

## INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

**The quality of this reproduction is dependent upon the quality of the copy submitted.** Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

# UMI

A Bell & Howell Information Company  
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA  
313/761-4700 800/521-0600



**AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN PERFORMANCE-  
BASED AURAL MUSICIANSHIP, MUSIC ACHIEVEMENT, AND  
SOCIALIZATION OF FIRST-YEAR MUSIC MAJORS**

**by**

**Molly Ann Weaver**

**A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy  
(Music: Music Education)  
in The University of Michigan  
1996**

**Doctoral Committee:**

**Professor James O. Froseth, Chair  
Professor Duane F. Alwin  
Professor Paul R. Lehman  
Assistant Professor Barton Polot**

**UMI Number: 9712117**

---

**UMI Microform 9712117**  
**Copyright 1997, by UMI Company. All rights reserved.**

**This microform edition is protected against unauthorized  
copying under Title 17, United States Code.**

---

**UMI**  
**300 North Zeeb Road**  
**Ann Arbor, MI 48103**

The [music] profession is indeed carried on by people . . . who have forgotten the human ear. Its pattern of education denies the only logical starting point for a genuinely creative art of music—the ear, and the manifold delights and stimuli that the ear, in conjunction with the experienced mind, can find in the exercise of imagination.

Harry Partch, 1948

© Molly Ann Weaver 1996  
All Rights Reserved

**To my parents,  
Marie and James Weaver**

## **ACKNOWLEDGEMENTS**

**The writer would like to express sincere gratitude to:**

**Professor James Froseth, mentor and friend, for his thoughtful guidance and warm encouragement, and for his peerless ability to identify and address critical issues in music education**

**Professor Duane Alwin, for his genuine interest in music education, and for his contributions to my development through the Institute for Social Research**

**Professor Judith Becker, for her model of pedagogy, for her contributions to my understanding of music as a cultural phenomenon, and for her inspiration of me to examine music education through several lenses**

**Professor Paul Lehman, for his model of scholarship, for his contributions to my development throughout my years of graduate study, and for his staunch advocacy of music education**

**Professor Barton Polot, for his model of critical reading and careful editing, for his technological expertise in music education, and for his valuable counsel and friendship**

**Professor Ralph Lewis and Professor Walter Everett, for their encouragement of all first-year students enrolled in music theory to participate in this study**

**Professor Joanne Smith, Ms. Kelley Benson, and Class Piano Graduate Student Teaching Assistants, for their facilitation of the computer-assisted keyboard training portion of this study**

**Mr. Roger Arnett, Ms. Patti Eyre, Mr. Michael Gould, and Mrs. Janet Schweizer, for their facilitation of numerous aspects of this study**

**University of Michigan School of Music first-year students, for their willingness to participate in this study**

**University of Michigan Alumnae Council, Center for the Education of Women, and Horace H. Rackham Graduate School, for their financial assistance**

**Dean Emeritus Allen and Mrs. Veronica Britton, for their financial assistance, and for their continued interest in my work**

**University of Michigan graduate students in music education during my years in residence as a doctoral student, for their steadfast support and friendship**

**My West Virginia University music education colleagues, for their collegiality, and for their contributions to a vital professional environment**

**Members of my family, for their love, encouragement, support, and understanding**

**Thank you.**

## TABLE OF CONTENTS

|                                                                                  |     |
|----------------------------------------------------------------------------------|-----|
| DEDICATION .....                                                                 | ii  |
| ACKNOWLEDGEMENTS.....                                                            | iii |
| LIST OF TABLES.....                                                              | ix  |
| LIST OF APPENDICES .....                                                         | xii |
| CHAPTER                                                                          |     |
| I. INTRODUCTION .....                                                            | 1   |
| Purpose of the Study                                                             | 5   |
| Problems of the Study                                                            | 5   |
| Need for the Study                                                               | 11  |
| Performance-Based Aural Musicianship and Music Achievement                       | 11  |
| Performance-Based Aural Musicianship and Socialization                           | 14  |
| Statement of Research Questions                                                  | 16  |
| Limitations of the Study                                                         | 17  |
| Definition of Terms                                                              | 17  |
| Summary                                                                          | 19  |
| II. REVIEW OF RELATED RESEARCH .....                                             | 20  |
| Introduction                                                                     | 20  |
| Performance-Based Aural Musicianship                                             | 20  |
| Summary                                                                          | 25  |
| Computer-Assisted Aural Skills Training                                          | 25  |
| Summary                                                                          | 37  |
| Music Achievement                                                                | 39  |
| Music History, Aural Music Theory, Written Music Theory, or Class Piano Outcomes | 40  |
| Other Outcomes                                                                   | 46  |
| Summary                                                                          | 48  |
| Socialization of Students Majoring in Music                                      | 49  |
| Summary                                                                          | 54  |
| Summary                                                                          | 55  |
| Comparison and Contrast of Present Study to Related Research                     | 56  |

|                                                             |           |
|-------------------------------------------------------------|-----------|
| <b>III. METHODS AND PROCEDURES .....</b>                    | <b>57</b> |
| Introduction                                                | 57        |
| Design of the Study                                         | 57        |
| Selection of Participants for the Study                     | 59        |
| First-Year Students Majoring in Music                       | 59        |
| Computer-Assisted Keyboard Ear-to-Hand                      |           |
| Coordination Training Subjects                              | 59        |
| Case Study Subjects                                         | 60        |
| Procedures Employed to Gather Student Descriptive           |           |
| Data                                                        | 60        |
| Procedures Employed to Gather Student Music                 |           |
| Achievement Data                                            | 61        |
| Music History, Aural Music Theory, Written Music            |           |
| Theory, and Class Piano                                     | 61        |
| Instrumental Ear-to-Hand Coordination                       | 61        |
| The Measure of Instrumental Ear-to-Hand                     |           |
| Coordination                                                | 62        |
| The Computer-Assisted Keyboard Ear-to-Hand                  |           |
| Coordination Training Opportunity                           | 65        |
| The Computer-Assisted Training Groups                       | 65        |
| The Computer-Assisted Training Content                      | 66        |
| The Computer-Assisted Training Delivery                     | 67        |
| Procedures Employed to Gather Student Socialization         |           |
| Data                                                        | 68        |
| The Case Study Method                                       | 69        |
| Interviews, Observations, and Journals                      | 70        |
| <b>IV. PRESENTATION AND INTERPRETATION OF THE DATA.....</b> | <b>71</b> |
| Descriptive Data for First-Year Students Majoring in        |           |
| Music                                                       | 71        |
| Instrumental Ear-to-Hand Coordination Data for First-       |           |
| Year Students Majoring in Music                             | 73        |
| First Term Music History, Aural Music Theory, Written       |           |
| Music Theory, and Class Piano Achievement Data              |           |
| for First-Year Students Majoring in Music                   | 77        |
| Relationships Between Instrumental Ear-to-Hand              |           |
| Coordination and Achievement in First Term Music            |           |
| History, Aural Music Theory, Written Music Theory,          |           |
| and Class Piano for First-Year Students Majoring in         |           |
| Music                                                       | 79        |
| Descriptive Data for Ear-to-Hand Training Subjects          | 81        |
| Pre-Training Instrumental Ear-to-Hand Coordination          |           |
| Data for Ear-to-Hand Training Subjects                      | 84        |
| First Term (Pre-Training) Music History, Aural Music        |           |
| Theory, Written Music Theory, and Class Piano               |           |
| Achievement Data for Ear-to-Hand Training                   |           |
| Subjects                                                    | 87        |

