly with the ability to perform. With increased performance achievement, however, correlations increase. McPherson makes a number of distinctions between sight reading and performing of rehearsed music, suggesting that the two are different skills which ought to be taught separately. The better sight readers in his study were characterised by their
demonstration of self-regulatory behaviours. Whether performance achievement of students in this present study is affected by sight reading ability will be explored.

One skill essential to efficient sight reading is "chunking", a technique which enables students to scan ahead in the musical score and perceive groups of notes as single units (Lannert & Ullman, 1945; Sloboda, 1974; Gruson, 1988) in a similar manner to skimming written language. In the beginning stages of learning, instrumental students tend to see one note only at a time though it seems possible that they could be taught to group notes together as a strategy. If students are taught a range of strategies which are demonstrated by efficient sight readers, the skill itself could be improved and, given the correlation with performance outcomes, so might overall instrumental performance.

Acknowledgment of the importance of sight reading to instrumentalists has prompted some research comparing various methods for teaching the skills (Palmer, 1976; Anderson, 1981; Shehan, 1987; Salzberg & Wang, 1989). Despite the complexity of music sight reading and its potential to influence performance achievement, it has received scant attention in the literature and it appears that few teachers teach the skill specifically to their students who are left to discover their own methods. Practice in the skill of sight reading may improve the skill itself, thereby enhancing both practice and performance outcomes.

3.3.2 Modelling

Most practice is founded on some form of modelling. Listening to teacher demonstration of music during instrumental instruction periods is a well established praxis which was carried beyond the “apprentice imitating the master” model by Suzuki (1983) by his introduction of audio tapes for home practice. Studies by Puopolo (1971), Duerkson (1972), Zurcher (1972), Folts (1973), Rosenthal (1984), and Zurcher (1987) confirm the effectiveness of practice models on
performance outcomes. Although other researchers (Hodges 1975; Anderson, 1981) found no significant differences, listening to exemplary models on audio tape led to greater accuracy of performance with advanced adult instrumentalists according to Rosenthal, Wilson, Evans, and Greenwalt (1988).

From classroom studies, Sang (1987) and Delzell (1989) conclude that teacher demonstration affects performance outcomes positively. Thus, as a pedagogical technique, modelling is generally considered effective in the development of performance skills. It is acknowledged that, for students to benefit from modelled performances for the purpose of music imitation, they need to be skilled listeners.

When Rosenthal (1984) examined the effects of modelling under differing conditions (verbal directions with aural model, aural model alone, verbal directions alone, and practice only), she found the aural model to be the most efficient. A later investigation of five conditions of practice - modelling, singing, silent analysis, free practice, and control - found that modelling and practice were significantly more effective than the other conditions (Rosenthal, Wilson, Evans & Greenwalt, 1988).

Concerning mental practice and memorisation, Lim and Lippman (1991) demonstrated that although listening to a perfect model resulted in increased performance outcomes over visual scanning of the music, it was practice that led to the highest level of performance. An earlier study (Lippman & Lim, 1988) which used models at slower than normal tempo for listening to and rehearsing with the recording, resulted in marginally improved performance. This technique was thought to be more appropriate with beginners or students whose listening skills were not highly developed.
One form of modelling which has yet to be explored is that made available by computers. The recording of a musical model which can be saved to disk and used in a similar way to audio recording has several additional advantages. Because the information saved is digital, it can be manipulated in tempo without changing the pitch of the music so students may make adjustments to suit their current level of fluency. The software may also have orchestral accompaniments which some students could find motivating.

Computer technology, because of its potential to be manipulated by the student in ways not possible with other forms, may contribute uniquely to practice. How students make use of the technology is addressed in this study.

3.3.3 Feedback

Feedback on musical performance comes to students in various forms, primarily from their teachers, but also from peers, family, and from self-analysis. This little-researched aspect of instrumental teaching and learning has recently received attention from Speer (1994) who suggests that instrumental teachers examine feedback applications during instruction. In his study, less experienced teachers gave more specific, positive feedback than the more experienced teachers, leading him to recommend that piano teachers re-examine their procedures during instruction. Findings by Speer and Duke (1987) suggest that instrumental students are more aware of teacher disapproval than approval, which could ultimately lead them to discontinue study. How students in this study respond to the anonymity of computer feedback will provide further information on its effectiveness.

In the early stages of learning, feedback has been shown to exert a powerful influence on skill and knowledge acquisition, and on motivation. Results of Sloboda and Howe's (1991) study indicated that personal warmth and encouragement from students' beginning teachers was more effective than a
confrontational style which emphasised achievement. From the study it was also recommended that teachers should use specific feedback in order to help students understand its significance. If students are given specific feedback on performance as well as directions on how to rehearse to improve performance, the connection between feedback and practice may become evident. Modelling these teacher behaviours may assist students to use internal cuing and self-feedback, and increase their ability to be self-regulatory during practice, thereby resulting in more effective practice.

3.3.4 Motivation

Motivation could be defined as an ability to set goals and systematically strive to reach them. For instrumental students, it is the inner urge to undertake purposeful activity that maintains practice habits as well as a number of other aspects of learning an instrument. Researchers have explored children's motivation to learn a musical instrument (MacKenzie, 1991) and choose a particular instrument (Bruce, 1992; Bruce & Kemp, 1993), but less is known about what motivates instrumentalists to rehearse once tuition has begun.

Children in Sloboda and Howe's (1991) study reported that they did not always enjoy practice and often needed the support of their parents to ensure it was done. Teachers suggest that motivation comes from setting goals such as examinations and concert performances, and having students record the amount of time they rehearse, and giving them feedback. However, the scant amount of literature on extrinsic motivation has not always supported this notion.

For performance success, motivation needs to be long term. What motivates students to long hours of practice and effort has been less explored and results have been contradictory. Rubin-Rabson (1940) concluded that extrinsic rewards may not increase students' motivation to rehearse while, in contrast, Wolfe (1984) found
that behavioural contracts effectively increased the amount of practice. Obviously further investigation in this field is warranted.

Motivation to rehearse appears to be a critical issue. The literature suggests that amount of deliberate, sustained practice, is a primary influence on performance outcomes. The ability to sustain a high degree of practice commitment for the maintenance of any skill is mandatory and well recognised by performers who also acknowledge that practice is not inherently enjoyable. Young children need the support of parents and teachers, in particular, to manipulate their environment so that it will provide the extrinsic motivation that may eventually lead to intrinsic motivation. Whether the young adults in this present study who are beginners need a similarly high level of external encouragement to pursue practice is unknown.

Sloboda (1989) suggests that positive experiences in early childhood are important factors in providing long-term motivation for musical involvement. Dweck (1986) and Vispoel and Austin (1993) conclude that self-confidence, which may indirectly influence motivation, can be a better predictor of achievement than I.Q. differences. Since practice is not inherently enjoyable for some students, positive experiences that enhance self-confidence seem to be important in encouraging and maintaining practice.

Professional instrumentalists have described the means by which they motivated themselves to rehearse (Hallam, 1995). Of twenty-two professional musicians, twelve were extrinsically motivated requiring the incentive of concerts to sustain their levels of motivation. Only five subjects were intrinsically motivated, expressing a joy in practice itself. Some stated a sense of loss if they did not rehearse daily and most agreed that the optimal practice session be forty minutes. To overcome the boredom of practice, these experts used techniques such as improvising or watching television during technical practice. Whether similar levels
of motivation can be provided to students in this study by computer
accompaniments is explored.

While environment appears to have considerable impact on the acquisition of
performance skills, other influences, including motivation, have also been
identified. In one study concerned with the early development of twenty-four
concert pianists (Sosniak; 1985), practice was a key element. Environmental
support, early lessons, and early practice regimes were strongly motivating factors.
For these subjects, practice became more focussed as they became more proficient.
Practice was highly directed by the teacher, in terms of what to rehearse, at what
tempo, and the number of hours or repetitions for each composition or technical
exercise. The motivation to rehearse was firmly entrenched after five or so years of
instruction, although occasional reminders from parents were required. Fear of
being unprepared for lessons, examinations or concerts was also a strongly
motivating factor to rehearse. By the middle years of learning, Sosniak found that
lessons and practice had been habitualised, and at least half the child's time was
taken up with piano activities.

According to Isaac Stern (1979), somewhere between the ages of ten and fourteen
years, individuals determine that music will play a significant role in their lives,
possibly as a profession, at which time serious practice begins. It appears then that
these individuals become self-motivated to become performers and presumably
come to understand the importance of practice.

Motivation to rehearse may also be affected by students' attribution to success.
Extensive exploration of attributions that students make to performance success has
been undertaken by Asmus (1985, 1986, 1989). If students believe they control
performance outcomes because of effort, they are more likely to rehearse than if
they doubt the likelihood of success. Highly-motivated students in the Asmus
(1989) study attributed success to effort while less motivated students emphasised ability.

In a recent article, Sloboda (1994) suggests that intrinsic motivation develops from the pleasure derived from musical experiences and extrinsic motivation from achievement. It appears that, if they are to be motivated to rehearse, students need to enjoy practice and believe that success depends more on practice than on innate ability.

If the learning environment conditions students solely by extrinsic rewards (such as winning competitions or gaining first place in class), competitive classroom structures may create inequality of motivation (Ames, 1984; Nicholls, 1984; McCaslin & Good, 1992). Whether beginner students understand that performance achievement is as much related to effortful practice as ability is unknown. However, it appears that sustaining practice motivation in beginner students is an important issue if performance outcomes are to be achieved.

3.4 TEACHERS' INFLUENCE ON PRACTICE

3.4.1 Teachers' attitudes to practice

Teachers' views on what constitutes practice appear to be based more on how they were taught themselves than on contemporary research. Minahan's (1986:23) article "The art and science of rehearsing" espouses what could be called the traditional wisdom of practice in which a set of standard psychomotor recommendations are made. "Begin...with a few technical exercises...start slowly...play all the pieces...play without dwelling on specifics...finish the piece and go on to the next".

If one accepts that the improvement of skills is primarily the result of practice, and given that in music most practice occurs away from the teaching environment,
teaching individuals how to rehearse becomes an essential part of instrumental instruction. A recent study by Barry & McArthur (1994) investigated the teaching practice procedures of a group of music teachers, most of whom reported that they almost always discussed the importance of practice techniques with their students and recommended specific practice strategies. However, the research produced contradictory results leaving this issue in doubt. Only half the teachers recommended mental practice, and little emphasis was placed on the importance of listening as part of practice.

This rare investigation sought to obtain direct answers to a set of questions which included issues with which many teachers are familiar. The findings of Barry & McArthur (1994) confirm the need for the present study by recommending more research to investigate both how students are taught to rehearse, and how students actually rehearse.

3.4.2 Teachers' recommended strategies

Weidenbach's study (1995a) investigated the practice attitudes and strategies of four hundred keyboard teachers registered with the NSW Conservatorium of Music. She found that generally teachers recommended strategies which were routine and non-individualised. They placed more emphasis on physical, technical, emotional and environmental aspects of practice, by a ratio of 6:1, than on intellectual planning and analysis. Pre-practice planning, mental practice and post-practice analysis were rarely mentioned. There was little evidence that students were encouraged to think for themselves about how they rehearsed, and strategies that would have enabled them to develop these skills were not taught. Furthermore, teachers were unaware of how their students rehearsed.

While the study identified the current praxis of practice based on teachers' articulated views, it raised several questions. How do students rehearse during
private rehearsal? Is there a common set of routine strategies generated independently by beginner students? Do students think about practice and plan deliberate practice strategies? Is there a set of strategies which is more effective for some students than others? The current study attempts to answer these questions which have been omitted in the literature.

3.4.3 Teaching practice as a skill
It is generally accepted that through continued and sustained practice, students learn to conceptualise and process larger units of musical notation enabling them to work with patterns rather than individual notes, thereby accelerating the process of learning repertoire as they become more experienced. If students are taught how to rehearse more effectively from the outset of instrumental learning, the time to acquire skills may be reduced. For this to occur, teachers would need to teach students how to construct their own practice sessions.

3.4.4 Summary
Although the literature is less substantial in music than in other performance domains, recent investigations in music suggest that rehearsal may be more significant than musical ability or predisposition to instrumental achievement, although this is not universally accepted. Teachers and students use the term practice frequently but it appears that current understanding of what constitutes effective practice is limited by lack of research, particularly in regard to beginners. Despite the sometimes conflicting results of research connected with sight reading, modelling, feedback, and motivation, these studies increase understanding of some of the constituents of practice.

Perhaps of greater importance is the attitude of teachers to practice. Few give students direction in how to rehearse, and often these are generalised rather than individualised. Rarely do teachers recommend that students think about their
practice nor do they teach students how to become independent monitors of their own rehearsal. When strategies are recommended, teachers generally fail to monitor their recommendations. If appropriate practice schemata are not passed on to instrumental performers, what are the consequences? Do students who develop their own schema become successful performers and those who fail to do so fall by the wayside? The conviction that performance success is more closely related to ability than practice appears to be more entrenched in music than other domains.

3.5 PSYCHOMOTOR ASPECTS OF INSTRUMENTAL PRACTICE

The following review of literature reveals that teachers place emphasis on motor development directing students to rehearse scales, technical exercises and to repeat pieces until they perform without errors but often, despite this repetition, students make little progress. In several studies reporting motor skills development in music, it has been observed that insufficient attention has been paid to investigating optimal practice techniques (Duerksen, 1972; Rainbow, 1973; Leonard & Colwell, 1976; Sidnell, 1986; Coffman, 1990). It is suggested that the emphasis should be on how to rehearse these motor routines rather than on what to rehearse.

3.5.1 Physical practice

Most studies of motor skills development have focussed on advanced instrumentalists with well established skills. These studies in such diverse fields as neurology, physiology and psychology are generally not helpful to teachers of beginning instrumental students, although they give some insight into the difficulties performers encounter. Sound spectrum analysis of musical performance behaviour (Rees & Michelis, 1991), analysis of touch (Lee, 1989), and rhythmic precision (MacKenzie & Van Eerd, 1990) have been made possible using computers, adding to the understanding of the complexities of piano playing.
Models for motor learning have been developed to explore how motor learning processes occur (Lashley, 1951; Attneave, 1957; Adams, 1971).

Motor programming in musical performance is hierarchical in nature, moving from the simplest single note movement to the performance of complex units, from short controlled sequencing to more automated processing (Gruson, 1988; Shaffer, 1988). In music, it appears that experienced instrumentalists employ cognitive analysis of a composition, breaking it into units small enough to be played automatically and that, with experience, these units become larger. In contrast, the novice sees the music from the smallest units (individual notes) and only after extensive practice does this change. If beginners rehearse in this manner, then teaching them to see the music in small sections rather than individual notes may make practice more efficient.

Sidnell (1986) claims that a large proportion of the time employed by instrumentalists in developing motor skills occurs without guidance during private practice. Consequently, for beginners who generally have little idea of how to rehearse these skills efficiently, this practice time is often inefficient. He identifies issues which he believes could provide relevant information concerning motor practice suggesting the need for research to clarify the following questions. Sidnell asks whether research could identify more effective methods of teaching motor skills:

- how can students be taught to conduct their private practice more efficiently?
- are there advantages to over-learning?
- does over-learning lead to retention?
- can optimal times for practice be identified?

Although Sidnell has not specifically addressed issues relating to beginning instrumentalists, it may be valuable to relate his practice questions to beginners to provide increased understanding of what constitutes effective practice conditions.
Clearly, the relevance of feedback is as important for the beginning instrumentalist as for the experienced performer, and encouraging the novice to think more about motor movements is a necessary precondition to facilitating motor skill development through practice.

As mentioned earlier, another topic which has been explored is “chunking”, the organisation of skilled sequential activities. This involves connecting information into larger, structured units to increase the amount of information in working memory. These units or “chunks” are associated with short term memory and have been identified with perception in music by Sloboda (1974), and games and sports by Chase and Simon (1973) and Charness (1979, 1991). It appears that, when sequences as opposed to individual notes are performed, greater fluency follows and improved skill development takes place. As larger chunks are processed, the level of performance fluency increases. Although expert performers are known to use this skill, it is not known whether beginners employ the strategy.

According to Sloboda (1993:90), the skilled performer needs:

a high degree of representational skills to be able to rapidly construct an appropriate performance plan on the basis of visual information where relevant cues are often only implicit, and one needs a high degree of motor programming skills to be able to assemble a fluent motor sequence at an appropriate speed.

It appears therefore that, with expert performers, motor programming has shifted from the deliberate to the automatic and that intellectual preparation prior to rehearsal has greater prominence. For the beginner, the act of transferring written notation to motor production appears initially to be a deliberate, painstaking act which is gradually improved by drill and practice.

Motor skills are acquired primarily through repetition during private practice. This is problematic for beginners for several reasons. Beginning keyboard students are struggling to master several skills simultaneously and may find difficulty in being able to analyse how they are playing physically while also trying to concentrate on
deciphering the written score and initiating motor responses on the instrument. Whilst there is considerable research on a variety of motor tasks by motor learning specialists, little is available on the effects of repetition and instrumental practice.

Although there is a dearth of information on practice procedures, the importance of developing technique through practice has been discussed. Writings about expert performers and master teachers such as Breithaupt, Leschetizky, Liszt, Matthay, Ortmann and Schultz (Uszler, Gordon & Mach, 1991) confirm their emphasis on technique and motor skills. Generally, however, the focus is on what to rehearse rather than how. Sandor's (1981) text on piano playing devotes a short chapter to practice in which he addresses issues related to metacognitive issues. This is a rare find in the literature. Unfortunately, writings such as these focus on knowledge of the physiological movements involved in piano playing and how to develop proprioceptive sensations which are beyond the needs of the beginning piano player.

Teachers and music examination boards generally emphasise the importance of technical motor exercises but according to Wilson and Roehmann (1994:511) “their role has never been systematically investigated.” Coffman (1990) demonstrated that physical practice was necessary for superior psychomotor development and that when physical practice was used alternately with mental practice, superior results were produced. Motor skills, essential elements of performance, are known to develop primarily through practice. However, it is taken for granted to such an extent that generally little reference is made to the fact.

3.6 COGNITIVE ASPECTS OF INSTRUMENTAL PRACTICE

When the term practice is interpreted as drill, the emphasis is on the psychomotor. However, there is potential for cognitive processing in various forms to occur throughout instrumental performance as well as prior to and following practice.
This was not evident in teachers' explanations of what constitutes practice (Weidenbach, 1995a).

In a cross-sectional study which measured performance across multiple trials, Gruson (1988) demonstrated that piano students of different levels of experience employed different levels of cognitive strategies which changed with increasing experience. From the pianists' descriptions she determined that over time, strategies became more complex, more abstract, and more flexible. This cognitive approach to practice analysis suggests that self-regulation develops with instrumental performers over time as a function of experience.

3.6.1 Self-regulated learning

The application of self-regulation in instrumental practice is not evident in the literature and, because of the dearth of studies related to music practice generally, it is not known to what extent such cognitive strategies are used by either expert or novice performers. Some music educators support the proposition that the key to musical independence lies in metacognition: learning how to maintain executive control over one's musical thinking (Boardman, 1989). However, studies exploring thinking behaviour during instrumental practice are rare other than that by Whitaker (1989) who investigated the thinking aloud of a pianist while rehearsing. Understanding how self-regulation has contributed to learning in other academic disciplines is a first step in exploring whether it is demonstrated in beginner instrumentalists as a natural phenomenon.

According to Butler and Winne (1995) self-regulated learning is controlled by a recursive flow of information as shown in the following diagram. Instrumental performers should follow a similar procedure for learning repertoire.
Kuhl and Goschke (1994) suggest that when self-regulated learners engage in academic tasks they draw on knowledge and beliefs to construct goals. This leads them to select strategies. Students' self-monitoring then leads to internalised feedback which they use to set new goals, re-examine strategies and set new procedures. When students monitor task engagement, their knowledge and beliefs may be altered influencing subsequent self-regulation.

According to Cormo (1989), self-regulated learning enables a student to approach a learning task effectively and with flexibility by calling on a particular set of strategies which include monitoring, elaboration, and effort-management. To some extent all instrumentalists call upon self-regulating processes as they rehearse to further develop performance skills. Whether these individuals can be described as self-regulated learners depends on the extent to which they understand how specific strategies can influence their practice and the degree to which they are prepared to apply these strategies to achieve their practice goals.

From extensive research, Zimmerman (1989:392) has concluded that students can be described as self-regulated learners to the degree that they are "metacognitively,
motivationally, and behaviorally active participants in their learning process." These students become agents of their own instruction when they personally initiate and direct their own learning efforts to acquire knowledge and skill. If practice is a critical factor in the development of instrumental performance skills, the ability to become a self-regulated learner would appear to be an essential factor in the realisation of effective practice strategies.

Zimmerman (1989) considers that to be identified as self-regulated learners, students must use specified strategies of self-efficacy to achieve academic goals. These strategies include organising and transforming information, self-consequating, seeking information, rehearsing and using memory aids (Zimmerman & Martinez-Pons, 1986).

Research has been conducted on a variety of behaviours considered to be self-regulatory: self-reinforcement, standard setting, delayed gratification, goal setting, self-efficacy perceptions, self-instructions, and self-evaluation (Zimmerman, 1989). This has motivated other researchers to attempt to integrate these items into general models of self-regulation (Zimmerman, 1981, 1983; Bandura, 1986).

Self-efficacy, a key factor affecting self-regulated learning (Rosenthal & Bandura, 1978; Bandura, 1986; Schunk, 1986; Zimmerman, 1986) relates to both students' use of learning strategies and self-monitoring. Students with high self-efficacy demonstrate better learning strategies (Kurtz & Borkowski, 1984) and more self-monitoring behaviours (Kuhl, 1985). Perception of self-efficacy has been shown to relate positively to task persistence (Zimmerman & Ringle, 1981), task choice (Bandura & Schunk, 1981; Zimmerman, 1985), effective study activities (Thomas, Iventosch & Rohwer, 1987), skill acquisition (Schunk, 1984) and academic achievement (Thomas et al., 1987).
Instrumental students with high levels of self-efficacy are more prepared to rehearse and attribute their success to practice than those with a lower level of self-esteem (Asmus, 1986). Other research shows that, when failure at a task occurs, self-efficacy is negatively affected on subsequent tasks so that when failure to progress in music occurs, both students and teachers may attribute this to lack of musical ability rather than lack of practice tasks (Zimmerman & Ringle, 1981).