|                                                                                                                                                                                                                                        |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Relationships Between Instrumental Ear-to-Hand Coordination (Pretest Score) and Achievement in First Term (Pre-Training) Music History, Aural Music Theory, Written Music Theory, and Class Piano for Ear-to-Hand Training Subjects    | 89  |
| Effects of Computer-Assisted Keyboard Ear-to-Hand Training                                                                                                                                                                             | 91  |
| “Test of Melodic Ear-to-Hand Coordination” (TMEHC) Pretest, Posttest, and Gain Scores                                                                                                                                                  | 91  |
| “Test of Melodic Ear-to-Hand Coordination” (TMEHC) Pretest and Posttest Mean Scores                                                                                                                                                    | 93  |
| “Test of Melodic Ear-to-Hand Coordination” Posttest Mean Scores by Grouped Principal Performance Medium                                                                                                                                | 94  |
| Relationships Between Instrumental Ear-to-Hand Coordination (Posttest Score) and Achievement in Second Term (Post-Training) Music History, Aural Music Theory, Written Music Theory, and Class Piano for Ear-to-Hand Training Subjects | 97  |
| Descriptive Data for Case Study Subjects                                                                                                                                                                                               | 101 |
| Christopher                                                                                                                                                                                                                            | 101 |
| Joanna                                                                                                                                                                                                                                 | 102 |
| Kelly                                                                                                                                                                                                                                  | 102 |
| Carrie                                                                                                                                                                                                                                 | 102 |
| Instrumental Ear-to-Hand Coordination Data for Case Study Subjects                                                                                                                                                                     | 103 |
| Music History, Aural Music Theory, Written Music Theory, and Class Piano Achievement Data for Case Study Subjects                                                                                                                      | 104 |
| Christopher                                                                                                                                                                                                                            | 104 |
| Joanna                                                                                                                                                                                                                                 | 105 |
| Kelly                                                                                                                                                                                                                                  | 106 |
| Carrie                                                                                                                                                                                                                                 | 107 |
| Interviews, Observations, and Journals of Case Study Subjects                                                                                                                                                                          | 107 |
| Christopher                                                                                                                                                                                                                            | 108 |
| Professor Armando Ghitalla                                                                                                                                                                                                             | 108 |
| Joanna                                                                                                                                                                                                                                 | 109 |
| Professor Stuart Sankey                                                                                                                                                                                                                | 110 |
| Kelly                                                                                                                                                                                                                                  | 110 |
| Professor Leslie Guinn                                                                                                                                                                                                                 | 112 |
| Carrie                                                                                                                                                                                                                                 | 112 |
| Graduate Student Teaching Assistant Gina Hart-Kemper                                                                                                                                                                                   | 113 |
| Relationships Between Deficiencies in Instrumental Ear-to-Hand Coordination; Achievement in Music History, Aural Music Theory, Written Music Theory, and Class Piano; and Socio-Musical Self-Esteem of Case Study Subjects             | 113 |

|                                                                                     |            |
|-------------------------------------------------------------------------------------|------------|
| Christopher                                                                         | 114        |
| Joanna                                                                              | 115        |
| Kelly                                                                               | 117        |
| Carrie                                                                              | 118        |
| <b>V. SUMMARY AND CONCLUSIONS .....</b>                                             | <b>120</b> |
| Purpose of the Study                                                                | 120        |
| Problems of the Study                                                               | 120        |
| Design of the Study                                                                 | 121        |
| Selection of Participants for the Study                                             | 122        |
| Procedures Employed to Gather Student Descriptive<br>and Music Achievement Data     | 122        |
| Procedures Employed to Gather Student Instrumental<br>Ear-to-Hand Coordination Data | 123        |
| The Computer-Assisted Keyboard Ear-to-Hand<br>Coordination Training Opportunity     | 124        |
| Procedures Employed to Gather Student Socialization<br>Data                         | 125        |
| Results                                                                             | 126        |
| Conclusions                                                                         | 133        |
| Implications for Music Education                                                    | 134        |
| Recommendations for Further Research                                                | 135        |
| <b>APPENDICES .....</b>                                                             | <b>137</b> |
| <b>BIBLIOGRAPHY .....</b>                                                           | <b>180</b> |

## LIST OF TABLES

### Table

|                                                                                                                                                                                                                                                                                   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 1. FALL TERM 1982 FIRST-YEAR STUDENT "TEST OF MELODIC<br>EAR-TO-HAND COORDINATION" (TMEHC) SCORES BY<br>GROUPED PRINCIPAL PERFORMANCE MEDIUM.....                                                                                                                                 | 7  |
| 2. FALL TERM 1991 FIRST-YEAR STUDENT "TEST OF MELODIC<br>EAR-TO-HAND COORDINATION" (TMEHC) SCORES BY<br>GROUPED PRINCIPAL PERFORMANCE MEDIUM.....                                                                                                                                 | 9  |
| 3. GENDER OF FIRST-YEAR STUDENTS MAJORING IN MUSIC .....                                                                                                                                                                                                                          | 71 |
| 4. ETHNICITY OF FIRST-YEAR STUDENTS MAJORING IN MUSIC .....                                                                                                                                                                                                                       | 72 |
| 5. MAJOR CONCENTRATION (PROGRAM) OF FIRST-YEAR<br>STUDENTS MAJORING IN MUSIC .....                                                                                                                                                                                                | 72 |
| 6. GROUPED PRINCIPAL PERFORMANCE MEDIUM OF FIRST-<br>YEAR STUDENTS MAJORING IN MUSIC.....                                                                                                                                                                                         | 73 |
| 7. "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)<br>MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE<br>MEDIUM OF FIRST-YEAR STUDENTS MAJORING IN<br>MUSIC .....                                                                                                                 | 74 |
| 8. ANALYSIS OF VARIANCE (ANOVA) FOR "TEST OF MELODIC<br>EAR-TO-HAND COORDINATION" (TMEHC) MEAN SCORES<br>BY GROUPED PRINCIPAL PERFORMANCE MEDIUM OF<br>FIRST-YEAR STUDENTS MAJORING IN MUSIC .....                                                                                | 76 |
| 9. FIRST TERM MUSIC HISTORY, AURAL MUSIC THEORY,<br>WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES<br>OF FIRST-YEAR STUDENTS MAJORING IN MUSIC.....                                                                                                                                 | 78 |
| 10. PEARSON PRODUCT-MOMENT CORRELATION<br>COEFFICIENTS FOR "TEST OF MELODIC EAR-TO-HAND<br>COORDINATION" (TMEHC) SCORES AND FIRST TERM<br>GRADES IN MUSIC HISTORY, AURAL MUSIC THEORY,<br>WRITTEN MUSIC THEORY, AND CLASS PIANO OF FIRST-<br>YEAR STUDENTS MAJORING IN MUSIC..... | 80 |

|                                                                                                                                                                                                                                                                                                 |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 11. GENDER OF EAR-TO-HAND TRAINING SUBJECTS.....                                                                                                                                                                                                                                                | 82 |
| 12. ETHNICITY OF EAR-TO-HAND TRAINING SUBJECTS.....                                                                                                                                                                                                                                             | 83 |
| 13. MAJOR CONCENTRATION (PROGRAM) OF EAR-TO-HAND<br>TRAINING SUBJECTS .....                                                                                                                                                                                                                     | 83 |
| 14. GROUPED PRINCIPAL PERFORMANCE MEDIUM OF EAR-TO-<br>HAND TRAINING SUBJECTS.....                                                                                                                                                                                                              | 84 |
| 15. "TEST OF MELODIC EAR-TO-HAND COORDINATION"<br>(TMEHC) PRETEST MEAN SCORES BY GROUPED<br>PRINCIPAL PERFORMANCE MEDIUM OF EAR-TO-HAND<br>TRAINING SUBJECTS .....                                                                                                                              | 85 |
| 16. ANALYSIS OF VARIANCE (ANOVA) FOR "TEST OF MELODIC<br>EAR-TO-HAND COORDINATION" (TMEHC) PRETEST MEAN<br>SCORES BY GROUPED PRINCIPAL PERFORMANCE<br>MEDIUM OF EAR-TO-HAND TRAINING SUBJECTS.....                                                                                              | 86 |
| 17. FIRST TERM (PRE-TRAINING) MUSIC HISTORY, AURAL<br>MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS<br>PIANO GRADES OF EAR-TO-HAND TRAINING SUBJECTS .....                                                                                                                                      | 88 |
| 18. PEARSON PRODUCT-MOMENT CORRELATION<br>COEFFICIENTS FOR "TEST OF MELODIC EAR-TO-HAND<br>COORDINATION" (TMEHC) PRETEST SCORES AND FIRST<br>TERM (PRE-TRAINING) GRADES IN MUSIC HISTORY,<br>AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND<br>CLASS PIANO OF EAR-TO-HAND TRAINING SUBJECTS..... | 90 |
| 19. "TEST OF MELODIC EAR-TO-HAND COORDINATION"<br>(TMEHC) PRETEST, POSTTEST, AND GAIN SCORES OF<br>EAR-TO-HAND TRAINING SUBJECTS.....                                                                                                                                                           | 92 |
| 20. t-TEST FOR "TEST OF MELODIC EAR-TO-HAND<br>COORDINATION" (TMEHC) PRETEST AND POSTTEST<br>MEAN SCORES OF EAR-TO-HAND TRAINING SUBJECTS .....                                                                                                                                                 | 94 |
| 21. "TEST OF MELODIC EAR-TO-HAND COORDINATION"<br>(TMEHC) POSTTEST MEAN SCORES BY GROUPED<br>PRINCIPAL PERFORMANCE MEDIUM OF EAR-TO-HAND<br>TRAINING SUBJECTS .....                                                                                                                             | 95 |
| 22. ANALYSIS OF VARIANCE (ANOVA) FOR "TEST OF MELODIC<br>EAR-TO-HAND COORDINATION" (TMEHC) POSTTEST<br>MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE<br>MEDIUM OF EAR-TO-HAND TRAINING SUBJECTS.....                                                                                             | 96 |

|                                                                                                                                                                                                                                                                                     |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 23. SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF EAR-TO-HAND TRAINING SUBJECTS.....                                                                                                                               | 98  |
| 24. PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) POSTTEST SCORES AND SECOND TERM (POST-TRAINING) GRADES IN MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO OF EAR-TO-HAND TRAINING SUBJECTS..... | 100 |
| 25. "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) PRETEST, POSTTEST, AND GAIN SCORES OF CASE STUDY SUBJECTS.....                                                                                                                                                               | 103 |
| 26. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF CHRISTOPHER .....                                                                                                                  | 104 |
| 27. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF JOANNA.....                                                                                                                        | 105 |
| 28. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF KELLY.....                                                                                                                         | 106 |
| 29. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF CARRIE.....                                                                                                                        | 107 |

**LIST OF APPENDICES**

**Appendix**

**A. APPLICATION FOR HUMAN SUBJECTS REVIEW.....138**

**B. GUIDELINES FOR INTERPRETATION OF “TEST OF MELODIC  
EAR-TO-HAND COORDINATION” (TMEHC) SCORES.....146**

**C. PARTICIPANT CONSENT.....148**

**D. “TEST OF MELODIC EAR-TO-HAND COORDINATION” (TMEHC)  
SCORING SHEET .....150**

**E. COMPUTER-ASSISTED KEYBOARD EAR-TO-HAND  
COORDINATION TRAINING PARTICIPANT INSTRUCTIONS....152**

**F. COMPUTER-ASSISTED KEYBOARD EAR-TO-HAND  
COORDINATION TRAINING EXERCISES SEQUENCE AND  
CALENDAR.....154**

**G. REPRESENTATIVE KEYBOARD EAR-TO-HAND  
COORDINATION TRAINING EXERCISES..... 156**

**H. *INSTANT REPLAY* SAMPLE RECORD REPORTS.....175**

## CHAPTER I

### INTRODUCTION

Traditionally aural musicianship training in undergraduate music curricula has emphasized the skills of music dictation, sightsinging, and sightreading. Music dictation requires one to recognize by ear alone and reproduce in music notation melodies, intervals, harmonies, rhythms, and meters.<sup>1</sup> Sightsinging requires one to imagine the sound of notated pitches or intervals and to perform them vocally without preparation. Sightreading requires one to perform notated music without preparation, usually on an instrument other than voice. The development of these aural skills is an important component in the education of musicians; it is relevant to all facets of music teaching and learning.

The development of aural skills presents a great challenge to music students and music teachers. Although a certain degree of musical aural awareness is innate, training can be effective in the development of aural skills. This training may take many forms and may be facilitated by a wide variety of pedagogical tools.

The process of developing aural skills is very similar to the way in which a language is learned. The acquisition of language skills depends on the learner hearing and experiencing the sounds of many words in context and

---

<sup>1</sup>New Harvard Dictionary of Music, 1986 ed., s.v. "Ear training."

eventually “training” the ears to discriminate between sounds. This process is facilitated when the learner is able to imitate and interact with a model.<sup>1</sup>

The idea of “training” ears to discriminate between sounds has assumed a central role in undergraduate music curricula. Gauldin describes five categories of necessary “ear skills” within undergraduate music curricula: (1) the ability to convert sound to symbol (traditional “music dictation”), (2) the ability to convert symbol to sound (music reading; “sightsinging” or “sightreading”), (3) the ability to compare symbol to sound (“error detection”), (4) the ability to convert symbol to imagined sound (“hearing” notation in one’s head without actual presence of sound), and (5) the ability to imitate a sound presented without symbol (“direct dictation” or “instant replay”).<sup>2</sup>

One of the greatest pedagogical challenges for teachers of aural skills is to determine the extent to which students are understanding aural concepts. According to Gauldin, sound-to-symbol (traditional “music dictation”) and symbol-to-sound (“sightsinging” or “sightreading”) ear skills are most traditionally employed in undergraduate music theory classes to assist teachers in aural skill examination of students. These processes have been the teacher’s “windows” into the mind and ear.