Zimmerman (1985) found that rewards for efficacy increased students' self-efficacy more than rewards for non-efficacy. Some instrumental teachers recognise this strategy, particularly those who know the importance of giving very specific feedback so that students understand its significance and, as a result, learn to give themselves positive feedback during private practice. Self-regulated learners are highly motivated, seeing themselves as competent, autonomous learners (McCombs, 1986; Schunk, 1986). They demonstrate the ability to select, structure, and create environments which will optimise learning (Wang & Peverly, 1986; Zimmerman & Martinez-Pons, 1986) by their behaviours and, as a consequence, continue to rehearse their skills. Whether beginning instrumental students possess these skills is unknown and it may be they need to be taught if private practice is to be effective.

Bandura (1986) sub-divides self-regulation processes into three distinct subprocesses: self-observation, self-judgement, and self-reaction. These are necessary strategies for deliberate practice. Self-observation involves the student in systematically monitoring performance. Listening to performance, analysing the results accurately, and planning how to change the outcomes are essential strategies for improving performance.

Self-judgement requires students to systematically compare their performance with a standard. In the case of instrumental performance, the model is generally provided
by the teacher during lessons but may also be provided by a tape-recording or by computer performance. There is already an extensive body of evidence detailing the positive effects on learning and performance when students have been taught to record their performance (Shapiro, 1984). Self-reaction follows self-observation and self-judgement, and determines what specific action will be taken, based on some prior knowledge of the potential effectiveness of the intended action.

When students are taught self-observation and self-judgement procedures, their ability to self-regulate skill development improves (Mace & Kratochwill, 1985). If instrumental students do not demonstrate self-observation and self-judgement, teaching them these procedures may improve the quality of their practice skills. For beginner students to self-observe while performing may be difficult because of the number of diverse aspects to which they must attend simultaneously. But using a keyboard equipped to record one's performance may help novices overcome this problem. In addition, using computer assisted keyboard software to demonstrate model performance, along with self-recorded performance, may assist students to develop self-judgement procedures ultimately influencing practice.

Self-reaction implies the ability to engage in self-instructive practice. It is clear from the music literature that self-regulated learning has not been explored in its relation to instrumental practice. Although literature supports deliberate practice as a critical factor in the development of expert non-instrumental performance generally, explanations of deliberate practice are both sparse and vague in music.

The social cognitivist approach to self-regulated learning is based on the view that students' self-regulated learning processes are observable and trainable through specific experience. Zimmerman's (1989) explanation of self-regulation is relevant to instrumental practice, particularly deliberate practice. Whether instrumental performers, particularly beginners, apply such strategies during practice without
being taught has not received attention previously but its exploration in this study may contribute to that knowledge.

3.6.2 The application of metacognitive thinking to instrumental learning

Colwell (1992) states there has been little research on metacognition undertaken to date in music. Metacognition is considered to be an essential sub-process of self-regulated learning in which individuals plan, organise, self-instruct, self-monitor, and self-evaluate at various times in their learning (Corno, 1986; Corno & Mandinach, 1983; Flavell, 1992). From Corno's (1986) view, self-regulated learning encompasses cognitive and affective processes as well as metacognition. To what extent students are able to be self-regulated will depend on their knowledge of appropriate strategies, and on the level of their metacognitive decision-making processes and performance outcomes.

While research into various aspects of metacognition is evident in relation to academic learning, there are few examples to be found which relate to music. Pogonowski (1989), in a rare discussion, explored the implications for music education including its effects on performance, clarifying for music teachers its potential applications. Recognising that students need to be helped to develop their own metacognitive potential, Pogonowski calls for instructors to teach their students how to set goals and identify strategies for themselves. She discusses individual metacognitive thinking and how, by sharing thoughts during group rehearsal, a form of "collective" metacognition and mutual reinforcement can occur.

Pogonowski's justification for teaching students to metacognize strategies during rehearsal is that it engages students in monitoring and evaluating their own progress and encourages them to get the most out of rehearsal time. She also comments on
the relevance of metacognition in listening activities, and the importance of knowledge and self-control.

One of the few articles to connect metacognition with practice (Kennell, 1989) includes discussion of musical thinking during rehearsal. Kennell suggests that the problem solving activities involved in decoding the complexities of musical notation into practical performance exemplify the use of metacognition. His confidence that all instrumental teachers actively demonstrate strategies for solving music problems to foster musical independence is encouraging though perhaps overly optimistic.

3.6.3 Mental practice

Mental practice is considered by many expert performers to be as effective as physical practice. The literature is rich in regard to mental practice which is rehearsing in one's imagination without physical performance. According to Trusheim (1987, in Colwell, 1992:475):

All musicians could easily spend some of their practice time using mental rehearsal to refine their mental concept and to solve technical and mechanical difficulties in their playing. Research has shown mental rehearsal to be an effective and efficient supplement to actual practice in many areas involving skilled physical activity.

Mental practice has been extensively investigated by psychologists and researchers in disciplines other than music including physical education. Richardson's (1967:95) definition of mental practice as “the symbolic rehearsal of a physical activity in the absence of any gross muscular movements” has relevance to instrumental performance skills. Other definitions - imaginary rehearsal, symbolic rehearsal, mental rehearsal, implicit practice and conceptualising practice - all reflect the concept of mental practice.

Mental practice was first mentioned by Washburn in 1916. She contended that minuscule movements occur even when one is only imagining the performance activity. Despite its relevance to music practice, it seems that few instrumental
teachers recommend mental practice to their students today. Another early researcher, Jacobson (1932), did not attempt to determine whether mental practice led to skill improvement but used electromyography to demonstrate that muscular activity occurred during periods of imagining a skill, especially when connected with movement experiences. Jacobson's findings have not been built on in contemporary research despite the acceptance of the importance of mental practice in such fields as sports.

Weinberg's (1982) review of mental practice concluded that its effectiveness depends on several variables including conceptualising ability, prior experience, specific task, and length of practice periods. Despite anecdotes from some professional pianists who discuss learning the musical score away from the instrument, Daniel Barenboim for example, this is a feat uncommon in most professional performers. It is usually not part of the repertoire learning approach of beginners as they are struggling to negotiate the complexities of reading notation and finding the correct notes on the instrument.

Rubin-Rabson (1940) found mental practice over-learning superior to physical practice over-learning for retaining memorised keyboard music. In her studies (1940a, 1940b), she discussed motor memory and logical memory which involve physical actions and muscular sensations while analysing a composition. In a later study, Rubin-Rabson (1941), suggested that, even in the absence of physical movement and despite the fact that rehearsal combines auditory, visual and kinaesthetic cues, the sensation of performance may be just as vivid as if with actual physical rehearsal.

It has been demonstrated that mental practice combined with physical practice was beneficial to skilled trombonists (Ross, 1985). Another study, using advanced instrumentalists (Rosenthal, Wilson, Evans & Greenwald, 1988), compared five
different practice conditions (modelling, singing, silent analysis, free practice and the control group) and concluded that modelling and practice were the most effective strategies, while singing and silent analysis were no more effective than sight reading.

Mental practice was found to be most effective when combined with physical practice (Lim & Lippman, 1991). As an additional aid during mental practice, subjects were given an auditory representation of the music along with the written score. The three practice conditions studied were mental practice, mental practice with listening, and physical practice. The researchers concluded that mental practice alone was not very effective for the majority of instrumentalists. While most instrumental teachers agree that motor skills are acquired and refined through physical practice and training, the importance of mental preparation has not been fully recognised and is generally not included in the list of music teachers' recommended practice strategies. This is despite more generic literature on learning which has recognised its importance.

In a rare study which investigated student practice behaviours in detail (Gruson, 1988), a number of the foregoing issues were addressed. Gruson recorded a range of behaviours rehearsing pianists commonly use. Uninterrupted playing, errors, repetitions, tempo changes, self-guiding speech, unilateral practice, discontinuance, performing non-designated compositions, interruptions, and measures of practice time were identified categories for her investigation.

More experienced students conceptualised their rehearsing behaviour and were able to describe more cognitively complex rehearsing strategies. In relation to changes in practice behaviours, these behaviours varied between students of different levels but not within individual students across the time of the experiment. Gruson concluded that beginning students worked at a controlled processing level, which
was limited by short term memory and was serial in nature, whereas the more experienced performers had achieved a level of automatic processing, being able to work with “chunks” of music materials rather than with individual notes. This supported Sloboda’s (1974) conclusions which differentiated experts’ and beginners’ practice behaviours.

3.6.4 Characteristics of deliberate practice.
Individuals acquire many essential living skills spontaneously through both observation and routine practice in everyday activities. Other more specific and technical skills are acquired through formal education which has provided both a means and the need to understand how skills develop. Conditions frequently cited as important in learning skills include motivation, willingness to attend to task, and structured teaching which includes presentation of the new materials, followed by a repeated trial – feedback cycle. The repeated trial becomes what is commonly known as drill and practice. Providing informative feedback is given, further skill development takes place. Without specific feedback, skill development often fails to occur or is minimal. This leads to the conclusion that practice alone will not result in developing expertise.

When practice occurs primarily through unchanging, repetitive drill, it is routine practice. Within the classroom environment, practice can be monitored by the teacher so that students are directed in the use of strategies which are effective for their particular needs. When teaching occurs on a one-to-one basis, explicit instructions on changes to be made during practice periods, based on individuals’ needs, can be suggested and deliberate practice strategies invoked.

It is understood that students may acquire skills through different forms of practice such as performing in the work environment, play through social performance activity, and through planned practice. Instrumentalists in paid work will play
repeatedly as an integral part of the performance but this is unlikely to be deliberate practice, nor is improvising or exploring the instrument deliberate practice. The goal of deliberate practice is not doing more of the same but rather devising special activities which will solve specific difficulties. Deliberate practice is intellectually as well as physically demanding and consequently needs to be limited in time.

Environmental factors, cognitive capacity and the role of deliberate practice in skill development have been investigated with strong support for the view that expertise develops through experience which comes with practice (Chi, Glaser, & Farr, 1988; Ericsson & Smith, 1991). According to Ericsson, Krampe and Tesch-Romer (1993:365), “the domain specific nature of experts' superior performance implies that acquired knowledge and skills are important to attainment of expert performance.” That is, expertise in one skill is unlikely to be transferred to a different skill.

Ericsson et al. (1993: 363) propose a theoretical framework which explains “expert performance in terms of acquired characteristics resulting from extended deliberate practice and that limits the role of innate (inherited) characteristics to general levels of activity and emotionality.”

Deliberate practice refers to purposeful, highly structured practice, probably the result of prior performance analysis, in which the player pays particular attention to critical aspects of performance in need of remediation. Deliberate practice includes repeated experiences which are analysed and, based on feedback, results in the implementation of further strategies to improve performance. Its explicit goal is to improve performance and it is a purposeful, effortful activity requiring intense concentration. According to Ericsson et al. (1993:368), “Specific tasks are invented to overcome weaknesses, and performance is carefully monitored to provide cues for ways to improve it further.”
They also suggest deliberate practice is a distinct activity in which the level of difficulty is adjusted to maximise improvement. The goal of deliberate practice is not doing more of the same. It is a “highly structured activity, the explicit goal of which is to improve performance” (p.368). Special activities are devised which will improve specific difficulties. Since deliberate practice in itself does not generate motivation, it is the result of deliberate practice which generates its application.

Ericsson and his colleagues conducted two studies to evaluate the effects of deliberate practice on performance outcomes. Firstly, they compared the amount of practice accumulated by the best violinists at a conservatoire with their less accomplished peers. Since the former had amassed 10,000 hours of practice and the latter half of that amount, it was concluded that amount of practice was the significant variable. Twenty-seven of the thirty violinists rated practice alone as the most relevant activity for performance improvement. The amount of current levels of practice did not distinguish the different levels of expertise as much as the accumulated practice, although the best of the violinists spent more time on music related activities than their peers.

In the follow-up study, Ericsson et al. (1993), replicated their original study with a group of pianists of more polarised levels of proficiency - adult expert pianists and amateurs. On average, the expert pianists began instruction four years earlier than the amateurs, and the total amount of accumulated practice was more than ten times higher for the experts. Findings generally supported the assertions that performance expertise is controlled by current amounts of practice and accumulated deliberate practice. These two findings have been supported in other research reported by Kaminski (1984).

Some studies have analysed practice to reveal qualitative differences (Gruson, 1988; Miklaszewski, 1989). Beginners acknowledge the importance of quantity of
practice, which is also emphasised by instrumental teachers. But whether they understand the importance of qualitatively monitoring practice strategies has not been investigated.

Expert performance appears to be acquired through extensive engagement in deliberate practice of relevant skills identified by expert teachers and coaches. Cognitive monitoring and self-regulation are essential components of deliberate practice for experts, and it would be useful to know if beginners apply similar techniques. Because practice is generally undertaken alone without the opportunity for feedback from external sources, it is unknown whether beginners seek internalised feedback. Having access to a computer appears to provide instrumentalists with opportunities to gain external feedback but whether beginners have sufficient skills to internalise this information is as yet unexplored.

If practice is a significant variable in the development of expert performance and since practice occurs in isolation, it is logical that expert performers possess effective, individualised practice schema. If these were not taught to them, one may assume the procedures were self-taught. For the beginner, progress is important in maintaining motivation, so if early establishment of effective practice schema can be introduced, skills may develop more rapidly and positive student attitudes developed. Attributing progress to practice rather than to ability would provide strong motivation to practice.

In the past, it has been common to attribute musical excellence solely to ability. According to Artur Rubinstein (1990:5), “The well-intentioned people who ask how to become a pianist show at the very outset that they start from a false premise. You don't become a pianist - either you are a pianist or you are not”.
When students receive such messages, they are more likely to attribute instrumental performance success to ability rather than practice, and therefore be less likely to spend the necessary time rehearsing. An opposing view is that “performance is a cognitive skill that is learned” (Sloboda, 1994:160). If the notion of effortful practice as the primary reason for success can be inculcated in beginning instrumental students, they may be more motivated to do it.

Understanding the manner in which beginner instrumentalists rehearse and identifying those variables critical to the facilitation of effective practice strategies would provide a scientific and rigorous approach to skill development in the earliest stages of instrumental learning. Whilst teachers are able to monitor and assess technique during instructional periods, knowing how their students rehearse privately is more difficult since this activity is generally undertaken away from the instructional environment.

It is acknowledged in the literature of both music and other disciplines that practice is fundamental to skills acquisition (Ericsson, Krampe, & Tesch-Romer, 1993) and that issues of quality of practice as well as quantity are relevant. Instrumental instruction through the conventional demonstration, modelling and feedback cycle has provided the foundation for past performance instruction. Students were expected to model the teacher's playing and to rehearse regularly but generally given little direction on how to rehearse. Metacognitive processes were not specifically identified as part of the process in any of the literature.

The effectiveness of individualised instruction provided by sports' coaches and subsequent improved performance levels has led to an increased understanding of the importance of personalised strategy planning in practice in other fields. When students use these specific strategies during practice, away from the coach, they are employing deliberate practice. It is suggested that instrumental teachers need to
provide the same support for their music students if practice is to improve proficiency and routine practice is to become deliberate practice. Probing practice behaviours of naive instrumentalists will contribute to a better understanding of how teachers could most effectively intervene.

3.7 COMPUTER TECHNOLOGY IN INSTRUMENTAL PRACTICE

Computer technology may be used as a tool for both teaching and learning. It can facilitate group teaching, provide support for students during practice, and monitor students' practice. As computer technology has become more widely used in education, researchers have sought to explain how computational environments impact on learning.

3.7.1 Cognitive apprenticeship

The notion of cognitive apprenticeship as described by Collins (1991) parallels the intensive apprenticeship model traditionally applied to the development of physical skills. Cognitive apprenticeship includes the use of modelling, coaching, and fading paradigm of traditional apprenticeship, but with emphasis on cognitive, rather than physical skills (Collins, Brown, & Newman, 1989). The resource intensiveness of apprenticeship has to some extent been lost in formalised education but the advent of computers has enabled apprenticeship learning environments to be developed. Instrumental practice may also be considered a form of cognitive apprenticeship. As instrumentalists progress to expert performer status, they come to rely less on the teacher and more on their own competence to learn independently.

Instrumental playing is a physical skill traditionally taught under the resource intensive apprenticeship model. Depending on software applications/programs, the current availability of dedicated music computers can enable students to utilise individualised, independent, self-managed learning environments. In the early
stages of instrumental learning, students rely on the feedback of their teachers. This can be likened to cognitive apprenticeship as teachers lead students to identify their own problems and suggest means of solving them.

When students listen to the computer exemplar of the music, model it, self-record, and analyse their own performances, they are undergoing a form of cognitive apprenticeship using metacognitive skills for self-directed learning during practice. Whilst there is still the need for direct teacher feedback for beginners, developing effective practice strategies early in performance learning may greatly assist students in their progress. However, whether beginner instrumentalists are able to make effective use of the technology without specific instruction is currently unknown and is a focus of this study.

3.7.2 Computer aided practice

The introduction of computers in music education occurred simultaneously with their introduction into general education during the 1950s. Programs to teach aural skills, music theory, composition, counterpoint, conducting, and musical analysis have continued to be developed and their effectiveness investigated. Several programs related to instrumental teaching can also be found in the literature. Kent's (1970) keyboard instruction system, Higgins (1991) independent study of clarinet playing and others demonstrate that the use of computers in music is not a new phenomenon.

However, the researcher found no evidence of studies investigating the application of computers as an aid to keyboard practice, or to the analysis of practice. There are reports of students learning keyboard in laboratory environments (Todd, Boltz & Jones, 1989; Wiggins, 1993; Forest, 1995) but these have not addressed practice. Several studies have investigated the use of the computer to analyse piano performance but these were concerned with aspects of technique rather than practice

The literature is rich in research on the effectiveness of computers to teach a range of other music skills and knowledge, and as a tool for analysis and composition, but not as a means of enhancing teaching, monitoring students or aiding practice per se. Uszler, Gordon and Mach (1991) support notionally the use of sequencers in keyboard learning suggesting that they assist the development of listening skills and encourage increased accuracy.

It is suggested that computers may directly affect performance outcomes, particularly when used to complement practice, because they promote instrumentalists’ use of metacognitive behaviours. As Collins (1991:136) so aptly put it in describing the use of computers to develop cognitive apprenticeship, “technology enables us to create environments where new methods of learning-reflection, articulation, and exploration - are possible”.

3.8 IMPLICATIONS FOR THIS STUDY
This review of the literature has placed practice within the framework of instrumental performance research and highlighted the general lack of attention given to practice by instrumental teachers and researchers. It has cited research on self-regulated learning and demonstrated that music educators have not yet connected this concept to practice, nor have they addressed the issue of metacognition as an essential component to the process, other than in general theoretical discussion.

A number of studies discuss the current status of expert performers (Uszler, Gordon & Mach, 1991) and some aspects concerning the broader issues of practice. However, until very recently, interest in specific practice procedures used
by either elite performers or novice instrumentalists has been minimal. The extent to which expert performers or developing instrumentalists use consistent, recurring strategies, and how these were acquired, is yet to be documented.

Although most instrumental teachers acknowledge the importance of practice, it appears that few teach appropriate cognitive strategies and many are unaware of the importance of applying these to practice. While sports coaches have made use of research on skills development to sports' practice, instrumental music teachers have yet to recognise the relevance of deliberate practice in music skill development.

The application of computer technology in music was also addressed in this review. Music educators have been at the forefront of research in the application of computer technology to teach a wide range of music skills and knowledge research since the 1970s. However, investigations into whether or not technology can be used by students to enhance practice were not found in the literature.

Based on this review, four conclusions have been reached. Firstly, practice is a more critical variable in the development of instrumental performance skills than currently acknowledged. Secondly, the construct of practice is not clearly understood by teachers, and students are generally not taught appropriate practice strategies. Thirdly, whether or not beginning instrumentalists generate their own practice schema without being taught specific strategies is unknown. And finally, despite the availability of computer technology and its application to both group and individualised instrumental teaching, its capacity to enhance practice has not been explored.

The research cited in this chapter has drawn together the particular influences on instrumental performance and the place of practice in its development. Chapter Four will present the research design and the methodology for this investigation.
CHAPTER FOUR
RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION
The main purpose of this study was to investigate how beginner keyboard instrumentalists practise and how practice influences performance. The study was designed so that evidence of how students physically practised and how much time they spent on rehearsal could be collected. The relative brevity of the study, fourteen weeks, reduced the likelihood of it investigating the metamorphosis of practice strategies across the period although this was not altogether discounted.

From an earlier study (Weidenbach, 1995b) it was concluded that instrumental teachers do not generally direct students to think about their practice. Practice planning based on reflection on outcomes during private rehearsal was generally ignored. This was considered by the writer to be potentially significant. Seeking information from students by directly probing how they thought about practice could be done via a series of questionnaires. More subtle collection of information could be achieved by setting problem solving tasks related to practice which could be analysed on the basis of levels of thinking. A less formal way of collecting data to enrich that already discussed was achieved through individual journals kept by students throughout the investigation.

In addition to how students practised, for how long, and whether they used metacognitive strategies for the purpose of practice, a final element related to the use of computers was included. How students made use of the MT100 Sequencer/ Sound Module as an aid during practice, and for what purposes they used the equipment, was to be explored. Observed measures, self-recorded feedback from students, and questionnaires were used to provide several different measures of their use of and attitudes to the technology.
Hence, the study was designed to use a combination of quantitative and qualitative measures. There are two primary paradigms which have influenced educational research this century. Firstly, there is the objectivist approach which concerns itself with realism, positivism, determinism and is said to be nomothetic because it has the potential to discover general laws. The opposing view, the subjectivist, is based on nominalism, anti-positivism, voluntarism and the ideographic, that is, the account of individual behaviour (Burrell and Morgan, 1979).

Since the aim of this study was to be able to report how a particular group of students practised, its focus was on the individual. There was no preconceived expectation of the findings and the study was regarded as an exploratory one. However, it did not preclude the possibility of producing a generalised practice schema which might be inferred from the results of measures taken across all students.

While the study was concerned with how individuals think about, reflect on, and manage their practice, it was considered that these behaviours might depend on the characteristics of individuals and their prior experiences. The quantitative outcomes-based approach to research aims to systematically control individual difference (Palmiter, M., Harold, R., Lynch, S. & Freedman-Doan, C. 1993). However, it has not that flexibility to explore the variations and complexities of individual differences in relation to particular contexts (Henwood and Pidgeon, 1993). It was clear that the needs of this study could only be answered by using a combination of quantitative and qualitative methods if a rich description of the behaviours of beginning instrumentalists were to be understood and explained.