Music dictation employs a sound stimulus but does not feature a sound response mode—a serious shortcoming. There is no way for student or teacher to discriminate aurally any potential differences between stimulus and response. It is simply a measure of one’s ability to transfer what is heard to music notation. Likewise, sightsinging and sightreading employ no sound

---

<sup>1</sup>Douglas R. Greer, Design for Music Learning (New York: Teachers College Press, 1980), 66-67.

<sup>2</sup>Robert Gauldin, “Teaching Music Theory: The Conservatory,” *Journal of Music Theory* 18 (Spring 1974): 76.

stimuli—a serious shortcoming—but do feature sound response modes that are performance-based. However, still there is no way in either mode for student or teacher to discriminate aurally any potential differences between stimulus and response. Sightsinging and sightreading are simply measures of one's ability to transfer music signs and symbols to vocal or instrumental performance. Although music dictation, sightsinging, and sightreading are forms of aural musicianship, they are fundamentally flawed forms in that they are not means for measuring aural skills in which both stimulus and response are heard.

Another—perhaps better—way of measuring aural skills may be by means of a mode of aural musicianship in which both stimulus and response are sounded. What might result from training in a performance-based mode of aural musicianship that features the transfer of sound—without symbol—to performance? According to Gauldin, the ability to imitate a sound presented without symbol (“direct dictation” or “instant replay”) is the most neglected aural skill in undergraduate training. Often it is a highly developed skill for performers of jazz or popular music, but it has been the subject of limited investigation with musicians trained in colleges and universities.

The ability to imitate melodic and harmonic patterns presented without symbols is an integral part of instrumental ear-to-hand coordination as defined by Froseth. Instrumental ear-to-hand coordination is “. . . the essential means employed to transfer what is heard, recalled, or imagined to instrumental performance.”<sup>1</sup> This skill has been referred to by other researchers as “playing

---

<sup>1</sup>James O. Froseth, “A Longitudinal Study of the Relationship Between Melodic Ear-to-Hand Coordination and Selected Indices of Musical Achievement at the University of Michigan School of Music” (unpublished research report, University of Michigan, 1985), 1.

by ear” or “ear-playing” and involves the ability to recognize and form an aural image of tonal-rhythmic patterns prior to their production.<sup>1</sup>

Lack of ear-to-hand coordination can restrict an instrumentalist to performance “by eye.” Eye-bound performers “. . . engage in what might be described as a sophisticated form of musical typewriting. Performing ‘eye-to-hand’ is, essentially, playing what is seen without hearing what is seen.”<sup>2</sup>

Instrumental ear-to-hand coordination provides an additional “window” into the mind and ear for investigation of aural skills. It is taught with a listen-play approach and requires a student to make discriminations between a sound stimulus and the sounds of her or his own performances on an instrument. Assisting students in developing aural skills with the aid of an instrument is to make productive use of an efficient tool. By directly employing performance instruments to develop and apply aural skills, a teacher can utilize the enthusiasm and expertise students bring to performance on their own instruments.<sup>3</sup>

Research conducted by Froseth and others suggests that instrumental ear-to-hand coordination can be improved with training. The evidence indicates that programs to develop instrumental ear-to-hand coordination might function as effective pedagogical aids in the development of aural awareness.

<sup>1</sup>Michael J. Kendall, “The Effects of Visual Interventions on the Development of Aural and Instrumental Performance Skills in Beginning Fifth-Grade Instrumental Students: A Comparison of Two Instructional Approaches” (Ph.D. dissertation, University of Michigan, 1986), 61.

<sup>2</sup>Froseth, “A Longitudinal Study,” 1.

<sup>3</sup>Michael D. Wilder, “An Investigation of the Relationship Between Melodic Ear-to-Hand Coordination and Written and Aural Theory Skills within an Undergraduate Music Theory Context” (Ph.D. dissertation, University of Michigan, 1988), 6.

Cultivation of aural musicianship skills is particularly critical to the success of those who choose music as a major because music is principally an aural phenomenon. A performance-based definition of aural musicianship is useful because it provides students and teachers with a means to discriminate aurally differences between a sound stimulus and a sound response—both are heard. It may well help to balance the traditional emphasis on signs and symbols with greater emphasis on sounds in aural skills development.

### Purpose of the Study

The purpose of this study was to investigate relationships between performance-based aural musicianship, selected indices of music achievement, and socialization of first-year music majors.

### Problems of the Study

The specific problems of the study were to investigate: (1) relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano for first-year students majoring in music who were enrolled in first term music theory during fall semester 1992 (N = 71); (2) relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano for first-year students majoring in music who were enrolled in class piano during winter semester 1993 (N = 16); (3) the effect of computer-assisted keyboard ear-to-hand training on "Test of Melodic Ear-to-Hand Coordination" (TMEHC) scores for first-year students majoring in music who were enrolled in class piano during winter semester 1993 (N = 16); (4)

effects of computer-assisted keyboard ear-to-hand training on relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano for first-year students majoring in music who were enrolled in class piano during winter semester 1993 ( $N = 16$ ); and (5) relationships between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization for first-year students majoring in music with the most severe deficiencies in performance-based aural musicianship who were enrolled in class piano during winter semester 1993 ( $n = 4$ ).

Although skill in performance-based aural musicianship is important to the success of students who major in music, results of a longitudinal study that began in 1982 revealed a considerable range of aural proficiency within highly select classes of first-year students who began collegiate music studies at the University of Michigan.<sup>1</sup> Specifically, performance-based aural musicianship skill levels within incoming classes, as measured by the "Test of Melodic Ear-to-Hand Coordination" (TMEHC),<sup>2</sup> ranged from deficient to adept. Of particular importance were differences related to principal performance medium. Table 1 contains mean score differences by grouped principal performance medium for first-year students who matriculated in fall term 1982.

---

<sup>1</sup>Froseth, "A Longitudinal Study."

<sup>2</sup>James O. Froseth, "Test of Melodic Ear-to-Hand Coordination (TMEHC)" (unpublished diagnostic test, 1982).

**TABLE 1. FALL TERM 1982 FIRST-YEAR STUDENT "TEST OF MELODIC  
EAR-TO-HAND COORDINATION" (TMEHC) SCORES BY GROUPED  
PRINCIPAL PERFORMANCE MEDIUM  
(N = 99)**

| <u>Medium</u>      | <u>N</u> | <u>Minimum Score</u> | <u>Maximum Score</u> | <u>Mean</u> | <u>S.D.</u> |
|--------------------|----------|----------------------|----------------------|-------------|-------------|
| Brass              | 21       | 25                   | 97                   | 66.8        | 19.1        |
| Keyboard           | 13       | 50                   | 97                   | 76.5        | 14.1        |
| Percussion         | 7        | 16                   | 35                   | 24.3        | 7.0         |
| Stringed           | 27       | 24                   | 98                   | 53.5        | 14.7        |
| Voice <sup>a</sup> | 16       | 16                   | 88                   | 56.0        | 19.5        |
| Woodwind           | 15       | 14                   | 100                  | 58.7        | 20.4        |
| Total              | 99       | 14                   | 100                  | 59.4        | 21.9        |

<sup>a</sup>administered on keyboard

Keyboard students had the highest average score (76.5), which represents a level of ear-to-hand coordination that can be interpreted as "strong" (see Appendix B for score interpretation guidelines). Percussion students had the lowest average score (24.3), which represents a level of ear-to-hand coordination that can be interpreted as "extremely weak." On average, brass students scored 66.8, which can be interpreted as a "substantial" level of ear-to-hand coordination. Woodwind students', voice students', and string students' average scores were 58.7, 56.0, and 53.5, respectively, each of which can be interpreted as a "moderate" level of ear-to-hand coordination.