Since students are not usually directed by the teachers to be reflective and self-regulated learners during practice, it was considered that metacognition may be the
critical variable in determining the effects of practice on instrumental performance outcomes. If, at the conclusion of this study,

a set of interrelated constructs (concepts), definitions, and propositions that presents a systematic view of the phenomena by specifying relationships among variables, with the purpose of explaining and predicting the phenomena

Kerlinger, in Cohen and Manion, 1989:15

can be deduced for this particular group of students, it may establish a beginning point for future investigations.

Since no control group was involved in the study, the design was essentially a case study method as will become evident later in the chapter as the procedures are described.

In the following section, details of the research design and methodology used in this study are presented. Firstly, the earlier research questions are re-stated and elaborated. This is followed by a description of the particular design of the study, including the sample, the environment, and the procedures used to collect the data. An explanation of the measurements used is accompanied by justification for these measurements.

4.1.1 Research questions

The primary purpose of this dissertation was to examine practice strategies and their influence on the performance outcomes of a group of novice keyboard instrumentalists, and to identify other potential mediating factors. The focal question, how can one characterise the effects of practice strategies on the performance outcomes of a group of novice keyboard instrumentalists, was subdivided into the following six questions to answer the needs of the investigation.

Question 1 What entry behaviours (predispositions) did students bring to the study?
Question 2  What practice behaviours were demonstrated by students during the study?

Question 3  What level of performance outcomes did students achieve at the conclusion of the study?

Question 4  Was practice influenced by personal characteristics (predispositions) exhibited by students at the commencement of the study?

Question 5  Were performance outcomes affected by particular practice strategies?

Question 6  Was the relationship between practice strategies and performance outcomes moderated by the influence of students' predispositions?

4.2  DESIGN OF THE STUDY

This study was conducted in a naturalistic setting during a one semester course of instrumental keyboard instruction offered, as an elective, to pre-service primary teachers. The study ran for one fourteen week semester, three hours per week.

4.2.1 Description of the sample

The subjects in this study were trainee teachers in the Bachelor of Education (Primary) degree at a metropolitan university in Sydney, New South Wales. As part of their course, they were required to select from a number of electives of which Keyboard Studies 1: An Introductory Course was an option. Twenty-one students, three males and eighteen females, who had not previously learned to play any keyboard instrument, enrolled in the course.

Other than to explain to students that the elective had been designed for students without previous keyboard experience, no means of screening or selecting the students was attempted. They were informed of the nature of the course and, for ethical reasons, the investigation being undertaken, and given the opportunity of
transferring to an alternative elective in the first week. Students were made known of the need for them to complete additional assessments and questionnaires, and to keep a personal practice journal and daily practice time log should they choose to continue the course. The focus on practice procedures was not emphasised in the explanation to students because the researcher wished to probe how students rehearsed when not provided specific instruction.

4.2.2 Setting and equipment

The study was conducted in a Micro Technology Music Laboratory in which a bank of 16 Roland KR33 Keyboards was connected to a Master Teaching Console, Roland TL16. Headphones enabled group and individual communication, and private rehearsal to occur. The KR33 Keyboards had a range of pre-set keyboard sounds which included piano 1, piano 2, harpsichord, vibraphone, electric piano, organ, strings, choir, chorus, tremolo, and key transpose.

To each keyboard was attached a Roland MT100 Sequencer/ Sound Module (MT100). The sequencer provided access to approximately 150 additional instrumental sounds via the Musical Instrument Digital Interface (MIDI) channel, and recording facilities.

The three main piano texts were The Joy of First Year Piano (Agay, 1972), Microjazz for Starters (Norton, 1986), and Roland Piano Skills Book 1 (Roland, 1988) of which there were multiple copies. These texts were supported by music software on mini-computer disks (2.8 inch quick disks) which provided demonstrations of the piano music as well as enhanced orchestral and rhythm backgrounds which could be accessed through the MT100. Multiple copies of the software were available on disk for class use as well as audio tape for practice outside the music laboratory. Supplementary music curriculum resources provided
by the researcher included simplified nursery rhymes, folk songs, popular music and classical collections.

New computer disks were provided for students to record private practice in laboratory sessions as were blank audio tapes for home recording. Individual note books were given to students to use as journals. Attached to the journal was a practice log for daily practice time entries to be recorded.

For practice outside the laboratory, students used a variety of keyboard instruments including piano, organ, electronic keyboard or synthesiser. None had access to the MT100 at home. An audio cassette player was required for self-recording home practice and to play demonstration tapes of the music being learned which were available on audio cassette if required.

4.2.3 Procedures
Prior to the beginning of the course, assessment was made of the entry skills and attitudes of students which included ability to use computers, attitude to computers, aural aptitude, and prior music skills. During the study, measures were taken of students' practice planning and rehearsal behaviours, and use of the MT100 during practice as an aid to learning. At the conclusion of the study measures were taken of students' performance outcomes, and attitudes to practice. Students attended three hourly sessions per week.

During the first hour of instruction, they were introduced to theoretical content, music notation and terminology, keyboard structure and nomenclature, and the general physical characteristics required to address the keyboard. Each week new repertoire was introduced and analysed in preparation for group practical sessions and previous repertoire was reviewed as necessary. Drill and practice of note names, rhythmic patterns, and explanations of new theory concepts, as they related
to the scores, were given in this lecture presentation at which all students were present.

In the second hour, students were divided into two smaller groups to allow individual access to keyboards and computers in the laboratory. Practical performance instruction, based on lecture content, was given. In addition to group performance, students were initially taught how to use the MT100 Sound Module/Sequencer, equipment previously unknown to them.

Each student spent a third hour in individual private practice in the laboratory. The researcher was present during these practice sessions and available for consultation as required. After three weeks, students were able to competently use the computer equipment, requiring little assistance from the teacher in its operation. Data on practice behaviours were collected from week four.

During private practice, students had access to software which provided pre-recorded demonstrations of the music they were learning. These models could be accessed as piano only version or with enhanced orchestral accompaniments. Students were able to self-record performance either simultaneously with the demonstration model or to record piano rehearsal alone for play-back.

Although students generally determined whether to use the MT100 or not, they were required to self-record rehearsal sessions five times during the semester. These recordings were made in the laboratory in weeks four, eight, and twelve. Students also self-recorded practice sessions outside the laboratory on to audio tapes during weeks six and ten. The purpose of the audio tapes was to find evidence of verbal behaviours - that is, thinking aloud strategies - which might accompany practice but could not be recorded on the computer disks. These
computer and audio-tape recordings chronicled students' individual physical practice procedures.

In addition to students' demonstrated psychomotor behaviours during practice, their ability to think about practice and apply metacognitive skills to planning was also probed. The researcher devised several different means of investigating the metacognitive behaviours of this group of students.

Students were encouraged to make regular entries related to their development in journals and, to prompt reflection, the researcher gave focus questions weekly. Questionnaires, which were varied in format and content, sought information through specific, forced choice, and open ended questions, and these were given routinely each week. Their purpose was to encourage students to reflect on their learning and to record their thoughts thereby providing data on the metacognitive processes they used for practice planning, implementation and reflection.

In weeks eight and twelve, students were set problems commonly encountered by instrumental students, to which they were required to provide solutions. The first of these related to strategy planning for mastering a difficult composition. The aim of this task was to investigate whether students used deliberate practice strategies. Deliberate practice, as described earlier in 3.6.4, is purposeful, highly structured practice. The second task required description of how students would independently teach themselves a new composition. Students were asked to describe, in writing, and step by step, the planning processes they would use to achieve these objectives. This task sought to probe students' independent learning abilities. Information on other aspects of metacognition was sought through questionnaires.
The MT100 Sequencer/ Sound Module and MIDI- controlled synthesisers were used by the teacher for instructional purposes and by students in rehearsal sessions. During the study, students were required to complete questionnaires relating to their attitudes to and use of the MT100. Systematic observation of students' use of it during private practice in the laboratory provided further evidence of how they used its facilities.

To summarise, the design of this study enabled the instrumental practice behaviour of students to be probed through both the psychomotor and cognitive modalities. Physical practice behaviours were observed and data collected in real time in the laboratory to assess the purpose and extent to which students made use of the computer equipment during private practice. Recordings of these practice sessions were made on the sequencer and saved to disk to enable analysis of the physical techniques students used during rehearsal. The taped audio recordings provided further data on practice behaviours. Through journals, questionnaires and specific written tasks, the thinking processes of students were chronicled for subsequent analysis.

![Table]

<table>
<thead>
<tr>
<th>ENTRY STATUS</th>
<th>PRACTICE BEHAVIOURS</th>
<th>OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABILITY TO USE COMPUTERS</td>
<td>METACOGNITION</td>
<td>PERFORMANCE</td>
</tr>
<tr>
<td>ATTITUDE TO COMPUTERS</td>
<td>PSYCHOMOTOR BEHAVIOURS</td>
<td>PRACTICE</td>
</tr>
<tr>
<td>AURAL APITUDE</td>
<td>COMPUTER AIDED LEARNING</td>
<td>COMPUTER AIDED PRACTICE</td>
</tr>
<tr>
<td>MUSIC EXPERIENCE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.1 Framework of the study
The three focus areas were, therefore, metacognitive processing in planning and implementation of practice, physical practice procedures, and use of the technology. These were then related to the performance achievement of students at the conclusion of the study. Figure 4.1 encapsulates the framework of the investigation.

Attention is drawn to the fact that the writer of this dissertation was both researcher and instructor. Although practice strategies were not specifically taught, it is acknowledged that the researcher’s dual role and the model she presented would have influenced the behaviour of the students and the study outcomes. Indeed, they were designed to do so. That is, the learning environment and stimuli provided to students encouraged practice, albeit covertly.

4.2.4 Instrumentation
Measurements were taken of incoming skills and attitudes of students (Entry Status), how they rehearsed (Practice Behaviours), and their performance achievement and attitudes (Outcomes). The following sub-set of questions is related to Question 1, Entry Status.

4.3 RESEARCH QUESTIONS
4.3.1 Question 1

What entry behaviours did students bring to the study?

To answer this question measures were taken of students' incoming skills in four discrete areas.

- Ability to use computers
- Attitude to computers
- Aural aptitude
- Music experience
Ability to use computers

Students' ability to use computers (AUC) was measured on a researcher-constructed self-report item (five-point scale). Students were asked two questions, whether they could use a micro-computer and if they did so regularly. The two items correlated 0.9 and their sum was used to measure student computer experience.

Table 4.1 Ability to use Computer

<table>
<thead>
<tr>
<th>Item</th>
<th>Cronbach alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 I can use a computer</td>
<td></td>
</tr>
<tr>
<td>2 I use a computer regularly</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Attitude to computers

Attitude to computers scale (ATC) was operationally defined as the sum of twenty-two self-report items (each on a five point scale). This scale was adapted by the researcher from the “Attitude toward computers scale” (Francis, 1993), originally a twenty-four item scale. The modified scale had high internal consistency (Cronbach alpha = 0.9). For details of individual items in this scale. (See Appendix 1, pp.205-206).

Aural aptitude

The ability to listen and make accurate assessments of the information heard is an essential skill in musical performance practice when auditory feedback of accuracy in playing may affect instrumental development. An appropriate assessment tool for measuring students' listening skills and ability to make sense of musical information was sought.

The Music Evaluation Kit (MEK, 1979), a criterion referenced test, measured students' performance in seven areas: Pitch Discrimination; Discrimination in the Length of Sounds; Volume Discrimination; Tone Colour Discrimination; Patterns
Recognition; Identification of Instruments and Instrumental Groups; and Knowledge of Musical Signs and Symbols. Although designed as a diagnostic tool for music teachers in Secondary Schools, because it called upon the students to make musical judgements, it was considered appropriate. Kuder-Richardson Formula 20 estimates of internal consistency for seven sub-scales provided by the author (Bryce, 1979) are reported in Table 4.2.

Table 4.2 Kuder-Richardson Reliability MEK

<table>
<thead>
<tr>
<th>Part 1 Pitch Discrimination</th>
<th>Part 5 Patterns Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR20 = 0.46</td>
<td>KR20 = 0.67</td>
</tr>
<tr>
<td>Part 2 Discrimination in the length of Sounds</td>
<td>Part 6 Identification of Instruments &amp; Instrumental Groups</td>
</tr>
<tr>
<td>KR20 = 0.67</td>
<td>KR20 = 0.59</td>
</tr>
<tr>
<td>Part 3 Volume Discrimination</td>
<td>Part 7 Knowledge of Musical Signs &amp; Symbols</td>
</tr>
<tr>
<td>KR20 = 0.61</td>
<td>KR20 = 0.73</td>
</tr>
<tr>
<td>Part 4 Tone Colour Discrimination</td>
<td></td>
</tr>
<tr>
<td>KR20 = 0.48</td>
<td></td>
</tr>
</tbody>
</table>

The MEK tests were administered under test conditions and summed as an overall pre-test of auditory aptitude (AA).

Music Experience

Prior music experience was operationally defined as the sum of responses to two self-report items (each on a five-point scale) concerned with reading music and playing a musical instrument. The Music Experience (ME) scale had high internal consistency (Cronbach alpha = 0.9). This scale was later used to determine whether practice strategies or performance achievement were influenced by prior music experience.
Table 4.3 Music Experience

<table>
<thead>
<tr>
<th>Item</th>
<th>Cronbach alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 I can read music</td>
<td></td>
</tr>
<tr>
<td>2 I play a musical instrument</td>
<td>0.9</td>
</tr>
</tbody>
</table>

4.3.2 Question 2

Were students metacognitively engaged in the planning and implementation of practice?

This second research question concerns the thinking and planning strategies students brought to practice during the study and included cognitive planning, physical practice, and use of the MT100.

Measures were taken of students' metacognitive involvement in the planning and implementation of practice strategies, and their ability to be self-directed in their learning. Students themselves reported specific thinking and planning behaviours on researcher-designed questionnaires. Reflections on their planning and progress were recorded in journals thereby providing additional data. Evidence of physical practice and the way in which specific techniques were used during rehearsal was collected and saved to computer disk and audio recordings following mandatory self-recording sessions. Researcher observations and student self-analysis of their use of the MT100 provided evidence of how and to what extent the computer was used during practice in the laboratory. The following section details the measures taken to probe cognitive aspects of practice.

Planned Practice

Planned Practice scale (PP), operationally defined as the sum of seven self-report items (each on a five-point scale) identified students' use of routine strategies. Each
of the items listed in Table 4.4 was presented to students on a five-point scale which recorded their use “none of the time” (1) to “all of the time” (5). The researcher-designed scale had internal consistency of Cronbach alpha = .7. From this measure the level of planned practice strategies (PP) was generated.

Table 4.4 Planned Practice

<table>
<thead>
<tr>
<th>Item</th>
<th>Cronbach alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I look at the timesignature</td>
<td></td>
</tr>
<tr>
<td>2. I look at the keysignature and accidentals</td>
<td></td>
</tr>
<tr>
<td>3. I identify the number of beats per bar</td>
<td></td>
</tr>
<tr>
<td>4. I identify musical signs giving directions</td>
<td></td>
</tr>
<tr>
<td>5. I count the beat as I play</td>
<td></td>
</tr>
<tr>
<td>6. I hum or sing as I play</td>
<td></td>
</tr>
<tr>
<td>7. I look ahead as I play</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**Self-Regulated Learning Strategies**

Whether music performers, particularly this group of novice instrumentalists, could be described as self-regulated learners formed another line of inquiry in this study. According to Zimmerman (1990), researchers have identified the key processes successful learners use to master academic learning. Whilst all learners use some regulatory processes, those who are described as self-regulated learners, use a wide range of strategies which enable them to operate within a self-feedback learning loop (Zimmerman, 1989).

The actions and processes self-regulated learners apply to learning enable them to take greater control of their achievement outcomes because they recognise those strategies which are effective for them, and they apply them according to needs. In the opinion of Zimmerman (1989), self-regulated learners subsequently apply systematic use of metacognitive, motivational, and/or behavioural strategies to achieve academic goals.
Each student was required to keep a journal which catalogued his/her progress across the fourteen weeks. Students were asked to reflect on their progress and to describe as fully as they could how they thought about their instrumental development. Each week, focus questions were given on a specific topic to aid reflection or draw attention to a particular aspect of their keyboard learning. Students were encouraged to comment on the equipment, the instructional procedures used by the researcher, course content or any other item which they considered influential on their development.

Table 4.5  Self-Regulated Learning Strategies

<table>
<thead>
<tr>
<th>Item</th>
<th>Category Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Self-evaluating</td>
</tr>
<tr>
<td>2</td>
<td>Organising &amp; transforming</td>
</tr>
<tr>
<td>3</td>
<td>Goal-setting &amp; planning</td>
</tr>
<tr>
<td>4</td>
<td>Seeking information</td>
</tr>
<tr>
<td>5</td>
<td>Keeping records &amp; monitoring</td>
</tr>
<tr>
<td>6</td>
<td>Environmental structuring</td>
</tr>
<tr>
<td>7</td>
<td>Self-consequating</td>
</tr>
<tr>
<td>8</td>
<td>Rehearsing &amp; memorising</td>
</tr>
<tr>
<td>9</td>
<td>Seeking social assistance from peers</td>
</tr>
<tr>
<td>10</td>
<td>teachers</td>
</tr>
<tr>
<td>11</td>
<td>adults</td>
</tr>
<tr>
<td>12</td>
<td>Reviewing records from note</td>
</tr>
<tr>
<td>13</td>
<td>test</td>
</tr>
<tr>
<td>14</td>
<td>textbooks</td>
</tr>
<tr>
<td>15</td>
<td>Other</td>
</tr>
</tbody>
</table>
Zimmerman's (1989:337) list of Self-Regulated Learning Strategies provided the framework for collating data on this question. (See Appendix 2, pp.207-208). Entries students made in individual journals were analysed according to Zimmerman's categories as shown in Table 4.5. These are not in hierarchical order but rather measures of strategy diversity students might apply during practice. For each student, every comment was assigned to one of the fifteen categories. This provided a measure of the total number of different comments made within each category. These items were recorded and summed to provide a measure of the extent of Self-Regulated Learning (SRLi). In addition, the actual number of categories to which an individual student made reference were recorded as a measure of diversity in self-regulation and the variable identified as Self-Regulated Learning Categories (SRLii).

**Independent Learning**

Ability to demonstrate Independent Learning strategies (IL) was evaluated through a problem solving task. Faced with a previously unseen composition, students were required to detail step by step how they would independently teach themselves this new work, given the usual conditions available in the laboratory.

**Table 4.6 Level of Independent Learning**

<table>
<thead>
<tr>
<th>Level</th>
<th>Level of description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Planned specific strategies based on analytical evaluations and identification of previously successful strategies based on self-analysis performance</td>
</tr>
<tr>
<td>4</td>
<td>Self-analysis of performance</td>
</tr>
<tr>
<td>3</td>
<td>Identification of new or unusual features of the music and potentially difficult sections</td>
</tr>
<tr>
<td>2</td>
<td>Use of the computer demonstration of the new work</td>
</tr>
<tr>
<td>1</td>
<td>Routine score analysis</td>
</tr>
</tbody>
</table>
Criterion measures were set to evaluate students' description of their procedures. From these data a measure of students' ability to demonstrate Independent Learning techniques (IL) was formulated. Answers were categorised according to a standards-based hierarchy of self-directed behaviours as shown in Table 4.6.

**Deliberate Practice**

A further problem solving task was designed requiring students to identify a piece in their repertoire which they had found difficult to master. They were asked to describe, step by step, how they dealt with the problem and to give specific details of strategies they had used. Criterion measures were set to evaluate their answers. The purpose of this measure was to determine the level of Deliberate Practice (DP) strategies students used for remediation. Answers were categorised on a standards-based scale according to the criteria shown in Table 4.7.

**Table 4.7 Level of Deliberate Practice**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description of level</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Planned deliberate strategies to remediate a specific problem following analysis of performance difficulties</td>
</tr>
<tr>
<td>4</td>
<td>Analysis of performance difficulties without selecting appropriate strategies</td>
</tr>
<tr>
<td>3</td>
<td>Use of several different strategies not based on particular justification</td>
</tr>
<tr>
<td>2</td>
<td>Use of a limited number of strategies</td>
</tr>
<tr>
<td>1</td>
<td>Unplanned repeated practice</td>
</tr>
</tbody>
</table>

**Self-Directed Physical Practice**

The following section details the measures taken to probe the physical private practice behaviours of students.
Students’ rehearsal behaviours were sampled five times during the fourteen week period of the study when they individually self-recorded three laboratory practice sessions on the MT100 which were saved to computer disk (weeks four, eight, and twelve), and two recordings of home practice on audio-tape (weeks six, and ten). A researcher-designed pro-forma was used to score raw data according to a set of six behaviours commonly exhibited by students during practice. Evaluations were made of how these strategies were used during practice, as shown in Table 4.8.

Table 4.8  Self-Directed Physical Practice

<table>
<thead>
<tr>
<th></th>
<th>Whole piece method</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Multiple drill</td>
</tr>
<tr>
<td>ii</td>
<td>Coordinated hands</td>
</tr>
<tr>
<td>iii</td>
<td>Corrected pitch errors</td>
</tr>
<tr>
<td>iv</td>
<td>Corrected rhythm errors</td>
</tr>
<tr>
<td>v</td>
<td>Tempo reduction</td>
</tr>
</tbody>
</table>

How these strategies were used in response to rehearsal outcomes determined a measure of Self-Directed Physical Practice (SDPP) strategies applied during practice based on the standards-based criteria shown in Table 4.9.

Table 4.9  Level of Self-Directed Physical Practice

<table>
<thead>
<tr>
<th></th>
<th>Evidence of self-regulation by modification of practice strategies based on performance outcomes feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Evidence of some modification based on performance outcomes feedback</td>
</tr>
<tr>
<td>3</td>
<td>Inconsistent response to performance outcomes</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical response to performance feedback with little modification</td>
</tr>
<tr>
<td>1</td>
<td>Mechanical response to performance feedback with no modification</td>
</tr>
</tbody>
</table>
Instructional and Motivational use of the MT100

During private practice sessions, weeks eight to fourteen, observational data were collected by the researcher via intermittent time sampling procedures for the purpose of measuring students' specific use of the sequencer. These measures recorded students' Observed Instructional Use of the MT100 (OIJUMT) and Observed Motivational Use of the MT100 (OMUMT). At the conclusion of the same sessions, students self-reported, on a five point scale, how they perceived they used the computer for the same reasons. Student Self-Reported Instructional use of the MT100 (SRIUMT) and Self-Reported Motivational Use (SRMUMT) were also recorded following the same procedures.

Instructional use of the MT100 was deemed to occur when students used it for the purposes listed in Table 4.10.

Table 4.10  Instructional Applications of the MT100

<table>
<thead>
<tr>
<th>Description of purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>i  Listen to the demonstration model</td>
</tr>
<tr>
<td>ii Rehearse with the demonstration model</td>
</tr>
<tr>
<td>iii Self-record rehearsal</td>
</tr>
<tr>
<td>iv Listen to self-recorded performance</td>
</tr>
<tr>
<td>v  Manipulate various functions of the pre-recorded disk</td>
</tr>
</tbody>
</table>

Motivational use of the MT100 was deemed to occur when students used it for the purposes listed in Table 4.11.
Table 4.11  Motivational Applications of the MT100

<table>
<thead>
<tr>
<th>Description of purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>i  Rehearse simultaneously with the orchestral accompaniments</td>
</tr>
<tr>
<td>ii Rehearse with altered enhanced backgrounds-</td>
</tr>
<tr>
<td>* mute various tracks</td>
</tr>
<tr>
<td>* change dimension of tempo</td>
</tr>
<tr>
<td>* change timbre</td>
</tr>
<tr>
<td>iii Listen to accompaniments of pieces not being studied</td>
</tr>
<tr>
<td>iv Manipulate dimensions of pieces not being studied</td>
</tr>
</tbody>
</table>

Specific Instructional Applications of the MT100

At the conclusion of the intervention, students were asked to report on how they had specifically used the MT100 for instructional purposes across the period of the intervention. Students self-reported on a five-point scale four discrete uses of the MT100 during practice (see Table 4.12). The extent to which the MT100 was used for each purpose was evaluated from this measure.

Table 4.12  Specific Instructional Applications of the MT100

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>i  Self-record</td>
</tr>
<tr>
<td>ii Listen to recorded performance</td>
</tr>
<tr>
<td>iii Listen to recorded performance for analytical purposes</td>
</tr>
<tr>
<td>iv To listen to the demonstration model before rehearsal</td>
</tr>
</tbody>
</table>
The data previously described have addressed the first two components of the study, Entry Status and Practice Behaviours (see Figure 4.1). The following section of this chapter describes how the data were collected on the final component, Outcomes. These include instrumental performance achievement, attitudes to practice, and computer-aided learning.

4.3.3 Question 3

What level of performance outcomes did students achieve at the conclusion of the study?

To provide answers to this question four sub-questions were formulated.

What level of performance achievement did the students reach?
What progress was made on repertoire?
Did students demonstrate ability to sight-read?
To what extent were students able to scan ahead during sight reading?

What level of performance achievement did the students reach in both quality and quantity?

Performance Achievement

Students performed three set works and two works of their own choice during the practical performance examination at the conclusion of the course. The performance criteria were measured by the five criteria as shown in Table 4.13. The sum of these measures for all five pieces produced the measure of Performance Achievement (PA). (See Appendix 3, pp.209-211).
Table 4.13  Assessment of Performance Achievement

<table>
<thead>
<tr>
<th>i</th>
<th>Accurate pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>ii</td>
<td>Accurate rhythm</td>
</tr>
<tr>
<td>iii</td>
<td>Musically satisfying tempo</td>
</tr>
<tr>
<td>iv</td>
<td>Observed marks of expression</td>
</tr>
<tr>
<td>v</td>
<td>Phrasing, technique, and style</td>
</tr>
</tbody>
</table>

*Repertoire Progress*

It was anticipated that some students would be more concerned with gaining marks for performance accuracy rather than extending their repertoire to more difficult pieces. Since each new piece in the tutors was progressively more difficult, a weighting was assigned to each successive piece so that the extent to which students had progressed in terms of difficulty in each of the texts could be valued. The measure Repertoire Progress (RP) identified the extent of students’ repertoire.

*Sight Reading Ability*

The literature suggests that performance outcomes may be affected by ability to sight read which itself may be influenced by ability to scan ahead during performance so measures of sight reading and scanning were also taken. To measure sight reading, an eight bar piece of Preliminary AMEB (Australian Music Examinations Board) standard was given to students to sight read. They were allowed thirty seconds to view the music without practice and then asked to play the piece. The same criteria used to measure performance works were used (see Table 4.13). The measure of sight reading ability (SRA) was generated from this test.

*Scanning Ability*

Some research suggests a connection between sight reading ability and scanning ahead whilst reading the score. In earlier studies, Sloboda (1974, 1977) found that efficient sight readers could produce up to seven correct notes after the music had been covered while poorer readers could only produce three or four notes. To
been covered while poorer readers could only produce three or four notes. To measure students' ability to read ahead, to scan the music, a different piece of music of similar standard to that of the sight reading score was given. Students were allowed thirty seconds to view the music. They were then asked to begin and to continue playing after the music had been covered. The number of notes students played accurately after the music had been covered was recorded (SCAN).

The final part of Research Question 3 concerns attitudes to practice, and the MT100 as an aid to practice.

4.3.4 Students' attitudes to practice

Practice

Students commented in the journals consistently on the importance of practice. However, it was considered that actual time spent on rehearsal would give a more reliable indication of students' commitment to practice. The importance students placed on practice was therefore determined by the measured amount of time, accumulated practice time (APT). Students entered practice times in a Daily Practice Log documenting both accumulation and distribution of practice. Data were then generated under the categories of time per day, per week, and accumulated practice across the fourteen weeks of the study. (See Appendix 4, p.212).

Computer Aided Practice

In seeking to determine student attitude to the use of the MT100, a questionnaire was given at the conclusion of the study. The Attitude to MT100 scale (ATMT) was operationally defined as the sum of five self-report items (each on a five-point scale). The questions are listed below in Table 4.14.
Table 4.14. Attitude to MT100 as an aid

<table>
<thead>
<tr>
<th>Items</th>
<th>Cronbach alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 I could learn to play keyboard just as well without the MT100</td>
<td></td>
</tr>
<tr>
<td>2 I found the MT100 helped me in learning to play music this semester</td>
<td></td>
</tr>
<tr>
<td>3 I prefer to learn to play keyboard without the computer</td>
<td></td>
</tr>
<tr>
<td>4 I enjoyed using the MT100 in my private practice sessions</td>
<td></td>
</tr>
<tr>
<td>5 If I had an MT100 at home I would use it to teach myself keyboard</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The scale had high internal consistency (Cronbach alpha = 0.8) and was used as a measure of attitude to the computer as an aid to keyboard practice.

This completes the description of the instrumentation for this study. In addition to the internal consistencies reported for various scales, marker reliability was also checked and found satisfactory for samples of behaviour on relevant measures. The results of all measures which will be reported in Chapter Five will provide descriptive accounts to answer questions 1, 2 and 3 of this study. Investigation of Research Questions 4, 5, and 6 will follow using the findings of questions 1, 2 and 3 and these will be discussed in Chapter Six.
CHAPTER FIVE
PRESENTATION OF THE DATA

5.1 INTRODUCTION

In Chapter Four, the research methodology, the key research questions, and the means by which data were collected and compiled, were described. The approach employed both quantitative and qualitative data to enrich the description of this particular group of novice instrumental students and to provide an understanding of their practice behaviours during the study. In this chapter, results of the first three research questions are presented.

The reader is reminded of the framework of the study, previously presented in Chapter Four (Figure 4.1) and by the following elaboration of that representation in Figure 5.1.

![Diagram](image-url)

Figure 5.1 Elaborated framework of the study
The central focus of this investigation was to discover how this particular group of beginners addressed keyboard practice. Results in this chapter are presented in three sections which parallel the three headings in Figure 5.1. The first section of this chapter reports the results of the measures taken concerning students’ Entry Status. Question 1 thus addresses the four factors thought to have the potential to influence the Practice Behaviours of students previously identified in Chapter Four - that is, Ability to use Computers, Attitudes to Computers, Aural Aptitude, and Music Experience.

5.2 QUESTION 1
WHAT ENTRY BEHAVIOURS DID STUDENTS BRING TO THE STUDY?

Students in this sample brought with them previously acquired knowledge and skills which had the potential to influence instrumental learning. Levels of proficiency in four specific skills, ability to use computers, attitude to computers, aural aptitude, and music experience were measured at entry level. In connection with the first two items, ability to use computer and attitude to computers, it was important to determine whether proficiency levels or attitudes would influence student use of the MT100 during the study.

The third measure was aural aptitude. As young adults, the students in this study could not be considered aurally naive having been exposed to music for at least two decades. However, listening, being as much a function of the brain as the auditory mechanism, may function at different levels of proficiency within any sample. Whether aural ability influenced how students rehearsed and self-monitored and, as a consequence, impacted on performance outcomes was explored. During rehearsal, in the absence of an instructor, the primary means of gaining feedback on accuracy of performance is via the aural mode.
Consequently, if students have deficiencies in listening ability, their practice may be less effective and their progress inhibited.

Finally, under this group of entry skills, the music experience of students was assessed. It was essential to know the level of instrumental skills, particularly keyboard skills, for all students at entry before evaluating their outcomes. The results of the entry measures are discussed in the following section.

5.2.1 Ability to use Computers

As previously described in Chapter Four, two questionnaire items sought information on use of, and familiarity with, computers (AUC). In the group of twenty-one students studied, approximately half showed confidence in using computers and reported regular use. Thus, in response to items on the initial questionnaire, fifty-seven percent of the students agreed or strongly agreed that they "can use a microcomputer" and forty-eight percent agreed or strongly agreed that they "use computers regularly." In later analysis, these two five-point items (familiarity and use) were summed to give a score on ability to use computers (mean = 6.8, s.d. = 2.4; Cronbach alpha = 0.9).

5.2.2 Attitude to Computers

The Francis (1993) Attitude Towards Computers Scale was developed for use with undergraduate college students and, on the basis of published data, was considered a reliable and valid uni-dimensional scale (see 4.3.1). As previously noted, for the students in this study, this twenty-four item scale was modified, based on initial analysis, by the removal of two items, after which the Attitude to Computers scale (ATC) produced a Cronbach alpha of 0.9. Figure 5.2 shows the distribution of scores on the twenty-two item scale. The distribution indicates generally positive attitudes to computers (mean = 84.3, s.d. = 10.2), and since
students varied on this measure, it was used as a potential predictor of subsequent practice strategies and performance outcomes.

![Graph showing distribution of scores for attitude to computers scale.](image)

Figure 5.2  Attitude to computers scale

### 5.2.3 Aural Aptitude

Aural ability is a skill essential to music engagement. To be able to hear what is sounded, to discriminate what is heard, and to identify, synthesise and analyse the outcomes, in this instance feedback on practice outcomes, is crucial to instrumental performance development. As previously discussed in 4.3.1, the Musical Evaluation Kit was used to measure a range of auditory skills of students.

The results of this diagnostic tool measuring Aural Aptitude (AA) indicate a spread of student ability across a range of twenty-five points, with a mean of 84.3 and s.d. of 7.6, the tri-modal distribution of scores being as shown in Figure 5.3. Close to one third of the students scored well below the rest of the students. Since the computer used in this study as a learning aid presented musical
information in audio form, the measure of student auditory ability was later used to determine whether aural aptitude influenced students' use of the MT100.

![Auditory Aptitude Test](image)

Figure 5.3  Aural aptitude

### 5.2.4 Music Experience

Although students in this study had reportedly not previously learned to play keyboard, each of them brought to the study some background in music experiences. The measures taken of prior musical experience (ME) provided the following information.

Students' formal musical experience was generally very limited. Of the twenty-one students in the study, only two could read notation and play a musical instrument. In response to an item on the initial questionnaire, only five of the twenty-one students agreed that they could read music (twenty-four percent) and no one strongly agreed with the statement. The remaining seventy-six percent were unable to read music notation. Only three students (fourteen percent) agreed or strongly agreed that they could "play a musical instrument" and had prior
instrumental lessons but none of these had played keyboard nominating drums, recorder and guitar as their instruments.

Responses on two five-point items, read music and play, (see Table 4.3) were summed to give a score for prior music experience (mean = 4.6; s.d. = 2.3; see Figure 5.4). The positive skew of the results gives an indication of the limited musical experience of this sample. This measure is later used to determine whether prior music experience influenced the manner in which students rehearsed or their performance outcomes.

![Music Experience](image)

Figure 5.4 Music experience scale

5.2.5 Summary of Entry Skills measures

Each of the foregoing four measures - Ability to use Computers, Attitude to Computers, Aural Aptitude and Music Experience - which describe students' incoming status will be used later to gauge their impact on both practice behaviours and performance outcomes. These data report on the results of individual measures - AUC, ATC, AA, and ME - without consideration of the interrelationships among these variables. Correlation results found only one
significant connection among the four variables, namely, Aural Aptitude and Music Experience (.52, p < .05).

The following section reports the data concerned with the Practice Behaviours exhibited by students in this study (see Figure 5.1).

5.3 QUESTION 2
WERE STUDENTS METACOGNITIVELY ENGAGED IN THE PLANNING AND IMPLEMENTATION OF PRACTICE?

At its most simplistic level, practice is merely physical drill which may not call on cognitive engagement. However, when experts rehearse they appear to use a set of quite complex behaviours for the purpose of solving a range of self-identified difficulties. They engage in sophisticated problem solving activities and cognitive processing which are transformed to metacognitive action. It appears that the physical behaviour is then only one of many components in the chain of events which leads to effective practice and increased performance outcomes in experts.

Whether the beginners in this study would use any of the more refined and complex behaviours used by experts for practice was to be explored. Therefore, a series of questionnaires and reporting activities was designed to probe students' thinking behaviours prior to, during, and after practice. Planned Practice, Self-Regulated Learning, Independent Learning, Deliberate Practice, and Self-Directed Physical Practice were addressed individually since each has the potential to contribute to an understanding of students' cognitive approaches to practice.
5.3.1 Planned Practice

This researcher-designed scale, Planned Practice (PP), was developed to measure student use of a set of routine practice strategies as previously detailed in Table 4.4. As a questionnaire, it was given to students in week nine by which time it was considered they would have developed some particular strategies. In general terms, each musical score consists of a standard set of music notation symbols. However, each piece of music is distinct by the particular arrangement of these symbols, and if the novice instrumentalist does not scrutinise the score beforehand, the practice is made more difficult. These items showed the extent to which students made use of this set of strategies each of which has the potential to activate cognitive engagement.

Identifying, prior to playing, time-signature and key-signature, beats per bar, particular musical signs, as well as counting, singing, and looking ahead in the score while rehearsing, are strategies many students are known to adopt during practice, though at what stage in their development this occurs is unknown. By the time they are attempting formal examinations which require them to sight read, students are generally directed by teachers in such basic pre-performance preparation. During this study, when new pieces were introduced to students by the instructor, analysis of the music, as described above, occurred. This provided a model which students might have subsequently adopted during private practice. They were, however, not specifically directed to do so.

Students were asked to respond to seven survey questions (see Table 4.4) designed to explore the manner in which they planned practice. Figure 5.5 shows the distribution of scores on the sum of these seven five-point items which produced a scale (Cronbach alpha of 0.7) with mean = 24.1 and s.d. = 4.8. The distribution was positively skewed. It indicated that many of the students made little use of this set of strategies which would be considered fundamental
behaviours for effective practice in more experienced instrumentalists. Such strategies as score analysis prior to beginning practice, reading ahead during practice, and seeking information about the pieces to be played assist students in organising their practice. Thinking about practice at this level is an indicator of students' metacognitive behaviour.

![Planned Practice Scale](image)

Figure 5.5 Planned practice scale

5.3.2 Self-Regulated Learning Strategies

Zimmerman's (1989) list of Self-Regulated Learning Strategies included fifteen categories of behaviours (see Table 4.5) shown to identify learners who self-regulate. Category fifteen was different from one to fourteen because it identified students who were not self-regulating, rather relying on advice from other individuals such as wanting the teacher to direct practice and to set goals. During this study, students kept journals in which they made entries each week based on self-reflection and also to answer researcher generated questions. The content of the journals was analysed, at the conclusion of the study, and students' statements categorised according to Zimmerman's classifications.
Firstly, the number of categories to which students' statements were attributed was considered. Not all students commented on each of the categories. One student only, addressed thirteen of the fifteen categories, another eleven, and a third student ten. For the remainder of students, reference was made to between five and nine categories, showing a range of ability to think broadly about strategic planning. One category which attracted only one response from one student was Self-consequating (item 7). Zimmerman (p.337) describes self-consequating as "statements indicating student arrangement or imagination of rewards or punishment for success or failure: e.g., 'If I do well on a test, I treat myself to a movie.'" Several students commented positively on successful practice sessions but the sole comment on self-rewarding was "I reward myself with a new song."

Another item which received minimal response, Seeking social assistance (11), concerned seeking feedback from adults. Although more than half the students sought feedback from their peers and the teacher (in equal proportion) only three students said they sought feedback from parents or other adults. Reviewing Records (12, 13) also received minimal attention from students, only one commenting on "using notes" (12), while no-one commented on "referring to tests" (13). Zimmerman describes Reviewing Records as "Statements indicating student-initiated efforts to re-read notes and tests" (p.337).

Students were provided with notes during lectures, exercises for score reading, and tutors which explained aspects of performance. Many students wrote notes on the music scores as well. It was therefore unexpected that only one comment was made by each of three students, the remaining eighteen not making reference at all to this category. Tests had not been given to students so it is understandable that no reference was made to item 13.
Students did remark on Reviewing records from textbooks (14). Throughout the researcher's analysis of student comments, adjustments were made to fit the music specific nature of their comments to Zimmerman's classifications. Students did not have a textbook to which they might refer, their references being the music tutor and the audio demonstration model of the music itself. Comments related to either of these were placed in category 14. Eleven comments all made reference to the computer indicating student reliance on that as a means of reviewing the music.

Table 5.1   Analysis of Self-Regulated Learning Strategies

<table>
<thead>
<tr>
<th>Item</th>
<th>Category Description</th>
<th>Student Selection</th>
<th>Sum of comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Self-evaluating</td>
<td>21</td>
<td>395</td>
</tr>
<tr>
<td>2</td>
<td>Organising &amp; transforming</td>
<td>21</td>
<td>179</td>
</tr>
<tr>
<td>3</td>
<td>Goal-setting &amp; planning</td>
<td>21</td>
<td>94</td>
</tr>
<tr>
<td>4</td>
<td>Seeking information</td>
<td>12</td>
<td>37</td>
</tr>
<tr>
<td>5</td>
<td>Keeping records &amp; monitoring</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>6</td>
<td>Environmental structuring</td>
<td>19</td>
<td>171</td>
</tr>
<tr>
<td>7</td>
<td>Self-consequating</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Rehearsing &amp; memorising</td>
<td>21</td>
<td>318</td>
</tr>
<tr>
<td>9</td>
<td>Seeking social assistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- from peers</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>- from teachers</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>- from adults</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>12</td>
<td>Reviewing records from</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- notes</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>- tests</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>- textbooks</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>15</td>
<td>Other</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 5.1 summarises the raw data. It details the number of students who addressed individual classifications, that is, twenty-one students commented on Self-evaluating (see Student selection), and the total number of responses made by all students in each category under Sum of Comments heading.

While the number of categories shown in Table 5.1 (Student selection) which students addressed gave an indication of the breadth of use of these general frames of reference, the total number of comments made within each category provided a measure of the depth and diversity of students' ability to articulate the extent to which they analysed their behaviours. At an individual level, the lowest number of comments made by one student across the fifteen categories was thirty-two while the highest number, 112, demonstrated that student's capacity to reflect on practice extensively.

These comments from journals provide insight into students' ability to think about practice. The following section reports on categories 1 to 15 in chronological order. It begins with the category for which the highest number of comments was made, Category 1, Self-evaluating. This section reports on the variety of comments made by students and the diverse ways in which they reflected on and wrote about their practice. There were twenty-one students in the study. Students' direct quotations will be acknowledged by reference number, that is, Subject one will be referred to as #1.

The data provided by the journals is extensive. If it were the major component of this study, the results would be reported to include analysis of all the comments from every student, possibly as individual case studies. However, the essential reason for collecting this information was to gain a more global picture of the students and their general ability to be self-regulatory. Being able to describe how the students reflected provides a rich description of their thinking and planning
strategies. Many of the comments made were common to several students. The first paragraph reports statements and each student who referred to it. Rather than overwhelm this chapter with too much detail by attributing a particular comment to every student who made it, for reference purposes, the comment will be acknowledged from only a few students even though several students may also have referred to it.

Zimmerman's (1989:337) definition for Item 1, Self-evaluating, includes "Statements indicating student-initiated evaluations of the quality or progress of their work." All students showed an ability to comment on the self-evaluating item (sum of comments = 395) this being the most reported category. Many statements were common to students so rather than reporting exact quotations from individual students, paraphrased comments will be used in some instances. At other times, direct comments from individual students will be directly quoted.

Concerning accuracy, students said they could hear and feel mistakes (#1, 3, 4, 5, 6, 8, 10, 11, 12, 15, 16, 18, 20, 21). For some students (#3, 4, 12, 17), singing as they played helped them to self-monitor. Several students reported having difficulties with rhythm (#2, 3, 4, 7, 10, 12, 15, 16, 21). In contrast, student #18 said the rhythms were easy but finding the correct pitch note on the keyboard was more difficult. One student connected ability to sight read with performance accuracy. "I don’t believe my talent lies in sight reading - I have to analyse the music first before playing" (#18). Another followed the score to see where she had made the mistakes (#1). A few students discussed the benefits of slow practice for identifying mistakes (#1, 4, 11, 20).

Although one student reported positively "My coordination is improving" (#2), other students made reference to the difficulties they were experiencing with
synchronising both hands which led to performance errors (#2, 4, 6, 7, 11, 13, 14, 17, 18, 20). Perhaps the most engaging comment came from the student who said “Most of the time the mind knows what to do but the message goes AWOL on the way to the hands” (#18).

Students used the MT100 to evaluate the quality of their performances either from analysis of their self-recordings (#1, 3, 6, 7, 12, 13, 15, 16, 21) or by using the demonstration model to check the accuracy of their playing (#7, 8, 9, 10, 18, 18, 20, 21). Others found playing with the accompaniments was a useful way of self-monitoring (all students except #2, 11, 13, and 18).