To investigate more fully the implications of these findings, descriptive data were gathered to investigate the relationships between melodic ear-to-hand coordination and achievement (grades) in first-year core curriculum

coursework (i.e., studio performance, ensemble, music history, and music theory). Strong positive relationships were found between melodic ear-to-hand coordination and achievement in music theory ear training ( $r = .78$  fall term 1982,  $r = .55$  winter term 1983).<sup>1</sup> Moderate positive relationships were found between melodic ear-to-hand coordination and achievement in music theory sightsinging ( $r = .50$  fall term 1982,  $r = .20$  winter term 1983).<sup>2</sup>

The strong positive relationships between instrumental ear-to-hand coordination and music theory ear training grades are especially notable when one considers that instrumental ear-to-hand coordination usually is acquired through informal (i.e., “by ear”) musical experiences. Seldom is instrumental ear-to-hand coordination specified as a curricular objective. These data suggest that an aural orientation to instrumental performance can be generalized to the rhythmic, melodic, and harmonic dictation skills associated with music theory ear training instruction. The moderate positive relationships between instrumental ear-to-hand coordination and music theory sightsinging grades are further evidence of the generalizability of performance-based aural musicianship.<sup>3</sup>

Moreover, analyses of more recent data—1990-1991 Unified and Special Audition<sup>4</sup> “Test of Melodic Ear-to-Hand Coordination” (TMEHC) scores—reveal the continued existence of disparities in performance-based aural musicianship

<sup>1</sup>Froseth, “A Longitudinal Study,” 10.

<sup>2</sup>Ibid.

<sup>3</sup>Ibid., 9.

<sup>4</sup>Unified and Special Auditions begin each year in December on the Ann Arbor campus. Audition requirements by instrument or program include performance of specified repertoire and completion of an applied aural skills test—the “Test of Melodic Ear-to-Hand Coordination” (TMEHC).

for incoming students according to grouped principal performance medium. Table 2 contains mean score differences by grouped principal performance medium for first-year students who matriculated in fall term 1991.

**TABLE 2. FALL TERM 1991 FIRST-YEAR STUDENT "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) SCORES BY GROUPED PRINCIPAL PERFORMANCE MEDIUM  
(N = 89)**

| <u>Medium</u>      | <u>N</u> | <u>Minimum Score</u> | <u>Maximum Score</u> | <u>Mean</u> | <u>S.D.</u> |
|--------------------|----------|----------------------|----------------------|-------------|-------------|
| Brass              | 8        | 33                   | 79                   | 55.8        | 17.1        |
| Keyboard           | 18       | 31                   | 100                  | 74.2        | 20.0        |
| Percussion         | 5        | 10                   | 95                   | 45.2        | 35.6        |
| Stringed           | 17       | 18                   | 94                   | 66.5        | 23.8        |
| Voice <sup>a</sup> | 8        | 30                   | 84                   | 48.5        | 18.6        |
| Woodwind           | 13       | 18                   | 93                   | 46.4        | 20.9        |
| Missing            | 20       | --                   | --                   | --          | --          |
| Total              | 89       | 10                   | 100                  | 59.8        | 24.2        |

<sup>a</sup>administered on keyboard

Keyboard students had the highest average score (74.2), which represents a level of ear-to-hand coordination that can be interpreted as "strong" (see Appendix B for score interpretation guidelines). Vocal students, woodwind students, and percussion students had the lowest average scores (48.5, 46.4, and 45.2, respectively), each of which can be interpreted as a "limited" level of ear-to-hand coordination. On average, string students scored

66.5, which can be interpreted as a “substantial” level of ear-to-hand coordination. Brass students' average score was 55.8, which can be interpreted as a “moderate” level of ear-to-hand coordination.

The consistently higher mean scores of keyboard students (76.5—highest of all groups in 1982, and 74.2—highest of all groups in 1991) suggest advantages inherent to keyboard instruments with respect to ear-to-hand coordination, although there is no direct evidence to confirm such a speculation. Specifically, use of the piano keyboard in aural skills training enables students to replicate in full both melodic and harmonic patterns. In addition, development of finger patterns and relation of them to specific musical sounds provides students with opportunities for kinesthetic reinforcement. Moreover, the piano keyboard offers—more than do most instruments—strong visual reinforcement of relationships (i.e., distances, or intervals) between pitches. Inherent aural, kinesthetic, and visual reinforcement properties of the piano keyboard may, in contrast to other performance media, provide a significant advantage to students for development of melodic and harmonic instrumental ear-to-hand coordination.<sup>1</sup>

Together, the results of the 1982 and 1991 performance-based aural musicianship test administrations substantiate the persistence, over a ten-year period, of a remarkably broad range of ability in melodic ear-to-hand coordination. Data suggest positive relationships between this skill and criteria for achievement in academic and performance realms of music. However, it seems that the music profession continues to permit undergraduate students to

---

<sup>1</sup>Barton L. Polot, “An Investigation of Aural Reinforcement and Kinesthetic Reinforcement as Variants of the Response Mode in Computer-Assisted Harmonic Aural Skills Training” (Ph.D. dissertation, University of Michigan, 1992), 3-4.

begin music degree programs at a disadvantage, that is, with potentially serious deficiencies in performance-based aural musicianship.

### Need for the Study

#### **Performance-Based Aural Musicianship and Music Achievement**

A cooperative venture between the Music Education Department and the Music Theory Department during fall term 1983 is evidence of awareness by University of Michigan School of Music faculty and staff of the disparity of performance-based aural musicianship as measured by the "Test of Melodic Ear-to-Hand Coordination" (TMEHC). To investigate effects of training, two instrumental ear-to-hand skills training programs were developed. The MLR Melodic Ear-to-Hand Skills Program<sup>1</sup> was designed to develop student ability to recognize and replicate melodic patterns on the major principal instrument through use of taped listen-play exercises. The MLR Harmonic Ear-to-Hand Skills Program<sup>2</sup> was designed to develop student ability to recognize and replicate harmonic patterns on a keyboard instrument through use of taped listen-play exercises. These programs were instituted in a tape laboratory; approximately ninety undergraduate and graduate students voluntarily participated.

---

<sup>1</sup>James O. Froseth, MLR Melodic Ear-to-Hand Skills Program (Chicago: G.I.A., 1985).

<sup>2</sup>James O. Froseth, MLR Harmonic Ear-to-Hand Skills Program (Chicago: G.I.A., 1985).