In evaluating their progress in terms of practice time, eight students acknowledged that they needed to practise more (#1, 2, 3, 5, 6, 7, 8, 9). Only one student commented that she “could not practise any more” (#16). Another acknowledged the importance of quality practice by stating “When I’m tired my practice is not so good” (#11).

The importance of motivation in maintaining progress was addressed by all students. Each one expressed the opinion that without practice they would not progress. Students were variously motivated by the following: enhanced keyboards (#1, 5, 18); familiar melodies (#1, 2, 6, 10, 11, 17); group performance (#3, 14, 18, 19); computer accompaniments (#3, 6, 7, 8, 10, 15, 19, 20); examination preparation (#8, 9); teacher feedback (#4, 5, 6, 7, 9, 10, 14, 15, 18); peer influence (#6, 8, 10, 11, 14, 15, 18, ); privacy of the laboratory (#12); and achievement (#5, 11, 13, 15, 20). Some students were de-motivated by: unfamiliar pieces (#4); lack of progress (#9, 18); progress of other students (#9); unfamiliar songs (#12); and difficult pieces (#18).
These comments demonstrate that students were able to be analytical and reflect on both positive and negative aspects of their practice, even without being instructed to do so. However, they generally lacked the skill to take the next step and select an appropriate strategy for remediation. It was clear that they thought about their progress beyond the needs of the prompt questions they were given to answer in their journals. One student did refer to the need to “try new strategies” (#3).

The next most commented on classification was Rehearsing and memorising on which every student made some comment (sum = 318). “Statements indicating student-initiated efforts to memorise material by overt or covert practice” (Zimmerman, 1989:337) were applied to this category. All students except #15 and #17 stated they tried to memorise their pieces. Students detailed the various strategies they used during practice to master their pieces and, frequently, the reasons for doing so. General statements concerning the need for repeated practice to master pieces were made by each of the twenty-one students. There was a recognition by all students for the need to practise if they were to progress.

Some students were specific, “Ianalyse my mistakes during practice then repeat until its accurate” (#15). Generally, students identified a variety of strategies they employed to enhance practice. Some were directly connected to the use of the sequencer such as; “change tempo” (#1, 14), “listen to model first” (#2, 4), “play with the model” (#1, 2, 4), “self-record” (#1, 2, 4), “rehearse with accompaniment” (#2, 5), “rehearse with the model” (without accompaniment) (#1, 4), “change timbre” (#1, 2, 4, 5), and “use the metronome” (on the sequencer) (#1, 18).
Other statements were more general; “rehearse with the score” (#8), “rehearse without the score” (#2), “rehearse each piece ‘x’ times” (#16), “mentally practice” (#16), “scan the music before beginning to play” (#16), “memorise the pieces” (#1, 2, 4), “play be ear” (#2), “sing in my head” (#4), “nod my head to the beat” (#9), “rehearse segments” (#2, 5), “practise slowly” (#1), “repeat difficult phrases” (#16), “practise exercises to warm up” (#14), and “rehearse away from the keyboard” (#6). Some comments were more thoughtful such as “singing helps my playing” (#16) or “I listen to mistakes then repeat after analysis” (#15), justifying the purpose of their strategy use. Others defied logic - “I did not use recording my playing very often but when I did it was useful” (#5).

Several comments in this category gave indicators of how students enjoyed practice. “Play the easy pieces first” (#8), and “play the pieces I enjoy” (#13, 19), “playing with the accompaniments is fun” (#6), and “playing with the accompaniments sounds professional” (#20). Many students stated that “changing tempo makes it easier” (#5), and “changing timbre is fun” (#20). Others commented that knowing the tune or being able to listen to it before playing made the learning easier and this too had a motivating effect, as did peer and parent approval.

There was a clear connection between rehearsing and memorising, and the influence of motivation. “Playing with the computer really motivated me” (#7).

Several made similar comments in this category to group learning and its effects. “Group learning is good because it provides competition and encouragement” (#3). Many referred to the value of using the accompaniment to assist them to play in time.
Attributing success to ability came from three students but even they, like all the others, acknowledged the importance of practice for improvement. Students' comments included; “missing practice is detrimental to my progress” (#1), “lack of practice equals lack of progress”, “you can never rehearse enough”, to one student who said she could not possibly rehearse any more than she was already doing (#16). Students implied that amount of practice was the material point. “If you don’t practise every day you lose it” (#4). “Keep rehearsing” and “really concentrate” were statements which did not lead to practice planning, the importance being placed on time rather than planning. Two students commented that they really enjoyed rehearsing (#7, 20) while a third said “Once I begin to practice I want to keep going because it is enjoyable” (#12). One student (#3) clearly differentiated between “playing” and “rehearsing” which was an astute observation.

Every student commented on the Organising and Transforming (item 2) category but despite their being able to describe the actions they took, few justified particular strategies. This category, according to Zimmerman’s definition, included “student-initiated overt or covert arrangements of instructional materials to improve learning; eg., I make an outline before I write the paper” (p.337). This parallels the pre-planning practice procedures described in the Planned Practice scale (see Table 4.4).

The most common strategies described by students in this category were listening to the computer model, undertaking some form of score analysis, and rehearsing hands separately. More than two thirds of the students commented on listening to the model indicating their conviction that familiarity with the music would assist their performance. “I listen to the model first - the tune then sort of is programmed in my memory after playing it a few times” (#18). A similar number discussed score analysis and although this was frequently a simple strategy such
as naming the notes or looking at the relationship between the notes, it also demonstrated pre-planning behaviour. One student observed that “by working out the piece and planning before you play gives you more confidence” (#20) which relates to motivation and attribution.

Environmental structuring (item 6) generated 171 comments as can be seen by Table 5.1. Students reported changing their physical setting at home. “I find a quiet room” (#10), “block out noises by using headphones” (#7), or “rehearse when no-one can hear me” (#7). Within the Micro Technology Music Laboratory, students used the environment to suit themselves. Some listened to other students to stimulate themselves to work harder, others discussed their problems with peers saying it was motivating to know peers had similar difficulties. Another group appreciated the anonymity provided by headphones and the privacy between student and teacher which afforded them a sense of security.

References to the computer were also included in this category when it was used in such a way as to alter the mode of learning through manipulation of the environment. Students were not obliged to use the computer during private practice so when they described how they accessed its multiple functions to make learning easier, this was considered an environmental change. Altering settings on the synthesiser such as changes to timbre to make learning “more interesting and stimulating” or “to make rehearsing more fun” or to use the accompaniments to “bring variety to rehearsal” were mentioned by several students. “The computer is fantastic because it makes the sometimes tedious task of learning more fun” (#15) was counteracted by another student who was not at all motivated to use the computer and could not find any reason for using it (#2). This particular student made the lowest number of comments and displayed a low level of analytical skills.
Goal-setting and planning (item 3 = 94) produced diverse statements. Some goals were long term such as “eventually playing with my mother” (#9), “learn to play Ave Maria for my grandmother” (#9), and “buy a better keyboard as soon as possible” (#1) for home practice. Many students commented on their intent to increase the number of practice times, in an immediate sense, so they could reach particular pieces within specific time frames such as “practise lots more in the holidays so I can learn all the pieces properly” (#13). Other goals were related to specific skills such as “teach myself to play by ear” (#2) and “try to memorise to increase concentration” (#20) implying that these skills would result in greater proficiency.

Many students aimed to be more methodical in their practice and stated their intention of planning practice sessions more systematically, developing a routine, and using a sequence for practice such as “play the easy pieces first to warm up and then do the hard practice” (#12). Several articulated the need to spend more time learning particular aspects of theoretical knowledge including “learn the bass notes before the end of the week” (#7).

The Seeking information category (item 4) produced basically three items. Firstly, a few comments referred to the need to consult note naming charts and keyboard charts to find the correct notes. The second reported the advantages of learning well known songs because they were easier to learn when the melodies were familiar. And finally, by far the most comments made were related to the computer. Students stated that listening to the demonstration model before attempting a new piece enabled them to discover how the song should sound and, having played the piece, comparing self-recordings with the original allowed them to determine accuracy of performance.
Seeking social assistance (items 9 and 10) from either peers or teachers produced fifty-eight comments. Being able to ask questions, to have discussions, to get peer evaluation and provide feedback to others were included in the comments. Statements were made concerning the pleasure derived from encouragement from peers and teachers, and affirmation that they were making good progress. One student's statement was that “rehearsing as a group was an excellent way of providing social assistance through peer comparison and the pleasure derived from other students’ comments” (#18). It should be also mentioned that there were a few students who were intimidated by such comparisons and did not seek social assistance, preferring anonymity.

Only nine students referred to category number 5, Keeping records and monitoring, resulting in twenty-three comments collectively. These mostly alluded to writing the names of notes and the meaning of signs, reviewing notes from lectures, mentally noting performance errors, and making weekly outlines. One student self-recorded at the beginning of rehearsal sessions, saved these, and reviewed at the end on the sessions and this was categorised as another form of record keeping.

Students had not been coached in the use of the diverse ways in which they might self-regulate yet it seems many did so automatically. Whether they have been taught these strategies in another setting or acquired them through their own ability to cognitively evaluate learning successes in the past is unknown. To what extent all students would have commented on more diverse categories, had they been taught, is interesting to contemplate.

Results of these data provided measures of the diversity of thinking procedures used by students according to the sum of the comments made (see Figure 5.6), and the number of specific categories each student addressed (see Figure 5.7).
Figure 5.6 demonstrates the range. While all students were able to identify and articulate a number of strategies they used for rehearsal, it was evident that some were better able to articulate these than other students.

Figure 5.6  Identification of self-regulated learner by items

Figure 5.7  Identification of self-regulated learner by categories
Fewer than twenty percent of students addressed more than sixty-five percent of the available categories (see Figure 5.7). Two students addressed only one third of the available categories indicating a low level of diversity in self-regulated strategy planning. These measures showed the diversity of ability in this group of students to demonstrate self-regulated learning strategies.

5.3.3 Independent Learning

In week 14, as an in-class activity within a restricted time frame, students were presented with a previously unseen musical score of equivalent standard to their current repertoire. They were requested to describe, step by step, and in point form, how they would prepare and rehearse this piece so that they could play it at the end of a one hour practice session. They were informed that the instructor would not introduce the work or present any analysis, as was the usual procedure with new works. However, the general laboratory conditions would apply, that is, the computer model and the teacher would be accessible.

Students who thought about practice could be expected to recall the procedures modelled previously by the teacher and apply those strategies they personally had found successful. Students who were able to teach themselves this new piece, without teacher assistance, through analysis of the music and their own strategic planning could be described as independent learners. Students' written descriptions of the processes they used were analysed and then coded on a standards based Independent Learning (IL) scale formulated by the criteria detailed in Table 4.6.

The criteria used in this measure are hierarchical so that students in level five incorporated those behaviours described in the lower levels. Only five percent of students described self-analysis of performance as a means of determining the strategies they would adopt as they rehearsed. Students on Level 5 used higher
order thinking to aid their learning of a new work while those on Level 1 were considered to be working at the most simplistic, non-analytical level.

The student placed at the upper level of the scale (Level 5) demonstrated ability to plan strategies based on analysis of progress of performance. Almost half the students discussed analysis of performance based on self-feedback but did not select strategies connected with this analysis (Level 4). About a third (Level 3) gave indications of analysing the music itself to identify new or unusual features prior to performance. At Level 2, some ten percent used the computer model as the main aid for learning the work. This latter group did not demonstrate metacognitive strategies as they were operating on a rote learning level.

The hierarchical nature of the behaviours identified in Table 5.2 therefore provide a means of identifying different levels of students' ability to think metacognitively when independently teaching themselves a new piece.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description of Level</th>
<th>% of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Planned specific strategies based on analytical evaluations and identification of previously successful strategies based on self-analysis of performance</td>
<td>5%</td>
</tr>
<tr>
<td>4</td>
<td>Self-analysis of performance</td>
<td>48%</td>
</tr>
<tr>
<td>3</td>
<td>Identification of new or unusual features of the music and potentially difficult sections</td>
<td>38%</td>
</tr>
<tr>
<td>2</td>
<td>Use of the computer demonstration of the new work</td>
<td>9%</td>
</tr>
<tr>
<td>1</td>
<td>Routine score analysis</td>
<td>0%</td>
</tr>
</tbody>
</table>
5.3.4 Deliberate Practice

Deliberate practice (DP) occurs when individuals select specific strategies, based on prior knowledge and experience of the success of such strategies, for the purpose of improving the current level of performance. In week eight, students were given a take-home questionnaire which asked them to identify one particular piece of music which they found more difficult to master than other works.

Students were requested to name the piece, state the particular problems they had with the work, and describe why they thought the piece was so difficult. They were asked to describe the different strategies they used and to summarise, in point form, how they attempted to overcome their difficulties. Their answers were assigned to levels according to Table 4.7.

Students who were able to select particular strategies to remediate a work which were based on clear analysis of the problem and the application of considered procedures they modified according to progress, were considered to be applying deliberate practice methods.

At the highest level (5), the student identified the problem, selected an appropriate strategy, and analysed the outcomes before continuing rehearsal. At the lowest level (1), explanations included “play the piece slowly”, “ask the instructor for help”, “play hands separately”, “repeat until happy with it”, “play it over and over again until I got it right”, and “avoid the piece altogether”. Generally these students commented on repeated practice or the use of one routine strategy without reference to the outcomes or to changing strategies. Students on the middle level (3) used a variety of strategies any of which may have been appropriate. However, they did not connect the strategy with the specific problem.
Only one student was placed in the highest level of deliberate practice planning procedures. This student analysed the problem, selected appropriate strategies and then, based on feedback of performance trial, adjusted the strategies. On Level 4, one student analysed performance to identify particular problems but did not then relate this to strategy selection.

About one third of the students used several different strategies such as rehearsing hands separately, reducing the tempo, isolating particular bars, clapping the rhythm, or listening to the model but these routine behaviours were non-selective, and not directly connected to the difficulty they had previously identified. These students indicated a lack of understanding that thinking about the problem and selecting specific strategies might lead to a solution. Students who only described unplanned drill and practice or the use of only one or two different strategies were considered to be functioning at the lowest level (1).

Deliberate practice has been described in the literature as a form of metacognition. Based on analysis of their own descriptions, students were, therefore, assigned to a level of Deliberate Practice, as shown in Table 5.3. Ten percent of students could be described as applying deliberate practice procedures (Levels 5 and 4), the remaining students being spread across levels 1, 2, and 3, so this measure was considered appropriate as an indicator of metacognitive functioning.
Table 5.3  Level of Deliberate Practice

<table>
<thead>
<tr>
<th>Level</th>
<th>Description of Level</th>
<th>% of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Planned deliberate strategies to remediate a specific problem following analysis of performance difficulties</td>
<td>5%</td>
</tr>
<tr>
<td>4</td>
<td>Analysis of performance difficulties without selecting appropriate strategies</td>
<td>5%</td>
</tr>
<tr>
<td>3</td>
<td>Use of several different strategies not based on particular justification</td>
<td>33%</td>
</tr>
<tr>
<td>2</td>
<td>Use of limited number of strategies</td>
<td>38%</td>
</tr>
<tr>
<td>1</td>
<td>Unplanned repeated practice</td>
<td>19%</td>
</tr>
</tbody>
</table>

5.3.5  Self-Directed Physical Practice

This measure was based on analysis of the recordings taken of students' strategies during practice and therefore provided evidence of how students physically behaved during practice sessions. Table 4.8 described the specific behaviours on which data were collected and subsequently categorised according to the criteria described below in Table 5.4. Students' practice was recorded on the MT100 during laboratory practice sessions in weeks four, eight, and twelve and saved to disk. In weeks six and ten, home practice sessions were recorded to audio tape.

Of the six discrete behaviours on which data were collected, (whole method, repeated drill, coordinated hands, pitch error correction, rhythm error correction, and tempo changes), there were some in which behaviour varied across students and others which were universally the same for all students. These behaviours were also analysed according to each student's application. When individual students used the same procedures consistently, in response to different outcomes, without modification, they were not self-directing, but rather having
selected particular strategies, they used them without consideration of effect. Their practice was therefore considered to be routine and automated.

*Whole Method*

Fourteen students used the "whole method" form exclusively, that is, they rehearsed each composition from beginning to end. At no time did this sub-group isolate difficult sections to rehearse separately from the complete work. Only one student consistently rehearsed sections within a work. Although the remaining students did, at some time, rehearse sections of a particular piece, this strategy was generally found to occur more towards the end of the study and very infrequently.

*Repeated Drill*

During practice, an instrumentalist may play one piece several times or play all the pieces once only. The evaluation of this behaviour depicted greater diversity in the way individual students rehearsed. No student demonstrated exclusive use of either consecutive drill procedures or single unrepeated performance. Most incorporated both strategies. Six students showed a preference for rehearsing each piece once only before playing the next piece, the remainder used both strategies.

*Coordinated Hands*

Rehearsing hands either together or separately are options students might select according to the difficulties they have identified during practice. This group of students generally rehearsed with coordinated hands. Half the students always rehearsed both hands together and although the remaining eleven students did rehearse hands separately, they used the technique less frequently.
Pitch Errors

The two most obvious errors beginning students are concerned with are those of pitch and rhythm. Generally pitch errors were recognised and students adopted one of two procedures in response to this recognition. They either corrected the error and then continued to play from that point in the music, or they immediately returned to the beginning of the piece without correction. Six students generally rehearsed by correcting individual notes and then continued to complete the piece, while five students tended to return to the beginning without correction. The remaining students applied both strategies. In this behaviour there was considerably greater diversity within individual students' selection of these two procedures than in the other six measures taken.

Rhythm Errors

Only one of the twenty-one students corrected rhythm errors and that was during one session only. Rhythm errors were ignored entirely by the remainder of the students. Whether this was due to lack of accurate feedback and non-recognition that a rhythmic error had occurred is unknown. It appeared that the melody was the over-riding element of the works which students most easily recognised during practice. Whether students hear rhythm errors more easily when listening to a recorded performance of their practice is unknown.

Tempo Change

When students drilled a piece they rarely reduced the tempo on subsequent trials, generally rehearsing initially at the same tempo. However, because of the difficulties they experienced, they were frequently forced to reduce the tempo at the problem points within the piece. Only seven students, each on one occasion only within one of the five recorded sessions, began repeated drill at a slower tempo. This indicates lack of analysis or ability to recognise the potential of reduced tempo to facilitate error detection and accurate performance generally.
Level of Self-Directed Physical Practice

From analysis of the six behaviours just described, only ten percent of students could be categorised as “self-directing” in their practice. Usually students' strategies, once determined, were fairly consistent, notwithstanding the problems they were having with mastering a particular piece. The extent to which students were flexible in the use of these strategies, according to self-feedback, was limited. The researcher summarised the use of self-directed strategies displayed during practice by using a five-point standards-based scale as shown in Table 5.4. Based on the accumulation of evidence described above, students were assigned a “level” corresponding to the extent of self-directed practice shown with the resulting distribution.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description of the level</th>
<th>% of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Evidence of self-regulation by modification of practice strategies based on performance outcomes feedback</td>
<td>9%</td>
</tr>
<tr>
<td>4</td>
<td>Evidence of some modification based on performance outcomes feedback</td>
<td>48%</td>
</tr>
<tr>
<td>3</td>
<td>Inconsistent responses to performance outcomes</td>
<td>28%</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical response to performance feedback with little modification</td>
<td>10%</td>
</tr>
<tr>
<td>1</td>
<td>Mechanical response to performance feedback with no modification</td>
<td>10%</td>
</tr>
</tbody>
</table>

5.3.6 Instructional use of the MT100

The following section reports on the final data collected for this section, that is, technology use. Investigating how students used the MT100 during the study required several measures to be taken. From weeks eight to fourteen, data were collected in laboratory practice sessions by investigator observation to assess the extent to which the MT100 was used for both instructional and motivational
purposes. Simultaneously, students reported on a survey how they thought they
used the MT100 during the same period.

One criticism, in the literature, of computer technology in keyboard laboratories
is that it is used more for motivational or trivial purposes, for example, for
accessing the enhanced accompaniments, than for instructional purposes such as
demonstration or for feedback and self-analysis. The purpose of observing
student behaviour from weeks eight to fourteen, was to test whether this
perception held true for this group of students. In addition to the observational
data, at the conclusion of each practice session, students were required to
complete a self-assessment of their use of the MT100 to determine whether
observed behaviours and self-reported behaviours correlated. The following
section describes the results of these measures.

Observed Instructional use of the MT100 (OIMUMT)

During private practice in the laboratory, students' use of the technology was
observed and data collected via intermittent time sampling procedures during
weeks eight to fourteen. In comparing the frequency of individual student use of
the MT100 for instructional applications, the data showed a wide range of scores
between students, from sixteen incidents to forty-six for the same number of
opportunities during which data were collected. These results produced a raw
score, (mean = 30.6, s.d. = 8.5), which was used for later comparison with other
data.

From the distribution of scores, the spread of student use of the MT100 for
instructional purposes is evident. (See Figure 5.8).
All students used the MT100 for self-instructional purposes as described in Table 4.10. They listened to the demonstration model, rehearsed with the model, self-recorded, listened to own recorded performance, and/or manipulated various functions of the MT100 to suit individual needs. Those students who demonstrated high or moderately high use for these purposes made up twenty-eight percent of the students.

Self-reported Instructional use of the MT100 (SRIUMT)

At the conclusion of the same practice sessions, students were requested to record the specific purposes for which they had used the MT100, that is, how often they made use of listening to the demonstration model, rehearsing with the model, self-recording, or listening to self-recorded performance. Students reported their use of the MT100 for these purposes on a five-point scale which ranged from "not used at all" (1) to "used most of the time" (5). These measures aggregated yielded a mean = 73.0, s.d. = 19.0, while the distribution of scores can be seen in the bar graph in Figure 5.9.
According to student perception, fourteen percent made moderately high to very high use of the computer for instructional purposes. As a measure of concurrent validity, these data - observed and self-reported instructional use of the computer - correlated to a moderately high level of 0.75.

5.3.7 Motivational use of the MT100

*Observed Motivational use of the MT100 (OMUMT)*

In comparing the observed frequency of individual student use of the MT100 for motivational purposes, the data showed a wide range among students, from five incidents to twenty-eight for the same number of opportunities. The measure of observed use of the MT100 for motivational purposes showed a mean = 12.9, s.d. = 6.6, while the spread of scores can be seen in Figure 5.10.
All students used the MT100 for motivational purposes as described in Table 4.11. They rehearsed with the orchestral accompaniments, manipulated various dimensions of the pre-recorded enhanced backgrounds, listened to unknown pieces and manipulated those accompaniments. The data are positively skewed showing that the majority of the students generally did not use the computer for motivational purposes to a high degree, only fourteen percent being in the upper levels. This result conflicts with other reports in the literature.

*Self-Reported Motivational use of the MT100 (SRMUMT)*

The measure of self-reported use of the MT100 for motivational purposes, collated in the same way as reported for Self-report Instructional use, provided the following data. The students' scores ranged between thirteen to seventy-eight producing a mean = 30.5 and s.d. = 13.6. Figure 5.11 displays the distribution of scores.
The results of students' use of the MT100 for motivational purposes were positively skewed. Generally, the majority of students made less use of the sequencer for motivational purposes than for instructional purposes. Their own perception was that they sought motivation from the computer less frequently than the observed data demonstrate. As a measure of concurrent validity, these data, observed and self-reported motivational use of the computer, correlated at the level of 0.9.

These data indicate that students made greater use of the MT100 for instructional purposes than for motivation though all students used the function of enhanced backgrounds and changing timbre at some time.

5.3.8 Specific instructional applications of the MT100
In week fourteen, students were asked to describe, via questionnaire, the instructional purposes for which they had mostly used the MT100 over the period
of the study (See Table 4.12). Data from four questions each on a five-point scale, provided the following information.

To the question “I use the MT100 to self-record frequently”, thirty-three percent of students agreed or strongly agreed with the statement. No student “listened to self-recorded performance” at the strongly agree level but thirty-eight percent did at the level of agree with the statement. To use the MT100 “to listen to self-recorded performances for the purpose of analysing” their practice, thirty-eight percent agreed or strongly agreed. However, the main use of the computer was for the purpose of listening to the demonstration and for this, fifty-three percent of students agreed or strongly agreed that they “listened to the pieces to see how they should sound”. These data were supported from journal analysis in which students frequently commented on the benefits of listening to the demonstration model prior to rehearsal.

Table 5.5 Specific Instructional Applications of the MT100

<table>
<thead>
<tr>
<th>Description</th>
<th>Statement</th>
<th>% students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-record</td>
<td>Agree/ strongly agree</td>
<td>33%</td>
</tr>
<tr>
<td>Listen to self-recorded performance</td>
<td>Agree</td>
<td>38%</td>
</tr>
<tr>
<td>Listen to recorded performance for analytical purposes</td>
<td>Agree/ strongly agree</td>
<td>38%</td>
</tr>
<tr>
<td>Listen to demonstration model before rehearsal</td>
<td>Agree/ strongly agree</td>
<td>53%</td>
</tr>
</tbody>
</table>

To this point in the chapter, results of the first two sections of the study have been reported, that is, the incoming skills of the students (Entry Status) and the measures taken during the study (Practice Behaviours). The third and final section of the data is now to be presented and reports items related to Question 3,
the outcomes of the study. These include practical performance achievement of students, and attitudes to practice, and the MT100.

5.4 QUESTION 3
WHAT LEVEL OF PERFORMANCE OUTCOMES DID STUDENTS ACHIEVE AT THE CONCLUSION OF THE STUDY?

To provide answers to this question, several measures were taken to evaluate the achievement of these novice instrumentalists in terms of their ability to perform on the keyboard, level of theoretical understanding, and attitudes to practice, group learning, and computer aided practice. This first section on performance achievement reports results on four measures, performance achievement, repertoire progress, sight reading and scanning.

5.4.1 Performance Achievement
Under examination conditions, at the conclusion of the study, students performed several works, three compulsory pieces set by the investigator and two selections of their own choice. Performance examinations were recorded to audio tape for subsequent assessment with student permission.

In evaluating performance, the brevity of the study was taken into consideration. Criteria were selected (see Table 4.13) which would indicate student ability to perform: pitch and rhythmic elements with accuracy; at a tempo that was not so slow as to sound laboured; observing marks of expression; and with musicianly interpretation of phrasing, technique and style. Given the simplicity of the music and consequently the phrasing, technique and style elements, this was considered within the capabilities of this group of beginner keyboard players.
The performance of each piece was measured on a five-point scale for each of the five measures as described in Table 4.13. A final performance score was collated from the sum of each of the five pieces performed. The range of scores as shown in Figure 5.12, was 51 to 101, mean = 78, s.d. = 14.0 indicating a spread of achievement across the twenty-one students (the maximum score possible being 125). The performance measure focussed primarily on accuracy. Those students who scored ninety marks or higher, played with accuracy and musical expression, between seventy and eighty-nine, students played with moderate levels of accuracy and fluency, while those below seventy performed at the lowest level of the measures.

![Performance Achievement](image)

**Figure 5.12** Performance achievement

### 5.4.2 Repertoire Progress

It is possible for some students to spend time rehearsing relatively fewer pieces, aiming for perfection, without extending their repertoire. As a consequence they may achieve a higher score than those students who were challenged to increase the number of pieces they were learning to demonstrate greater competence. Students were encouraged by the investigator to progress to new pieces as soon as
they felt able, and were told that additional marks would be given in the examination for more advanced repertoire. A weighting of one point per piece was awarded. This somewhat arbitrary figure acknowledged that each subsequent piece in the tutor was at an increased level of difficulty without adding excessively to the score. In terms of extent of repertoire, students demonstrated considerable disparity of progress (twenty-one points to fifty), the distribution of scores being shown in Figure 5.13. There was a mean of 35.1 and s.d. = 8.4.

![Repertoire Progress](image)

Figure 5.13 Repertoire progress

Some of the struggling performers considered that mastery of each piece was essential before progressing to newer works and as a consequence did not extend their repertoire.

### 5.4.3 Sight Reading Ability

Research suggests that performance outcomes may be influenced by the ability to sight read so students were given a previously unseen eight-bar piece of music which they were able to visually scan for thirty seconds before being required to play at sight. The piece was well within the capabilities of all students to perform
and, after some practice, would have been mastered within several trials. Students' ability to sight read ranged from being able to play only the first bar to being able to play the complete section with accuracy. Figure 5.14 indicates that scores ranged from five to twenty-four, (mean = 13.4, s.d. = 5.3).

![Sight Reading Ability](image)

Figure 5.14  Sight reading ability

These data will be used later to determine whether performance achievement of this population was influenced by the ability to sight read.

### 5.4.4 Scanning Ability

It has been suggested in the literature, that the ability to sight read is influenced by ability to scan ahead in the music while sight reading. Students were presented with a second piece of unseen music of eight bars length, the equivalent standard of the sight reading test piece. They were informed that this was another sight reading exercise but that the music would be covered at some point and they were to continue to play as far as possible after they could no longer view the score. This was not a skill that had been taught during the study.
The range of notes accurately played varied from zero to eleven. Five students were unable to read ahead by even one note whereas one student played accurately eleven notes after the score had been covered. The mean score for the sample was 3.6 notes, s.d. = 2.8. The scores were positively skewed showing a general inability to scan ahead while sight reading. These data as shown in Figure 5.14 will be used later with those of Figure 5.15 to determine whether ability to scan does influence sight reading for this group of students.

![Scanning ahead while sight reading](image)

Figure 5.15 Scanning ability

Students' ability to perform in each of the four measures taken showed a spread of achievement. Given that none had played keyboard before and all were exposed to the same teaching methods, later analysis will attempt to identify the variables responsible for the disparity in performance achievement. Special comment needs to be made concerning the student who accurately performed eleven notes after she could no longer see the score. It appeared during this task that the last notes were played, not from visual memory but as a result of guess-work. One might
suggest that this student generated these notes with accuracy due to prior knowledge of tonal conformity.

5.5 STUDENT ATTITUDES

5.5.1 Practice

Significance of practice

Data from journal entries indicated the importance students placed on practice. According to the journals, eighteen students attributed performance achievement to practice, and even the three who considered ability as having the most significant effect, also acknowledged its importance. However, it was considered that the measure of accumulated practice was a stronger indication of students' commitment to practice.

Accumulated Practice

Amount of practice time has always been considered crucial for performance progress by instrumental teachers, and recent research has shown that elite performers can be differentiated from advanced performers by the number of hours accumulated prior to reaching adulthood. Students in this study were required to complete a daily practice time schedule which was attached to their journals. The data provided information on the total number of hours accumulated over this fourteen week study, the amount of practice per day, and the number of days per week on which practice occurred. The results of analysis of accumulated practice time showed considerable diversity across the students, (see Figure 5.16) producing a mean = 2013 minutes, s.d. = 820.
Figure 5.16  Accumulated practice time

The data on amount of practice in Figure 5.16 show a wide distribution of scores which are positively skewed. Students rehearsed between seventeen and seventy-eight hours across the fourteen weeks, the average amount of time for the group being 2.4 hours per week. In relation to distribution of practice, the average number of days per week was three. None rehearsed every day, two students rehearsed five or six days per week, thirteen on three or four days, and the remaining six only one or two days per week. In terms of time and distribution, there was considerable diversity in this measure.

The data will be used to determine whether any correlation exists between performance achievement and accumulated practice.

5.5.2 Computer Aided Practice

Students' answers to five questions concerning the MT100 gave an indication of their attitude to the ease of use of the computer, their willingness to use it, and the extent to which it had assisted their keyboard learning. Results indicated that
students were generally very positive to the use of the computer as an aid to practice (see Figure 5.17). The scale produced a mean = 19.2, s.d.= 2.6. A more in-depth discussion will be provided in Chapter Six to highlight particular benefits students identified.

![Attitude to MT100](image)

**Figure 5.17** Computer aided practice

### 5.6 SUMMARY

The results described in this chapter have reported all the data collected on Entry Status, Practice Behaviours, and Outcomes providing answers to the first three questions in this study. These questions were:

1. What entry behaviours did students bring to this study?
2. Were students metacognitively engaged in the planning and implementation of practice?
3. What level of performance outcomes did they achieve at the conclusion of the study?
The results provide evidence of the skills and attitudes students exhibited at the beginning of the study, the extent to which they thought about their practice, both in preparation and implementation, and how they physically rehearsed. It also described how students used the MT100 as well as their attitude to the computer as an aid to keyboard learning.

Chapter Six will report the connections between Questions 1, 2, and 3 to provide answers to Questions 4, 5 and 6.
CHAPTER SIX
DISCUSSION AND ANALYSIS OF RESULTS

6.1 INTRODUCTION

The purpose of this study was to probe the rehearsal strategies of a group of
novice keyboard instrumentalists and to explain any relationships which existed
between student predisposition, practice procedures and performance outcomes.
Central to the study was the exploration of the extent to which these instrumental
students were metacognitively engaged in practice planning and implementation.
How thinking about practice, pre-practice planning and physical rehearsal
affected post practice outcomes were key elements while how to make most
effective use of the MT100 was also a central focus of this study. The variables
addressed in this study are shown in Figure 6.1.

![Figure 6.1 Framework and variables of the study](image)

141
Six questions were devised to facilitate this investigation. Questions 1, 2 and 3 which sought to describe students' Entry Skills, Practice Behaviours during the study, and Outcomes, were addressed in Chapter Five. Questions 4, 5, and 6 which explore the relationships between Entry Status, Practice Behaviours, and Outcomes, are described in this chapter.

The relationships examined in this study use correlation techniques. Had the study involved a much larger number of students, the relationships between Entry Status, Practice Behaviours and Outcomes could have been analysed using structural equation modelling to test hypothesised links in an overall model. However, given the limitation of a sample of 21 students, relationships were explored in pairwise fashion and a global picture was formulated by synthesising the results from the separate analyses. The limitations involved in the approach, largely a function of the small sample size, need to be kept in mind when findings are interpreted. However, by looking for consistent patterns across the whole model, and then by seeking to understand and elaborate on the patterns using qualitative data from observations, interviews, informal discussions, and students' written accounts, good interpretative sense can be made of the data.

For individual correlations, only those which are statistically significant (the generous level of $p < 0.1$ is used because of the small $N$) are considered. This level of significance corresponds to a moderate $r$ of 0.36 on a two-tailed test of significance. However, as noted above, interpretation is based on a pattern of overall relationships and takes account of the magnitude of the correlations (remembering that $r^2 = \text{the proportion of variance accounted for}$).

6.2 ENTRY STATUS

The first question, Question 4, concerns the relationship between Entry Skills and Practice Behaviours, "Was practice influenced by personal characteristics
exhibited by students at the commencement of the study?" The reader is reminded of the variables identified within these two categories by Figure 6.2.

![Diagram of Entry Status variables](image)

**Figure 6.2** Entry status variables

Before attempting to link the effect of particular practice procedures with the performance outcomes of novice instrumentalists, it is essential to take into consideration the effects of prior knowledge, skills, and predisposition. Whilst a number of entry level variables might have been included in this study, the four selected were considered the most relevant, the reasons for their selection being previously explained in Chapter Four. The following section will firstly discuss the interrelationships between Entry Status variables and then the influence of these individual items on Practice Behaviours.

### 6.2.1 Interrelationship of Entry Status variables

*The Ability to use Computers*

In this study, students were introduced to the MT100 Sequencer Sound Module, a music dedicated computer, with accompanying software, which had the potential to support keyboard learning and practice. The MT100 was integral to the delivery of instruction and was also available to students, as a learning aid, during
practice. Although students were not compelled to use it during practice, it was compulsory for them to use it to self-record practice for later teacher analysis.

Those students having limited computer experience might have avoided using the sequencer as an aid during the study because of lack of computer confidence. As a consequence, they may not have gained any benefit from its potential advantages. However, since it was mandatory for them to self-record, they were forced to gain skills in using the equipment. Although the measure Ability to use Computers was considered a potential influence it did not correlate significantly with any of the other Entry Status variables.

**Attitude to Computers**

Although this measure had the potential to influence other measures taken in the study, it did not correlate significantly with any other variables in Entry Status.

**Aural Aptitude and Music Experience**

Of the four measures taken on entry, only Aural Aptitude and Music Experience were significantly correlated \((r = .52)\). Aural perception and discrimination skills are essential for instrumental performance so this is a result one would expect.

6.3 **QUESTION 4**

**WAS PRACTICE INFLUENCED BY PERSONAL CHARACTERISTICS EXHIBITED BY STUDENTS AT THE COMMENCEMENT OF THE STUDY?**

The answers to this question are detailed in the following section, the significant correlations being shown in Figure 6.3.
6.3.1 Ability to use Computers

In relation to metacognitive skills used in practice, the Ability to use Computers measure correlated negatively with one item, Self-Regulated Learning Categories (SRLii) \((r = -0.56)\). For this group of students, those who were more familiar with computers reflected less on their practice. According to their journal entries, they addressed a smaller number of categories for performance analysis, from the range identified in Zimmerman's measure of Self-Regulation (see Table 4.5). Students who were less experienced using computers, prior to the study, relied more on their cognitive ability to gain performance feedback. These students selected more diverse cognitive strategies in trying to identify their difficulties and in seeking possible solutions to their performance problems.
In examining the influence of Ability to use Computers on Practice Behaviours, the positive connections between this variable and the several measures taken of use of the MT100 during the study were notable by their absence. The lack of connection between Ability to use Computers and the Computer Aided Learning measures was unexpected. From this it is conjectured that because students were taught how to use the MT100, prior ability to use general computers did not influence student use of the music computer during the study.

In later discussion it will be shown that positive correlations did connect use of the MT100 to Attitude to MT100 indicating that specificity rather than generality is important in computer applications. That is to say that prior experience in one computer application may not necessarily transfer to another. Likewise, given specific instruction in the operation of a particular computer, students' prior attitude may have little influence on either attitude or application.

6.3.2 Attitude to Computers

Although the measure Attitude to Computers correlated with Planned Practice (r=.38), there were no other significant correlates. Those students who displayed positive attitudes towards computers generally planned their practice methodically using a range of essential strategies for rehearsal. One might suggest that students who feel positively towards computers do so because they are methodical thinkers and work in a similar logic pattern to that provided by computers, hence the connection with the aspects of Planned Practice. Perhaps the experience of using computers, which necessarily calls on systematic sequencing of processes to use the software, enhances students' ability to think methodically.

6.3.3 Aural Aptitude

The data show little evidence of connections between Aural Aptitude and Practice Behaviours except for one variable, Self-Regulated Learning Items (SRLi).
Students who thought about their practice and were able to articulate diversity within the categories by the number of comments they made in reflecting on their instrumental learning, were those whose aural aptitude was of a high standard. For students to be able to reflect critically and perceptively on both practice and progress, fine aural perception, aural discrimination and aural memory skills are essential in providing feedback for analysis.

Aural Aptitude and Self-Regulated Learning Items, by the positive results ($r = 0.47$), indicate that students' level of aural perception of their performance outcomes during rehearsal sessions influenced their ability to reflect critically on their practice planning and implementation strategies. These students addressed a wide range of issues which had the potential to impact on rehearsal praxis and influence performance outcomes.

### 6.3.4 Music Experience

There was also a connection between Music Experience and the Self-Regulated Learning Items measure (SRLi). Students were identified as self-regulated learners, based on journal entries, by the diversity and extent of analytical comments. These demonstrated students' ability to listen, to self-evaluate, and to articulate strategies they used in planning practice and the analysis of successful outcomes.

It appears that through the experience of prior music learning, instrumentalists have acquired some ability to reflect on their performance development. This enables them to follow the model shown in Figure 6.4. Self-Regulated Practice occurs when the student rehearses and listens to the resulting performance to gain feedback via self-monitoring. From this information, analysis of the outcomes is followed by selection of specific strategies which are then used for subsequent rehearsal. This suggests that it may be important to teach novice instrumentalists a
range of self-regulation skills in the earliest stages of learning rather than wait for it to occur naturally.

![Diagram](image)

**PLANNING STRATEGIES**

**PHYSICAL PRACTICE**

Rehearse

Self-Regulate

Self-monitor

Self-analyse

Figure 6.4 Self-regulating practice model for novice instrumentalists

In answering Question 4, it is clear from the foregoing description that each of the four measures taken at the commencement of the study (Entry Status) had some impact on students' Practice Behaviours (see Figure 6.3), most particularly those concerned with the measures taken of metacognitive behaviours. Although students evidenced diverse levels of skills and attitudes at the commencement of the study, each of the four measures connected at moderately strong levels with four of the six measures taken of metacognition.

One might conclude that while incoming skills showed weak correlations with how students physically practised, and how they used the computer, the significant component was their ability to think about and plan practice at an intellectual level. It is suggested in the model shown in Figure 6.4 that beginning instrumentalists might benefit from being made aware of the need to spend as much time thinking and planning as physically performing.
6.4 PRACTICE BEHAVIOURS

During this study, there were eleven measures taken of Practice Behaviours under three categories, Metacognition, Psychomotor Behaviours and Computer Aided Learning. Before reporting the connections which were shown to exist between Practice Behaviours and Outcomes, the variables within Practice Behaviours are examined, and how they were interrelated with one another is described.

6.4.1 Interrelationship of Practice Behaviour variables

Metacognition

Figure 6.5 shows how the measures under Metacognition interrelated with other Practice Behaviours.

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* Planned Practice
* Self-Regulated Learning i
* Self-Regulated Learning ii
* Independent Learning
* Deliberate Practice

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![Diagram of interrelationship of practice behaviours and metacognition](image_url)

Figure 6.5 Interrelationship of practice behaviours and metacognition
Students who scored high on the Planned Practice variable, that is, those students who said they used a set of basic strategies prior to and during practice, such as mentally reviewing the score before playing, also scored well on the Self-Regulated Learning Items (SRLi) measure. SRLi, the analysis of students' thinking about their practice and progress, according to their journal entries, identified students whose metacognitive approach to practice enabled them to analyse the effects of practice and their performance outcomes. These students articulated a range of strategies in self-evaluating, organising, planning, seeking information, environmental structuring, rehearsing, and seeking feedback from various sources.

Later, how these variables connected with performance Outcomes will be described to show a strong connection between Practice Planning, Self-Regulated Learning and Performance Achievement. This supports the premise that thinking about practice is an important aspect of physical rehearsal and results in increased skill development. This is an important finding. The writer found no evidence of prior investigations into metacognitive aspects of practice and its application by beginners.

The data also show a relatively high correlation for those students who demonstrated the ability to be Independent Learners with the strategy of Practice Planning \((r=.44)\). Students who thought about the music before they performed the piece and planned strategies were more able to teach themselves a new composition independently of teacher assistance. Since student practice occurs away from teacher intervention, it is suggested that more attention be given to showing students how to think about and plan their private practice sessions so that they become more effective independent learners.
Self-Regulated Learning Items (SRLi) correlated at a moderate level with Planned Practice ($r = .41$) and moderately high levels with Self-Regulated Learning Categories (SRLii) (.51) and Independent Learning (.6). The only category within the Metacognition group of items which did not correlate significantly with any of the other items was Deliberate Practice. It is therefore proposed that the measures within Metacognition were reliable for four of the five items and that they provide a dependable assessment of students’ metacognitive abilities.

There may be several reasons for Deliberate Practice not fitting with this group. As previously described, Deliberate Practice is a term describing the use of specific strategies for quite specific purposes. These strategies are usually taught by coaches, particularly in sports, to students having advanced skills. In sports, the application of deliberate practice has been highly successful but whether the strategies would be as productive with instrumental players in their early stages of development can only be conjectured.

In music, according to Ericsson, Krampe, and Tesch-Romer (1993), deliberate practice is highly structured, purposeful practice which has the explicit goal of improving performance by inventing specific tasks to overcome weaknesses. Another distinct feature of deliberate practice is the adjustment of the level of difficulty to maximise improvement. It is suggested that without such strategies it would be difficult to achieve expert levels of instrumental performance. However, it is unlikely that beginner instrumentalists have sufficient pre-requisite skills to be able to employ deliberate practice strategies.

During this study no mention was made of deliberate practice to students and it is assumed that beginners would need further experiences before they could be taught to call upon deliberate practice strategies themselves.
Psychomotor Behaviours

The data showed two connections between ability to use metacognitive strategies during practice and Psychomotor Behaviours.