One of the most meaningful outcomes of this project was student testimony to the positive relationships between improvement in instrumental ear-to-hand skill proficiency and improvement in both principal instrument performance and academic studies at the School of Music. Students reported improvements in listening skills (63% of participants), melodic interval recognition (91%), harmonic progression recognition (63%), dictation skills (63%), memorization skills (43%), intonation skills (53%), sightreading skills (46%), and improvisation skills (60%)—abilities necessary for success as a music major. In addition, they testified to greater overall knowledge of their principal performance media:<sup>1</sup>

My listening abilities (intonation and recognition of intervals) have improved.

It helps you to know your instrument better.

The program alerts me to progressions occurring in music—I have learned that certain chords support certain scale degrees.

It has helped me to hear intervals—I don't see how it could do anything but help performance.

Although these positive, enthusiastic student responses substantiated the benefits realized by some, several other student assessments of the experience revealed frustration over inability to monitor one's progress in instrumental ear-to-hand skill training:<sup>2</sup>

No instruction as to how to listen or what to listen for.

There is no way of checking one's self with the melodic sets.

---

<sup>1</sup>Ralph Lewis and James O. Froseth, "Utilization of CAI for Self-Directed Aural Skills Training" (unpublished research report, University of Michigan, 1984), 2.

<sup>2</sup>Ibid., 1.

I'm not sure if it's the weakness of the program or it's my weakness but I sometimes cannot tell whether I imitate the tunes correctly or not—I cannot check it myself.

No feedback!

In response to students' expressed frustrations over lack of "feedback"<sup>1</sup> in instrumental ear-to-hand coordination training, a computer-assisted instructional program was developed to provide aural skills training with instantaneous, individualized aural feedback. In practice mode, *Instant Replay*<sup>2</sup> performs a programmed exercise, records the student's keyboard response, compares the computer-generated presentation with the student's response, and informs the student whether the response is "Correct" or "Incorrect." If the response is "Incorrect," the student is allowed to select from among: "Hear Your Response," "Hear the Item," "Try Again," or "Go On." *Teacher Create*,<sup>3</sup> an instructional authoring system, also was developed; it gives teachers the means to control the content, sequence, presentation, and record-keeping features of *Instant Replay*.

This technology is valuable in that it presents an aural model (to be played back instrumentally by the student) and responds to student attempts with individualized feedback. The student has an immediate opportunity to listen and discriminate between the model and her or his own replications.

---

<sup>1</sup>"Feedback" is defined in this study as the process of informing a student whether a response is "correct" or "incorrect" during computer-assisted instruction.

<sup>2</sup>James O. Froseth and Barton Polot, *Instant Replay: An Authoring System for Performance-based Ear-training Version 1.0* (Chicago: G.I.A., 1991).

<sup>3</sup>James O. Froseth and Barton Polot, *Teacher Create: Melodic and Harmonic Ear-to-Hand Training at the Keyboard Version 1.0* (Chicago: G.I.A., 1991).

These self-initiating, self-directing, self-monitoring capabilities are valuable characteristics that distinguish some applications for computer-assisted aural skills training. Many other applications for computer-assisted aural skills training offer no opportunity to discriminate aurally between a model and replications, or offer no individualized feedback.

In consideration of previously identified positive effects of performance-based aural musicianship training on selected indices of music achievement,<sup>1</sup> a more comprehensive study of these relationships regarding first-year students was warranted. Specifically, the researcher investigated effects of computer-assisted keyboard ear-to-hand coordination training (using *Instant Replay*) on selected indices of music achievement for students in a class piano setting. As substantiated previously in this document, participation in this study by students in class piano was particularly appropriate; the inherent aural, kinesthetic, and visual reinforcement properties of the keyboard (in contrast to most other performance media) make it an ideal instrument for the development of performance-based aural musicianship skills.<sup>2</sup>

### Performance-Based Aural Musicianship and Socialization

On the basis of pilot case studies and informal discussion with students majoring in music regarding performance-based aural musicianship, it came to the attention of this researcher that the frustration expressed regarding weaknesses in instrumental ear-to-hand coordination is part of a penetrating

---

<sup>1</sup>Froseth, "A Longitudinal Study."

<sup>2</sup>Susan E. Wheatley, "An Application of Chunking to the Memory and Performance of Melodic Patterns" (Ph.D. dissertation, University of Michigan, 1991), 68.

frustration that many students experience in the broad context of majoring in music. Success in performance-based aural musicianship relates directly to success in core curriculum coursework taken by all students majoring in music (i.e., studio performance, ensemble, music history, music theory, and class piano). Accordingly, deficiency in instrumental ear-to-hand coordination—inability to hear aural stimuli and to replicate and discriminate in response—profoundly affects the life of a student majoring in music by encumbering achievement in the core curriculum. In other words, student socio-musical self-esteem<sup>1</sup> and, ultimately, potential for success as a music major depend heavily on proficiency in performance-based aural musicianship.

In an effort to capture the poignancy of developing one's musicianship to the greatest extent possible—of addressing one's musical weaknesses and of “coming to grips” with what it takes to be successful in a competitively charged musical and academic environment—it was appropriate to propose a study that eclipsed the typically clinical nature of research on achievement. Through case studies of selected first-year students, the researcher documented the impact of deficiencies in performance-based aural musicianship on academic performance, and relationships between subsequent performance-based aural musicianship training and socio-musical self-esteem. Specifically, the researcher probed the stress and trauma associated with student inability to make acute aural discriminations in music performance and academic situations. Additionally, the investigator explored effects of computer-assisted

---

<sup>1</sup>In this study, “socio-musical self-esteem” comprises individual student confidence and satisfaction in oneself based on academic and musical experiences (e.g., core music curriculum course achievement) as well as related social experiences (e.g., peer and teacher perceptions of one's achievement in music history, aural music theory, written music theory, or class piano and of one's performance in studio or ensemble).

melodic and harmonic keyboard ear-to-hand coordination training (using *Instant Replay*) on this stress and trauma.

### Statement of Research Questions

1. What is the nature of the relationship between instrumental ear-to-hand coordination and music history achievement of first-year students majoring in music?
2. What is the nature of the relationship between instrumental ear-to-hand coordination and aural music theory achievement of first-year students majoring in music?
3. What is the nature of the relationship between instrumental ear-to-hand coordination and written music theory achievement of first-year students majoring in music?
4. What is the nature of the relationship between instrumental ear-to-hand coordination and class piano achievement of first-year students majoring in music?
5. What is the effect of computer-assisted keyboard ear-to-hand training on "Test of Melodic Ear-to-Hand Coordination" (TMEHC) scores of first-year students majoring in music?
6. What is the effect of computer-assisted keyboard ear-to-hand training on the relationship between instrumental ear-to-hand coordination and music history achievement of first-year students majoring in music?
7. What is the effect of computer-assisted keyboard ear-to-hand training on the relationship between instrumental ear-to-hand coordination and aural music theory achievement of first-year students majoring in music?
8. What is the effect of computer-assisted keyboard ear-to-hand training on the relationship between instrumental ear-to-hand coordination and written music theory achievement of first-year students majoring in music?
9. What is the effect of computer-assisted keyboard ear-to-hand training on the relationship between instrumental ear-to-hand coordination and class piano achievement of first-year students majoring in music?
10. What is the nature of the relationship between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization of first-year students majoring in music?

### Limitations of the Study

1. This study was limited to first-year students majoring in music enrolled at the University of Michigan (Ann Arbor) for the entire 1992-1993 academic year (N = 89).

2. The computer-assisted keyboard ear-to-hand coordination training portion of the study involved only those first-year students majoring in music enrolled in the second term of class piano during winter semester 1993 (N = 16).

3. The computer-assisted keyboard ear-to-hand coordination training portion of the study was exploratory rather than experimental in design. Owing to the considerable needs of all study subjects enrolled in class piano with respect to instrumental ear-to-hand coordination, and owing to the previously identified positive effects of ear-to-hand coordination training, the researcher elected not to employ a control group.

4. The melodic materials used in the computer-assisted keyboard ear-to-hand coordination training portion of this study were limited to those employing a stationary hand position with the right thumb anchored on middle C.

5. The harmonic materials used in the computer-assisted keyboard ear-to-hand coordination training portion of this study were limited to those employing primary chords (tonic, subdominant, and dominant) in a stationary hand position with either the right thumb anchored on middle C or the left little finger anchored on C one octave below middle C.

6. In the computer-assisted keyboard ear-to-hand coordination training portion of this study, only the scores of subjects with complete data were included in the analyses.

7. Generalization of the results of this study to other populations is limited by the specific characteristics of the university, school of music, and participants involved in this investigation.

### Definition of Terms

*Performance-based aural musicianship* is a term employed in this study to describe active modes of response to music stimuli. Performance-based aural musicianship includes, among other things, sightsinging, aural transposition (i.e., performance of music in other keys and modes without the

aid of music notation), melodic ear-to-hand coordination,<sup>1</sup> and harmonic ear-to-hand coordination. For purposes of this study, performance-based aural musicianship was measured with the “Test of Melodic Ear-to-Hand Coordination” (TMEHC).

*Instrumental ear-to-hand coordination* (“playing by ear” or “ear-playing”) is defined as “. . . the essential means employed to transfer what is heard, recalled, or imagined to instrumental performance.”<sup>2</sup> It requires a kinesthetic sense particular to each performance medium, that is, to the specific instruments of brass, keyboard, percussion, stringed, and woodwind families.

*Computer-assisted keyboard ear-to-hand coordination training* is defined as training in which a computer presents aural models of melodic or harmonic exercises to a student, who responds by playing them back on a keyboard instrument. The computer responds to student attempts with instantaneous, individualized aural feedback that offers the student an opportunity to listen and discriminate between the model and her or his own replications.

*Music achievement* in this study comprises two indices: (1) results of an ear-to-hand measure, the “Test of Melodic Ear-to-Hand Coordination” (TMEHC), and (2) grades in music history, aural music theory, written music theory, and class piano courses.

---

<sup>1</sup>It is possible to render melodic patterns vocally but, owing to the difficulty of reliable assessment of vocal performance, the voice was not employed in this study.

<sup>2</sup>Froseth, “A Longitudinal Study,” 1.

*Socialization*<sup>1</sup> is defined as student acquisition, through education and training, of habits, beliefs, and accumulated knowledge necessary to achieve successfully as a student majoring in music at the University of Michigan.

*Socio-musical self-esteem*<sup>2</sup> is defined as individual student confidence and satisfaction in oneself based on academic and musical experiences (e.g., core music curriculum course achievement) as well as related social experiences (e.g., peer and teacher perceptions of one's achievement in music history, aural music theory, written music theory, or class piano and of one's performance in studio or ensemble).

### Summary

A definition of aural musicianship as a performance-based phenomenon represents a new way of thinking about the aural aspects of music training that relates uniquely to selected indices of music achievement and socialization. Thus, research investigating the relationships between performance-based aural musicianship, music achievement, and socialization of students majoring in music will be valuable to those involved in the undergraduate education of music majors.

---

<sup>1</sup>Webster's Third New International Dictionary of the English Language: Unabridged, 1964 ed., s.v. "Socialization."

<sup>2</sup>*Ibid.*, s.v. "Self-esteem."

## **CHAPTER II**

### **REVIEW OF RELATED RESEARCH**

#### **Introduction**

A review of related research yielded a number of studies relevant to the present study. Although no parallel studies were found, performance-based aural musicianship, computer-assisted applications for aural skills training, music achievement, and socialization of students majoring in music each have been explored and described by other researchers. It should be noted that the generalizability of the research presented in this chapter to the present study must be considered with caution. It is not the purpose of this review to outline each study in depth, but instead to highlight those features that have a direct bearing on the present study. The sources of this review included published books, periodicals, dissertations, and unpublished manuscripts.

#### **Performance-Based Aural Musicianship**

A review of research relevant to performance-based aural musicianship as defined in this investigation yielded studies by Sang, Humphreys, Froseth, Kuehn, Markovich, Wilder, and Polot.

Sang,<sup>1</sup> in a study of a skills-based instructional effectiveness model for beginning teachers in instrumental music education (n = 16), reported that modeling skills (ability to demonstrate fundamental elements of music performance—including performance-based aural musicianship skills of melodic and harmonic ear-to-hand coordination) were a strong predictor of instructional effectiveness.

In a related study of teachers of first-year instrumental music students (n = 19), Sang<sup>2</sup> defined modeling as a teacher's ability to demonstrate musical or musically-related performance behaviors, including tone quality, articulation, phrasing, vibrato, posture, playing position, and embouchure, as well as melodic and rhythmic sequences by ear (performance-based aural musicianship). He concluded that a teacher's ability to model and degree of use of modeling in beginning instrumental classes were strongly and positively related to successful student performance.

Humphreys<sup>3</sup> investigated the effectiveness of an harmonic ear-to-hand coordination training program for undergraduate students majoring in instrumental music education (n = 45). He collected data on melodic ear-to-hand coordination test results, musical discrimination test scores, grade point average, class level, aural music theory achievement, written music theory

---

<sup>1</sup>Richard C. Sang, "Modified Path Analysis of a Skills-Based Instructional Effectiveness Model for Beginning Teachers in Instrumental Music Education" (Ph.D. dissertation, University of Michigan, 1982).

<sup>2</sup>Richard C. Sang, "A Study of the Relationship Between Instrumental Music Teachers' Modeling Skills and Pupil Performance Behaviors," *Bulletin of the Council for Research in Music Education* 91 (Spring 1987): 155-59.

<sup>3</sup>Jere T. Humphreys, "An Investigation of an Experimental Harmonic Audiation Skills Testing and Training Program for Instrumental Music Education Majors" (Ph.D. dissertation, University of Michigan, 1984).

achievement, keyboard experience, and guitar experience. Twenty-two of the subjects were randomly assigned to an experimental group that received a 35-minute group harmonic ear-to-hand coordination training session on piano, guitar, or autoharp once a week for eight weeks. Twenty-three of the subjects were randomly assigned to a control group that remained in a methods laboratory class during this time. Analyses of results revealed: (1) the efficacy of the harmonic ear-to-hand coordination training program in developing ability to perform harmony implied by taped melodies; (2) weak relationships between ability to harmonize melodies presented in notational mode and those presented in auditory mode; (3) that melodic ear-to-hand coordination, aural music theory grades, written music theory grades, and musical discrimination scores were the strongest predictors (in decreasing order) of harmonic ear-to-hand coordination; and (4) that keyboard experience was a particularly weak predictor of harmonic ear-to-hand coordination.