![Diagram of Practice Behaviours](image)

Figure 6.6  Interrelationship of practice behaviours and psychomotor behaviours

There were moderately high correlations between Self-Directed Physical Practice with Self-Regulated Learning Items ($r= .57$) and Independent Learning ($r= .56$). The measure Self-Directed Physical Practice was based on students' recordings of private practice. When students rehearsed mechanically, without changing procedures during practice, they were using drill procedures without calling on critical thinking strategies. However, when they varied their procedures based on the results of their practice, they were using feedback to select particular strategies and using problem solving skills.

That the level of Self-Directed Physical Practice correlated positively with Self-Regulated Learning Items (SRLi) indicates that students who were able to describe and reflect on the procedures they used in connection with their instrumental development to a high degree were also those who thought during
practice. These students adjusted their practice strategies based on analysis of actual performance outcomes during rehearsal.

Students who scored high on the Independent Learning measure were also shown to be thoughtful during actual rehearsal (Self-Directed Physical Practice) these items correlating moderately highly (r=.56). Students who self-monitored during actual practice, and, who thought about and used different strategies to correct faulty performance, were more able to learn a new composition without teacher assistance.

*Computer Aided Learning*

The third set of behaviours measured during the study was concerned with the use of the MT100. These are grouped under Computer Aided Learning. Both observational data and student self-report measures were used to generate these data (see Figure 6.7). These results show that Computer Aided Learning items interrelated with other practice behaviours. The number of significant correlations gives an indication that students who made more use of the computer tended to engage in more cognitive behaviour. All four measures of the use of the MT100 also correlated moderately or highly with one another.

Significantly, students who were able to describe how they rehearsed, why they selected strategies, and their progress, as measured by Self-Regulated Learning Items (SRLi) and Self-Regulated Learning Categories (SRLii), (r=.44) and (r=.43) respectively, made significant use of the MT100 for instructional purposes. Both measures of observation and self-report on the use of the sequencer for instructional purposes correlated highly.
Figure 6.7  Interrelationship of practice behaviours including computer aided learning

Students who used the computer for both instructional and motivational purposes were those identified as Self-Regulated learners. The students, therefore, who systematically planned and self-monitored made most use of the computer as a learning tool. The measure of Independent Learning also correlated positively, albeit at a moderate level, with Self-Report Instructional use of MT100. Those students who were able to describe appropriate strategies for teaching themselves a new composition used the computer as an aid to their independent self-instruction.

Connections have been shown between several of the three sets of Practice Behaviours measures taken during the study. Conclusions to be drawn from these connections will be discussed in Chapter Seven. The following section explores the relationship between Practice Behaviours and Outcomes.
6.5 QUESTION 5
WERE PERFORMANCE OUTCOMES AFFECTED BY PARTICULAR PRACTICE STRATEGIES?

There are three parts to this question. The first part examines the influence of students' thinking about practice, Metacognition, on their performance outcomes. This is followed by discussion on the way in which outcomes connected with students' physical rehearsal, Psychomotor Behaviours, according to recorded rehearsal evidence. Finally, the third section reports on the effects of technology, Computer Aided Learning, and its relationship to performance outcomes. Measures included in each of these three sections are described in Figure 6.8.

![Diagram](Image)

**Figure 6.8** Practice behaviours and outcomes variables
6.5.1 Metacognitive aspects of practice

The measures under this heading sought to determine whether students who functioned at higher levels of thinking by the demonstration of complex thinking and planning behaviours through the incorporation of a range of strategies, would produce increased performance outcomes. Analysis of results of metacognitive processes and their impact on performance appear in Figure 6.9. The following section discusses the impact of Metacognition on Outcomes.

![Diagram of practice behaviours and outcomes](image)

**Figure 6.9** Relationship between metacognitive practice behaviours and outcomes

*Planned Practice*

Students who planned practice by using strategies such as scanning the music to identify time-signature, key-signature, beats per bar, and musical signs, before beginning to rehearse, and to count or sing as well as looking ahead during rehearsal reached higher levels of achievement in terms of quality of performance \(r=.43\). This supports the assertion that thinking about strategies and applying
them prior to and during rehearsal are effective. Planned Practice was an influence on Performance Achievement.

Self-Regulated Learning
From this group of variables under the metacognitive heading, the item which correlated most highly with performance achievement was that of Self-Regulated Learning Items (SRLi). Some students reflected in depth on their performance development in their journals, particularly in regard to rehearsal, being able to articulate a wide range of skills and strategies in planning. In addition, these students used feedback to self-evaluate progress, they set goals, sought information, and structured their environment (see Table 4.5). It was this group which made the most significant progress, Performance Achievement correlating highly ($r = .65$) with SRLi. The same students also made the most significant repertoire progress, that is, they learned more advanced pieces than other students ($r = .7$).

Self-Regulated Learners acknowledged the importance of practice while the Accumulated Practice measure indicates they also rehearsed for longer periods.

Independent Learning
Performance achievement was also influenced by students who had developed skills which facilitated the learning of new pieces independently of the teacher. Through their description of the means by which they would analyse new works and the strategies they would apply, students demonstrated Independent Learning ability. Students were described as Independent Learners when they gave a detailed description of the steps they would implement for the purpose of teaching themselves a previously unseen composition. The level at which they functioned as Independent Learners was determined by the detailed descriptions they gave and how these were categorised were presented in Figure 5.2.
Those students who conducted simple routine score analysis of the piece and accessed the demonstration model through the computer as their only strategies were considered to be functioning at the lower end of the Independent Learning scale. It appears that students who produced successful performance outcomes were those who planned strategies based on analytical evaluations of previously successful strategies. They planned, rehearsed, gained self-feedback from outcomes, identified problems, and selected strategies which formed the basis of their planning procedures for the next cycle of rehearsal. Thinking about practice, therefore, played a prominent role in the organisation of successful practice. Assisting students to become Independent Learners rather than rote learners appears to be important in successful instrumental development in beginners.

Earlier, from Figure 6.5, it was seen that Independent Learning and Self-Regulated Learning (SRLi) correlated positively (.6). Figure 6.9 indicates that Independent Learning was also an influence on Performance Achievement. Those students who thought intensively about practice procedures, were identified as the most competent in learning a new piece without teacher assistance, and the same students also achieved higher levels of performance outcomes.

**Deliberate Practice**

The data for Deliberate Practice were generated from students' explanations of how they sought to remediate their performance of a piece which was not progressing satisfactorily. Students' listed strategies were placed in an hierarchy the lowest of which was applied to students who demonstrated no defined organisational strategies, but merely used repeated drill and practice. At the higher end of the spectrum, students analysed the problem, determined appropriate remediation, rehearsed and re-analysed the outcomes. Based on this feedback, students then applied a new set of strategies to their next rehearsal.
From the Scanning Ability measure, taken at the conclusion of the study, it was found that those students who adopted Deliberate Practice strategies were the most able in reading ahead in their music while sight reading (r = .36). The measure of Deliberate Practice identified those students who followed a cycle of planning, rehearsal, analysis of outcomes, selection of specific strategies to remediate particular problems, and then followed these steps by beginning the cycle again. These students were methodical and approached their practice with deliberate intentions. It appears that this was reflected particularly when they were sight reading.

It has been suggested in the literature that sight reading is a quite specific skill which ought to be taught separately with students being given directions into how to approach the task. It appears that some students intuitively develop skills in deliberate practice which influence their sight reading strategies. It is suggested that all students, in the beginning stages of instrumental learning, would be advantaged by some general instruction in the development of a methodological approach to sight reading and deliberate practice. Furthermore, encouragement and possible strategies for following a metacognitive approach to all aspects of performance rehearsal is recommended so that students can take greater control of their thinking.

Each of these variables previously described point to the importance of metacognitive engagement in performance rehearsal for the achievement of instrumental proficiency. The relationships connecting Practice Behaviours with Performance Outcomes reported in Figure 6.9 demonstrate the importance of metacognitive engagement before, during, and after rehearsal to increase performance skills.
6.5.2 Psychomotor Behaviours

Self-Directed Physical Practice

Performance Achievement was also affected by students' ability to be flexible in the manner in which they physically rehearsed. Self-Directed Physical Practice was the measure taken from the recorded practice sessions of students. The strategies which were detected during analysis of these recordings included six particular behaviours. These were whole method practice, repeated drill, hand coordination, pitch and error detection with subsequent strategy response, and tempo changes. How students used these strategies was investigated to determine if students were fixed in their application of these behaviours or whether they modified their procedures according to the progress they were making.

Results of the analysis of these six individual behaviours were provided in Chapter Five but it is relevant to reiterate at this point the most illuminating outcomes. Firstly, although pitch errors were almost universally corrected, following one of three previously described strategies, rhythm errors went uncorrected by all but one student. Other results indicated that, generally, students did not make use of reduced tempo as a strategy to be used on repeated drill following performance errors. While students slowed their pace during the piece at the difficult sections or as they made errors, they rarely reduced tempo before beginning repeated rehearsal. It is concluded from this that some students had neither thought about the ways in which rhythm errors should be addressed, if in fact they recognised them, nor that slowing the tempo would give them time to think ahead as they practised.

The measure Self-Directed Physical Practice was shown to influence Performance Outcomes by a correlation of $r=.63$. The data show that those students who adopted flexible strategies during physical practice, and who were applying metacognitive processes during rehearsal, reached higher levels of performance.
proficiency. Students, therefore, who rehearsed mechanically rather than selectively applying particular strategies for specific purposes, made less progress than those who were more cognitively involved. This study did not attempt to judge whether any particular strategies were more effective than others, for example rehearsing hands separately as opposed to being in coordination. Rather, it was concerned with determining whether selecting different strategies for specific purposes was more effective than following a fixed set.

Self-Directed Physical Practice also influenced other outcomes as can be seen in Figure 6.10.

![Figure 6.10](image)

Relationship between psychomotor practice behaviours and outcomes

Students who were able to think about the effectiveness of their strategies and to alter them during physical practice also made greater progress in learning new pieces (Repertoire Progress). If one is able to change procedures according to the particular problem and select those which prior experience has shown to be
successful, one would expect learning to be enhanced. For example, the student who fumbled at a particular bar but continued repeated drill without either isolating the difficult section or reducing the tempo would be less likely to master works as quickly as the student who did. It is concluded that individual students will find some strategies more effective than others, and these may be different across students, but it seems that flexibility of approach is essential to affect instrumental progression.

These strategies also seem to have influenced students' ability to sight read. Students who were alert during their practice used some of the same strategies during sight reading. Sight reading has previously been defined as the first rehearsal of a previously unseen work but when the piece is replayed, sight reading becomes rehearsal. The skills are clearly similar, the major difference being that on repeated rehearsal the music becomes more familiar. It is therefore not surprising that strategies applied in Self-Directed Physical Practice influenced Sight Reading Ability.

There was also a positive relationship between Self-Directed Physical Practice and Accumulated Practice ($r=.38$). It is possible that for this group of students, those who adopted flexible practice methods devoted more time to practice because the variability of their behaviours created motivation which led to progress.

From Figure 6.10 there appears to be sufficient evidence to suggest that flexibility during practice (Self-Directed Physical Practice) results in increased levels of Performance Achievement, Repertoire Progress, and Sight Reading Ability.
6.5.3 Computer Aided Learning

*Instructional and motivational use of the MT100*

The final section of Question 5 explores student use of the MT100 to assess whether particular strategic use of the computer affected performance achievement. Results described in Chapter Five showed that although students used the MT100 for both instructional and motivational purposes, greater use was made of its instructional capabilities. Despite the generally held belief and assertions in the literature that students will use the sequencer software and synthesisers for their entertainment value rather than educational reasons, this was not supported by the results. In the analysis of the affect of the MT100, when used for instructional purposes, instrumental performance outcomes were affected positively.

The extent to which students made progress in extending their repertoire of pieces was also influenced by instructional use of the computer. Students had access to the software demonstration models of works from all of the music tutors so they were not prevented from learning new pieces because the instructor had not introduced or modelled them. Having access to the software had two advantages. Firstly, students could progress at their own rate without being inhibited by the slower progress of their peers. They could use the demonstrations in the manner in which the instrumental teacher would have modelled the works, and provide themselves with feedback by rehearsing simultaneously with the model to assess accuracy of performance.

The second advantage was being able to select any pieces to learn. This gave students flexibility in their choice of repertoire. In personal discussion and through journal entries, students frequently expressed their reasons for rehearsing certain pieces more than others. Sometimes it was because some works were easier than others but more commonly it was because they particularly enjoyed the pieces even if they were more difficult. The second advantage of having the
The extent to which students made use of the MT100 for instructional purposes impacted on Performance Achievement. That students had access to the demonstration models of the complete repertoire which they could use for a range of purposes was no guarantee that they would use it. Nor could it be assumed that it would be used effectively. In Figure 6.3 it was shown that neither Ability to use Computers nor Attitude to Computers significantly correlated with either Instructional or Motivational use of the MT100 so students were not inhibited by these predispositions.
It was also known that students were competent in using the MT100 because they had to self-record practice sessions which were saved to disk. Therefore neither students' predisposition of attitude nor ability to use the MT100 affected their use of the sequencer. The reasons for some students not making greater use of it as an aid during practice are unclear but that it influenced Performance Achievement for those who did is shown in Figure 6.11. Of greater interest is that when the MT100 was used for instructional purposes it affected Performance Achievement, (observed measures r= .38 and self-reported measure r=.39) whereas there was no significant relationship between motivational applications and Performance Achievement.

Each of the four measures of use of the MT100 showed positive relationships with Accumulated Practice. There was a high correlation between Self-Reported Motivation use of MT100 (.75) so those students who were motivated by the computer's enhancements such as accompaniment rehearsed more. However, it does not follow that this increased time resulted in increased Performance Achievement. In fact, it will be shown later in this chapter that, when the interrelationship of Outcomes variables are explained, there was no significant correlation between Accumulated Practice and Achievement. Students may have been motivated by the computer and devoted more time to practice but this did not necessarily result in increased performance achievement.

6.5.4 Practice

Significance of Practice

While every student acknowledged the importance of practice for progress to occur, there was a small number, three, who nevertheless attributed instrumental success primarily to ability. The accumulated practice times of two of these three students were well below the mean. This supports other research studies which
have shown that students are less likely to rehearse when they attribute performance success to ability rather than effort.

Accumulated Practice

Student attitude to practice, as expressed in their journals, was reported in the previous paragraph. It was considered that another measure, total amount of recorded practice times during the study, as recorded in the time schedule, would also reflect positive attitudes to practice. The results of Accumulated Practice and the dispersion across the 14 weeks were provided in Chapter Five showing the wide disparity between those who rehearsed the most and the least. Several students commented that they would like to have done more practice but pressure from other university studies prevented them from doing so. Nevertheless there was a core of students who rehearsed considerably more than others.

In looking at the variables connected with Accumulated Practice Time it was found that there was no significant correlation with Performance Achievement. Students, therefore, who rehearsed more than their peers did not necessarily achieve higher levels of performance outcomes. This suggests that it is quality of practice, particularly thinking practice, which is more effective than quantity of practice which is mechanical and unplanned. There is also another point to consider. According to Ericsson, Tesch-Romer and Krampe (1993) there is a tendency for some advanced instrumentalists to deliberately underestimate actual practice time to emphasise ability rather than effort. While this is unlikely for this group of beginner instrumentalists, it is noted.

In relation to amount of practice and use of the technology, there were several measures which were related and these are to be discussed next.
6.5.5 Computer Aided Practice

Attitude to MT100

Computer Aided Practice was found to be influenced by each of the measures taken on applications of the MT100 during the study (Computer Aided Learning). The scale, Computer Aided Practice, was drawn from a questionnaire given to students in the final week of the study. Students were asked to evaluate the effectiveness of the MT100 as a tool for assisting their private rehearsal sessions (see Table 4.14). Those who expressed positive attitudes to the MT100 were shown to have used it for both instructional and motivational purposes which correlated positively with the Computer Aided Practice measure (see Figure 6.11). The levels at which students were observed using the MT100 for instructional and motivational purposes as well as their self-reported levels were reflected in their stated attitudes to the sequencer.

As reported in Chapter Five (Table 5.5) all students used the sequencer software for self-recording, monitoring self-recording, and for analysis of performance. However, the most significant use was made of the facility to preview previously unheard pieces by listening to the demonstration model before playing, more than half the students agreeing that they used it frequently. Clearly they valued this particular facility of the MT100.

6.6 OUTCOMES

While the answers to “Were performance outcomes affected by particular practice strategies?” were provided by the previous section, the extent to which Outcomes measures were interconnected is now to be explored (See Figure 6.12).

6.6.1 Interrelationship of outcomes variables

Performance Achievement and Repertoire Progress were moderately correlated ($r=.57$). Some students spent so much trying to perfect their beginning pieces they
did not learn as many new works as other students. While accuracy of performance is important, the opportunities for reinforcing new skills are missed when students remain on the simpler pieces for too long.

Sight Reading was also connected to Performance Achievement which some instrumental teachers might predict. The more efficiently the beginner reads the music score for the first time, the fewer trials will be needed to reach mastery and the faster progress is likely to be. Previous research has also suggested that sight reading ability is a reliable predictor of performance achievement. Furthermore, it appears to be a skill which would be enhanced if specifically taught. Given the connection found in this study between Performance Achievement of instrumentalists in the very early stages of learning and Sight Reading (r=.5), further support is given to the need for instruction in sight reading techniques.

![Diagram of Outcomes]

**Figure 6.12** Interrelationship of outcomes variables
A connection was also found between Repertoire Progress and Sight Reading Ability. Those students who were more competent at sight reading learned a greater number of pieces than those who were not so efficient. From these results it is clear that ability to sight read results in both accuracy of performance and extended repertoire.

The only other relationship in Outcomes measures was Significance of Practice with Accumulated Practice. Most students stated that practice was important and for some this was reflected in the amount of practice recorded over the period of the study.

6.7 QUESTION 6

WAS THE RELATIONSHIP BETWEEN PRACTICE STRATEGIES AND PERFORMANCE OUTCOMES MODERATED BY THE INFLUENCE OF STUDENT PREDISPOSITION?

The purpose of Question 6 was to explore the more complex association shown to exist between student predisposition (Entry Skills), Practice Behaviours and Outcomes. There was no significant relationship between Ability to use Computers and Outcomes. Attitude to Computers connected significantly to the Outcomes measure Attitude to the MT100 as a means of aiding practice ($r = .39$) however it did not correlate significantly with any measure related to Practice Behaviours. Therefore it can be said that the incoming measure of student Attitude to Computers did not influence the Outcomes measures according to the way students practised.

Aural Aptitude, however, showed some correlation. In direct connection with Performance Achievement, it correlated 0.36. Of greater significance was that it influenced Performance Achievement through the Practice Behaviour Self-
Regulated Learning Items measure \( r = .47 \) which in turn influenced Repertoire Progress \( r = .7 \), Accumulated Practice Time \( r = .45 \), and Attitude to Practice \( r = .51 \). In answer to Question 6 it can therefore be stated that there was a relationship between practice behaviours and performance outcomes with practice behaviours in turn influenced by Aural Aptitude.

The final Entry Skills behaviour was Music Experience. This variable and the Outcomes measure Repertoire Progress were connected to a moderate level of significance \( r = .55 \). Music Experience correlated with the Practice Behaviour Self-Regulated Learning Items with \( r = .49 \). Since Self-Regulated Learning Items were connected with Performance Achievement, as stated in the previous paragraph, Outcomes were influenced by Practice Behaviours which were in turn influenced by the measure Music Experience (see Figure 6.13).

Figure 6.13  The moderating influence of entry skills through practice behaviours on outcomes
From the results of these measures it appears that for the subjects in this study performance outcomes and attitudes were influenced by how students practised which in turn was affected by the aural aptitude and prior music experiences they evidenced prior to the commencement of the study.

This concludes the discussion and analysis of results as they relate to questions 4, 5, and 6. In Chapter Seven, general conclusions drawn from the study including further questions which are prompted by the results will be discussed together with recommendations for future research.
CHAPTER SEVEN
SUMMARY, DISCUSSION AND IMPLICATIONS

7.1 INTRODUCTION
The purpose of this study, as described in Chapter One, was to explore the physical and cognitive characteristics of the practice behaviours of a group of novice instrumentalists. More specifically, it aimed to identify those students who were metacognitively active participants in their own learning and to determine the influence of metacognition on performance achievement.

The need for the study was based on the knowledge that, currently, there are no means of determining which beginning instrumentalists will become successful performers. Neither measures of general intelligence nor music tests which purport to identify musical ability have been found to be useful predictors. Recent emphasis in the literature on skills development in music, and to a more significant degree in sports, has created interest in practice. However, how instrumentalists practise, most particularly beginners who are naive in the manner of practice, has been previously unexplored. A further problem is that there is no clear understanding of what constitutes practice.

Although in the past, practice has been assumed to take place and taken for granted by instrumental teachers, it has generally been an invisible aspect of instrumental teaching and learning. The purpose of this dissertation was to make visible the practice behaviours of a group of keyboard performers. It was the intention to explore not only how these students physically practised, but also how they thought about practice and what effects this had on achievement. The central question guiding this study was "how can one characterise the effects of
practice strategies on the performance outcomes of this group of novice performers?"

Lack of prior research has left instrumental teachers without research-based evidence of the means by which they might most effectively assist their students in strategic practice planning. Because few teachers have monitored their students' private practice sessions, they are unable to determine the most effective strategies and how they can best lead their students to the attainment of optimal performance achievement.

The researcher did not begin with specific hypotheses but did use an overall conceptual model to explore a series of research questions. Her experience in her own practice, one prior study, and discussions with other instrumental teachers and students, led her to suspect that metacognitive engagement could hold the key to the question. Although psychomotor practice is clearly a fundamental component of instrumental practice, routine drill and practice might be considerably less effective than physical practice which is founded on reflection and planning. Notwithstanding the underlying considerations of metacognitive effect, because of the dearth of previous research, the writer considered it important to spread as wide a net as possible to capture potential influences on practice.

The results of this exploratory study, which were detailed in Chapters Five and Six, led to several conclusions which are now postulated. It is acknowledged that they are generalisable to a restricted population, given the nature of the sample studied, but they might be generalised to novice instrumentalists in Australian teacher education courses and they suggest further research on other populations.
7.2 MAJOR OUTCOMES OF THE STUDY

7.2.1 Student predisposition

There was a moderate correlation between Aural Aptitude and Self-Regulated Learning which leads the writer to suggest that auditory perception and discrimination may be facilitating factors for students to engage metacognitively in practice. The measure of Music Experience also evidenced a moderate connection with Self-Regulated Learning leading one to propose that, through prior instrumental music experience, students have acquired some skills in self-directed learning. Recognition of the importance of auditory aptitude and prior music experiences on self-regulated learning during practice is notable particularly because Performance Achievement was itself influenced by the self-regulated learning capacity of students. (See Figure 7.1).

Figure 7.1 Influence of predisposition on self-regulation

7.2.2 Metacognitive Practice

Based on the results of this study, there is strong evidence to suggest that among the students in this study, there was a group who were metacognitively active participants in practice. Furthermore, the research evidence shows that students in this group were the more successful achievers in performance outcomes.
In reflecting on the outcomes of the study, it is clear that the potential of many students to be reflective, analytical, and self-directed may, in the past, have been under-estimated. Despite the instrumental naivety of this group of students, several showed a capacity to report extensively on how they cognitively planned and analysed practice across several dimensions.

From past praxis, there has been a tacit implication that beginners learn primarily by rote, and drill and practice. It was found in this study, following analysis of journal entries, that some students were capable of thinking quite broadly and deeply about both practice and progress. This reflection was sometimes prompted by researcher questions but generally students wrote spontaneously about their thoughts on progress or lack thereof. Despite being untaught in practice procedures, some students demonstrated considerable capacity for perceptive analysis, even to the point of verbalising that they understood their minds knew what to do even though their hands often failed to respond. These students clearly did not rely on repetitive, mechanical practice alone.

Students’ ability to articulate their thoughts about practice highlighted the potential beginners had to apply metacognitive processes to their practice. For example, they recognised that to practise when fatigued was not productive, that trying new and diverse strategies was important for progress, and that analysis was critical to effective strategy selection. In relation to computer assisted practice, they acknowledged that the sequencer was an aid for both motivational and instructional purposes. One student astutely observed that “practice” and “playing” were different.

Many students were able to define which strategies and conditions were personally most effective. This they based on the selection of different strategies which they found had previously yielded results. There was also a core of students
identified as independent learners because they demonstrated the capacity to learn new pieces independently, that is, without teacher instruction or assistance.

Another interesting finding in this study was that some students were able to be identified as self-regulated learners. Metacognition is one element in self-regulation. Based on analysis of journal entries, students’ level of self-regulation was evaluated but this was not restricted to students’ cognitive behaviours and the ways in which they described their thinking about practice. Students also demonstrated an ability to self-regulate their psychomotor behaviours through conduct detected during their recorded practice sessions. From analysis of these recordings, some students were identified as self-regulated learners by their modification of strategies during actual practice.

While a core of students consistently practised using the same procedures, mechanically, and without regard to the progress they were making, others used a variety of strategies interchangeably. There was, therefore, a range of behaviours which could be described as self-regulated behaviours and it was found that students’ use of such behaviours was correlated with more successful performance.

Many instrumental teachers suggest there are particular rehearsal strategies which are more effective than others. For example, to play slowly, or to play hands separately are frequently recommended, among other behaviours. This fails to recognise the individuality of students in their preferences for learning or indeed in their capacity to learn in particular ways. What may be effective for one student may be entirely inadequate or inappropriate for another. Furthermore, there is now growing evidence that students demonstrate preferences for using particular modalities in music learning (Dunn, 1994) and the teacher’s role ought to be to help students identify their most appropriate modes of learning. It was
the students in this study who took control of their own practice who were the more successful performers.

The students who were metacognitively active in this study had not been influenced by prior instruction. Therefore, if this can occur fairly naturally in some students (albeit prompted by stimulus questions from the teacher), it is possible that by giving deliberate instruction to all students in a range of thinking strategies to be applied to instrumental practice planning and implementation, metacognition can be used to very positive effect.

This study provides relatively strong evidence that it was metacognitive directed practice which led to performance achievement. Therefore, the importance of teaching students how to become metacognitively engaged throughout practice cannot be over-emphasised.

7.2.3 Influence of Metacognitive Practice on Performance Achievement

There was evidence that performance outcomes were significantly influenced by practice which was metacognitively focussed. Students who used planned practice strategies, who were able to learn repertoire independently of the instructor, and were also identified as self-regulated learners by the diversity and depth of their analysis, were the most successful students. The relative importance of these skills is shown in Figure 7.2.

This was one of the most important findings of the study. Those students who were identified as Self-Regulated Learners achieved higher levels in both performance achievement and repertoire development. Clearly, being able to analyse practice strategies and to be able to put into place effective procedures based on cyclic analysis produced the more positive results.
Another important finding was that students who applied metacognitive control over their psychomotor behaviours also achieved higher levels of performance achievement. Self-Directed Physical Practice measures the extent to which students adjusted their practice strategies during rehearsal. The importance of metacognitive activity during practice was shown by the results reported in Chapter Six. The relative importance comparing it with other metacognitive behaviours is shown in Figure 7.2.

Teaching students to monitor their physical practice and to make adjustments to their strategies, based on practice success, would seem to be more important than suggesting a fixed set of strategies for students to use mechanically during practice sessions. Thinking about practice prior to engaging in it as well as during physical practice itself was shown to be an important element in effective rehearsal.
7.2.4 Sight Reading

Measures of students' performance outcomes were widely distributed and special mention should be made of the interrelated nature of three of the measures of achievement. Earlier research findings have pointed to the influence of sight reading on performance outcomes, though not in the case of beginners. This latter qualification was not supported in this study. Sight reading was shown to influence both performance achievement and repertoire development. The literature also suggests that sight reading ability may be a useful long term predictor of instrumental performance success. Given the importance then of this aspect of instrumental praxis, it is recommended that sight reading be taught as a discrete, though interrelated, skill alongside performance instruction.

In relation to amount of practice, no significant correlation was found between performance achievement and accumulated practice suggesting that it is quality of practice which is the more predominant influence rather than quantity of practice. Students who emphasised verbally the importance of practice did practise more, according to the measure of accumulated practice. However, achievement was not influenced by amount of time. In later discussion, it will be shown that it was indeed the influence of metacognitive behaviour during practice which impacted most on performance achievement.

7.2.5 Computer Aided Practice

Evidence was found that use of the MT100 to aid practice did positively influence performance achievement. The availability of the sequencer during practice did not guarantee that it would be used effectively. For this to occur, there is a need for students to think about how best to use the computer. Although it was considered that students' prior experience with computers and their attitude to computers might affect their preparedness to use it during practice sessions, this
was not found to be the case. Significantly, students who used the computer for instructional purposes made significant gains over those who did not.

Another important finding was that students' use of the computer as an aid to practice was not influenced by prior ability measured at the beginning of the study. It seems that, once students are taught how to use the MT100, competence leads to confidence which will over-ride prior negative attitudes. However, those students who showed positive attitudes towards computers at the commencement of this study were shown to have the most positive attitudes when asked to comment on their perceived value of the MT100 at the conclusion of the study. These are important findings for teachers considering incorporating the use of the sequencer in instrumental music instruction.

Although the literature provides no evidence of investigations on the application of music sequencers, such as the MT100, to aid practice, it has frequently been stated that students generally use the computer, particular enhanced backgrounds, for motivational rather than instructional purposes. In this study, although the majority of the students acknowledged its motivational qualities, observational data confirm that they used the sequencer during practice more extensively for instructional purposes than for self-motivation. The value of the sequencer as an aid during practice sessions, therefore, needs to be recognised and its potential to enhance performance achievement capitalised on. It was highly significant that one of the most used functions of the sequencer was to listen to a demonstration model prior to practice thereby indicating the importance students placed on this facility.

Keyboard teachers generally understand that students experience greater difficulty reaching rhythmic accuracy than pitch precision. From the students' expressed views, it appears that they considered being able to practise simultaneously with a
perfect model via the sequencer an effective means of correcting faulty rhythm. Another interesting finding was that although students consistently made errors, both melodic and rhythmic, on repeated rehearsal, they rarely began at a reduced tempo although they invariably had to slow down at the point of difficulty. If students can be encouraged to begin to practise more slowly, the sequencer will provide tempo reduction, a facility not previously possible with audio tape models. Students then have the opportunity of practising with an accurate model at a tempo commensurate with their existing skill level which can then be incrementally increased as their competence develops.

There was only one student who could find no advantage in using the computer and consequently made little use of it. Her clear preference was for personalised teacher attention. This student had some previous instrumental learning experience and her attitude reflected those found in an earlier study (Weidenbach, 1994:52). For the subjects in that investigation, it appeared that “prior experience of individualised instruction set a model of learning which inhibited the use of a different mode of teaching.” Teachers should therefore not be deterred by the initial resistance of some students to the use of the sequencer for computer aided practice, but recognise its basis in previous experience.

Results displayed in Figure 6.4 (Chapter 6) showed the connection between metacognition and use of the MT100. Students identified as Self-Regulated Learners were found to make greater use of the MT100 for both instructional and motivational purposes. It appears that those who thought deeply about their practice strategies were able to perceive the advantages of using the sequencer and did so. The use of the computer for instructional purposes (though not motivational purposes) was found to influence performance achievement so its use as an aid to practice is supported. The relative value of the computer when used as an aid during practice is shown in Figure 7.2.
7.3 IMPLICATIONS FOR INSTRUMENTAL TEACHERS

There are three major recommendations emanating from this study. They relate to the teaching of practice, particularly metacognitive practice, computer aided practice, and sight reading.

7.3.1 Teaching students about practice

Previous research (Barry & McArthur, 1994; Weidenbach, 1995b) has shown that teachers generally do not discuss practice with their students, nor do they monitor it. When it is discussed, little emphasis is placed on individualised thinking processes but rather generalised strategies are recommended. This study has provided evidence of the importance of practice, particularly that which is metacognitively directed.

There is, therefore, a need for teachers to discuss and teach practice strategies to their students. However, if they recommend particular strategies to students, it would be more sound, pedagogically, to provide students with knowledge of an extensive range of possibilities so students have a range of options with which to experiment. Once these are understood by their students, emphasis should be placed on the importance of individual student selection, according to their understanding of which of these strategies produce the most positive results. Promoting the application of metacognitive processes, rather than a narrowly focussed drill and practice schema, will enable students to take greater responsibility for their own learning. Being self-regulated instrumental learners should lead to increased performance achievement.

7.3.2 Computer Aided Practice

This second set of recommendations relates to computer aided instruction and practice. During lessons, instrumental teachers provide students with accurate models of the music being learned as well as giving feedback on student
performance. When students practise away from the teacher, neither model nor feedback is available. Students may practise inaccurately for a week before they are corrected at their next lesson thereby slowing down their progress. Additionally, they are faced with the more difficult task of un-learning that which is inaccurate.

It is widely known that many piano teachers oppose the use of electronic keyboards and sequencers considering them to be poor substitutes for acoustic instruments. They also consider the modelled performance demonstrations provided by sequencers as mechanical and unmusical.

Given the results of this study whereby the MT100 was found to affect performance achievement positively, as well as the recognition by students that being able to listen to or perform simultaneously with the model led to greater accuracy of performance, teachers need to consider the benefits of this approach. Additionally, most students said they were motivated by the additional enhancements provided by the accompaniments as well as opportunities to manipulate the sequencer models. This motivation may be one means of maintaining the interest of students and reducing the attrition rate, particularly of beginners.

There is also the additional advantage that students' private practice may be recorded and saved to disk which would then be available to teachers for analysis of the practice schema their students use. If teachers could be encouraged to use the technology for its positive benefits, there might be advantages to both their students' progress and teachers' own professional viability.
7.3.3 Sight Reading

The third recommendation to teachers relates to the important aspect of sight reading. Given the outcomes of this study and the connection established between sight reading and performance, it is recommended that teachers pay considerably more attention to the development of this skill, particularly for beginners, than they have in the past. Recent investigations have led to an understanding of the importance of sight reading but to date there is little evidence of it being taught as a specific skill.

Teachers, initially, need to identify the individual skills of sight reading and then provide instruction to their students. They should also go further and teach students how to identify for themselves the means by which they can improve their own sight reading.

The importance of sight reading has been established previously by McPherson (1993) and Sloboda (1993, 1994). The suggestion of Sloboda (1993:88) that sight reading ability is “one of the best predictors of high levels of musical achievement” lends even more support to its importance and should be taken seriously by teachers. Already there is considerable research delineating the chief characteristics of sight reading to which teachers can refer. As a specific skill, it has not received the attention it appears to warrant in terms of the teachers actually providing instruction on its development. This is strongly recommended.

7.4 IMPLICATIONS FOR FUTURE RESEARCH

Lack of prior research on the topic of practice suggests a need for further research. The qualitative nature of this study, and consequently the demands of time involved, need to be considered for future investigations. The results provide some basis from which to develop further studies and it may be that methods which are less intensive may be able to be constructed.
The small population in this study needs to be expanded and, given the number of keyboard/piano teachers in the field - some 700 are currently registered with the NSW Conservatorium of Music as accredited teachers - there is a considerable teacher population from which to draw. A team effort would make it possible to broaden the sample in numbers as well as in diversity of population. Having a variety of teachers involved would enhance the variety of teacher behaviours able to be studied. If researchers were able to work with teachers as co-researchers, in an action research model, a large study focussed on metacognitive behaviours could be attempted.

It would be worthwhile for aspects of the present study to be replicated. Practice is clearly an influential component of instrumental performance development at all levels, not only for beginners, and future studies could also be extended beyond keyboard learners and directed to a diversity of instruments.

It is recommended that studies be conducted over a longer time period to determine whether some metamorphosis takes place as instrumentalists reach increasing levels of expertise. The work of Gruson (1988) has already investigated the practice behaviours of instrumentalists at different stages of development, albeit in quite small numbers, which would provide a baseline from which to work. During longitudinal studies, there would be opportunities to track students who cease instrumental instruction. In this way, it might be possible to determine the reasons for the high levels of attrition which currently exist among beginners.

Within these proposed investigations, there are specific topics which should be explored.
1 There is a need to investigate metacognitive processes in practice more thoroughly, to discover if beginner instrumentalists can be led to self-regulation at an early stage, and to determine whether a generalised model, a practice schema, could be developed. Very few studies have investigated aspects of metacognition in music learning.

2 Some instrumentalists appear to become self-directed during their earliest stages of tuition but there is currently no understanding of whether certain predispositions exist to facilitate this learning state. Do some students develop their own practice schema unaided, and is it the students who are unable to do so who become the instrumental “drop outs”?

3 There is clearly a need to know more about sight reading, what its components are, what particular skills constitute the whole skill, how it can be taught effectively, and to what extent it impacts on instrumental achievement. At what point in an instrumentalist’s development can it be used as a predictor of future excellence if at all?

4 There are a number of questions related to the use of computers in keyboard learning. Is learning with the aid of a sequencer more effective than without? To what extent can its facilities substitute for teacher input, and what are its limitations or disadvantages? Can students be taught more sophisticated skills and hence make more effective use of the MT100 or similar sequencers? Are there any predispositions which influence the potential of a student’s use of the sequencer for instructional purposes?

Many computer packages exist for keyboard learning. Analysis of the effectiveness of these would be useful given the increasing growth in their sales.
There is still little understanding of effectiveness of group keyboard teaching and learning. How effective is it for beginners? Would it be more effective if students were taught more self-regulatory behaviours? What is the optimal time for daily practice for beginners? At what point does fatigue negate progress? How influential is peer interaction?

7.5 CONCLUSIONS

This study has provided some insights into the practice behaviours of a group of young adult keyboard instrumentalists in the earliest stages of their learning. The focus has been on the behaviours demonstrated by students who were not given direction by their instructor on the application of any particular strategies. Existing knowledge of practice and the schemas developed by individual instrumentalists is in its embryonic state and if teachers are to lead students to best praxis in practice, there is a need to know more about the process of effective rehearsal. Discovering how students can tap the potential they have for exerting greater metacognitive control during practice will add to pedagogical knowledge.

As 19th century piano teacher Annie Curwen stated in her principles of pianoforte instruction:

Never tell a pupil anything that you can help him to discover for himself.”

Curwen, 1286 :viii).
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## APPENDIX 1  Student Questionnaire - Attitude toward computers

### STUDENT NAME

Read the statements below, then circle the number which is applicable to you

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strongly disagree</td>
<td>disagree</td>
<td>unsure</td>
<td>agree</td>
<td>strongly agree</td>
</tr>
</tbody>
</table>

1. I feel at ease when I am around computers
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

2. I feel comfortable when a conversation turns to computers
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

3. Learning about computers is boring to me
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

4. I like learning on a computer
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

5. Working with a computer would make me nervous
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

6. I feel aggressive and hostile toward computers
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

7. Computers make me feel uncomfortable
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

8. I get a sinking feeling when I think of trying to use a computer
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

9. I would feel comfortable working with a computer
   1. Strongly disagree | disagree | unsure | agree | strongly agree |

10. Computers make me feel uneasy and confused
    1. Strongly disagree | disagree | unsure | agree | strongly agree |

11. I'm not the type to do well with computers
    1. Strongly disagree | disagree | unsure | agree | strongly agree |
<p>| | |</p>
<table>
<thead>
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<th></th>
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<tbody>
<tr>
<td>12</td>
<td>I would like working with computers</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>13</td>
<td>The challenge of solving problems with computers does not appeal to me</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
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<tr>
<td>14</td>
<td>I think working with computers would be enjoyable and stimulating</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
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<tr>
<td>15</td>
<td>I do not enjoy talking with others about computers</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>16</td>
<td>Learning about computers is interesting</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>17</td>
<td>I enjoy using a computer</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>18</td>
<td>Computers are boring</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>19</td>
<td>Learning about computers is something I can do without</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>20</td>
<td>Computers are not exciting</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>21</td>
<td>Studying about computers is a waste of time</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>22</td>
<td>It is fun to figure out how computers work</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>23</td>
<td>Learning about the different uses of computers is interesting</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>24</td>
<td>I enjoy learning how computers are used in our daily lives</td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>
### Self-Regulated Learning Strategies

<table>
<thead>
<tr>
<th>Categories/Strategies</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Self-evaluating</td>
<td>Statements indicating student initiated evaluations of the quality or progress of their work; e.g., “I check over my work to make sure I did it right.”</td>
</tr>
<tr>
<td>2. Organising and transforming</td>
<td>Statements indicating student initiated overt or covert rearrangements of instructional materials to improve learning; e.g., “I make an outline before I write my paper.”</td>
</tr>
<tr>
<td>3. Goal-setting and planning</td>
<td>Statements indicating students’ setting of educational goals or sub-goals and planning for sequencing, timing, and completing activities related to those goals; e.g., “First, I start studying two weeks before exams, and I pace myself.”</td>
</tr>
<tr>
<td>4. Seeking information</td>
<td>Statements indicating student-initiated efforts to secure further task information from nonsocial sources when undertaking an assignment; e.g., “Before beginning to write the paper, I go to the library to get as much information as possible concerning the topic.”</td>
</tr>
<tr>
<td>5. Keeping records and monitoring</td>
<td>Statements indicating student-initiated efforts to record events or results; e.g., “I took notes of the class discussions; “I kept a list of the words I got wrong.”</td>
</tr>
<tr>
<td>6. Environmental structuring</td>
<td>Statements indicating student-initiated efforts to select or arrange the physical setting to make learning easier; e.g., “I isolate myself from anything that distracts me”; “I turned off the radio so I can concentrate on what I am doing.”</td>
</tr>
<tr>
<td></td>
<td>Self-consequating</td>
</tr>
<tr>
<td>---</td>
<td>-------------------</td>
</tr>
<tr>
<td>8.</td>
<td>Rehearsing and memorizing</td>
</tr>
<tr>
<td>9-11.</td>
<td>Seeking social assistance</td>
</tr>
<tr>
<td>12-14.</td>
<td>Reviewing records</td>
</tr>
<tr>
<td>15.</td>
<td>Other</td>
</tr>
<tr>
<td>PERFORMANCE # 1 - ISM</td>
<td>Score</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
</tr>
<tr>
<td>1 The pitch was accurate</td>
<td>3 2 1</td>
</tr>
<tr>
<td>2 The rhythm was accurate</td>
<td>3 2 1</td>
</tr>
<tr>
<td>3 The tempo was musically satisfying</td>
<td>3 2 1</td>
</tr>
<tr>
<td>4 The expression marks were observed</td>
<td>3 2 1</td>
</tr>
<tr>
<td>5 Phrasing, technique and style were effectively used</td>
<td>3 2 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PERFORMANCE # 2 - Microjazz</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The pitch was accurate</td>
<td>3 2 1</td>
</tr>
<tr>
<td>2 The rhythm was accurate</td>
<td>3 2 1</td>
</tr>
<tr>
<td>3 The tempo was musically satisfying</td>
<td>3 2 1</td>
</tr>
<tr>
<td>4 The expression marks were observed</td>
<td>3 2 1</td>
</tr>
<tr>
<td>5 Phrasing, technique and style were effectively used</td>
<td>3 2 1</td>
</tr>
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<table>
<thead>
<tr>
<th>PERFORMANCE # 3 - Joy</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The pitch was accurate</td>
<td>3 2 1</td>
</tr>
<tr>
<td>2 The rhythm was accurate</td>
<td>3 2 1</td>
</tr>
<tr>
<td>3 The tempo was musically satisfying</td>
<td>3 2 1</td>
</tr>
<tr>
<td>4 The expression marks were observed</td>
<td>3 2 1</td>
</tr>
<tr>
<td>5 Phrasing, technique and style were effectively used</td>
<td>3 2 1</td>
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**PERFORMANCE # 4 - Own choice**

<table>
<thead>
<tr>
<th></th>
<th>The pitch was accurate</th>
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<tr>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
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<td>The tempo was musically satisfying</td>
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<tr>
<td>4</td>
<td>The expression were observed</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Phrasing, technique and style were effectively used</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
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**PERFORMANCE # 5 - Own choice**

<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>The rhythm was accurate</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>The tempo was musically satisfying</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>4</td>
<td>The expression marks were observed</td>
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<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Phrasing, technique and style were effectively used</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
**SIGHT READING**

1. The pitch was accurate
   5 4 3 2 1

2. The rhythm was accurate
   5 4 3 2 1

3. The tempo was musically satisfying
   5 4 3 2 1

4. The expression marks were observed
   5 4 3 2 1

5. Phrasing, technique and style were effectively used
   5 4 3 2 1

---

**SCANNING**

Number of notes played after the score was covered

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**WEIGHTING**

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**SUM**

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APPENDIX 4  Practice Log - Weeks 1 to 14.

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[Students were provided with a complete Practice Log for 14 weeks].