A longitudinal study by Froseth<sup>1</sup> investigated predictive characteristics of melodic ear-to-hand coordination (n = 99). This study was particularly comprehensive; it examined ear-to-hand coordination in relation to individual principal performance medium, grouped principal performance medium (i.e., brass, keyboard, percussion, stringed, voice, woodwind), degree program, instrumental ensemble, and component/composite grades in music theory. The relationships between ear-to-hand coordination and music theory grades were especially notable; specifically, those of ear-to-hand coordination to ear

---

<sup>1</sup>James O. Froseth, "A Longitudinal Study of the Relationship Between Melodic Ear-to-Hand Coordination and Selected Indices of Musical Achievement at the University of Michigan School of Music" (unpublished research report, University of Michigan, 1985).

training, sightsinging, and written components were strong, moderate, and weak, respectively.

Kuehn,<sup>1</sup> in a replication of the 1985 Froseth study, corroborated the earlier findings with virtually the same results ( $n = 42$ ). Importantly, this strong corroboration occurred in an undergraduate setting very different from that of the original study. The fact that students from two contrasting geographical regions and in different educational settings made similar learning gains using the same instructional materials adapted to the local environment suggests applicability of ear-to-hand coordination across institutions, student populations, and undergraduate music curricula.

Markovich<sup>2</sup> investigated the effects of timbre familiarity with one's principal performing instrument and the effects of training on the development of melodic ear-to-hand coordination ( $n = 110$ ). He found no evidence that familiarity with the timbre of one's principal performing instrument significantly aids the performance of melodic patterns ear-to-hand. Training study results indicated that melodic ear-to-hand coordination can be improved through training.

Kuehn,<sup>3</sup> in a replication of the 1985 Markovich study, discovered that melodic ear-to-hand skills improved significantly as a result of MLR

<sup>1</sup>John W. Kuehn, "A Three-Year Study of the Relationship Between Freshman Melodic Ear-to-Hand Scores and Standard Indicators of Musical Achievement at Indiana University of Pennsylvania Department of Music," *PMEA News* (May 1990): 14-15.

<sup>2</sup>Victor A. Markovich, "An Investigation of the Effects of Matching Timbre and Training on Melodic Ear-to-Hand Coordination of College Music Majors" (Ph.D. dissertation, University of Michigan, 1985).

<sup>3</sup>John W. Kuehn, "The Effects of Training on the Melodic and Harmonic Ear-to-Hand Coordination of Undergraduate Music Majors in an Educational Setting," *PMEA News* (March 1989): 20-22.

Melodic/Harmonic Skills Training Program<sup>1</sup> participation (n = 28). He also found that harmonic ear-to-hand skills improved significantly as well.

Wilder<sup>2</sup> reported that melodic ear-to-hand coordination was highly correlated with aural music theory skills and was a most effective predictor of first-year student aural music theory grades (n = 83). In addition, he found that melodic ear-to-hand coordination as well as aural music theory skills were effectively retained over time.

Polot<sup>3</sup> compared computer-assisted harmonic aural skills instruction in ear-to-pencil and keyboard ear-to-hand modes, and investigated the relative importance of kinesthetic reinforcement and aural reinforcement in the keyboard mode (n = 21). With respect to performance-based aural musicianship, he concluded that little correlation exists between harmonic ear-to-pencil skills<sup>4</sup> and harmonic keyboard ear-to-hand skills. Subjects are far less likely to identify primary chords by sound than by sight. In addition, he identified the existence of a significant interaction between aural reinforcement and kinesthetic reinforcement of aural skills training.

<sup>1</sup>The MLR Melodic/Harmonic Skills Training Program is a self-directed program by James O. Froseth that features individualized instruction and self-monitoring of practice and progress.

<sup>2</sup>Michael D. Wilder, "An Investigation of the Relationship Between Melodic Ear-to-Hand Coordination and Written and Aural Theory Skills within an Undergraduate Music Theory Context" (Ph.D. dissertation, University of Michigan, 1988).

<sup>3</sup>Barton L. Polot, "An Investigation of Aural Reinforcement and Kinesthetic Reinforcement as Variants of the Response Mode in Computer-Assisted Harmonic Aural Skills Training" (Ph.D. dissertation, University of Michigan, 1992).

<sup>4</sup>Polot defines "ear-to-pencil skills" as the ability of an individual to codify accurately a musical stimulus on paper.

## Summary

In summary, the studies related to performance-based aural musicianship suggest that: (1) performance-based aural musicianship can be improved through training, (2) performance-based aural musicianship is a strong predictor of instructional effectiveness, (3) both aural reinforcement and kinesthetic reinforcement are important components of harmonic aural skills instruction, (4) melodic ear-to-hand coordination is the strongest single predictor of harmonic ear-to-hand coordination, (5) melodic ear-to-hand coordination is highly correlated with aural music theory skills and is effectively retained over time, and (6) melodic ear-to-hand coordination is applicable across institutions, student populations, and undergraduate music curricula.

### Computer-Assisted Aural Skills Training

Computer-assisted instruction in general education dates from the late 1950s; computer-assisted instruction in music dates from 1967.<sup>1</sup> A review of research relevant to computer-assisted aural skills training as defined in this investigation yielded studies at the college level by Kuhn and Allvin; Thompson; Cooper; Vaughn; Killam, Bales, Hamilton, and Scott; Baczewski; Canelos, Murphy, Blombach, and Heck; Killam and Bales; Placek; Jousse-Wilkins; Garton; Hofstetter; Platte; Gross and Griffin; Shannon; Bowman; Bresler; and Polot.

---

<sup>1</sup>William Higgins, "Technology," in Handbook of Research on Music Teaching and Learning, ed. Richard Colwell (New York: Schirmer, 1992): 481.

Kuhn and Allvin<sup>1</sup> were among the first music researchers to recognize the need for a musical response mode in computer-assisted sightsinging and ear training instruction. They noted that extramusical verbal or symbolic response modes (multiple choice, true-false, comparison, notation) had been employed exclusively in previous instruction, thus limiting understanding of the sightsinging and ear training teaching and learning processes. In a study to examine interaction between student and machine (n = 10), they developed a series of sightsinging exercises, tests, and branching criteria specifically designed for use with an experimental pitch extraction device. This device extracted pitch information directly from each note of a student musical performance and made this information available to the computerized teaching device for evaluation of the performance. The evaluation data were used to decide whether a student should repeat a specific exercise, proceed in the program, or repeat similar material for additional practice. In addition to the programmed instructional sequence, prior to each exercise a student could elect to hear a model. After each exercise, under certain conditions a student could request either to skip ahead, repeat, or go back to a previous set of exercises. The investigators found that students experienced increased pitch awareness owing to the increased and conscious attention to pitch production necessary to receive feedback from the computer. They also found that students' ability to interrupt the computer sequence of sightsinging exercises and tests relieved stress and enabled them to continue to work successfully.

---

<sup>1</sup>Wolfgang E. Kuhn and Raynold Allvin, "Computer-Assisted Teaching: A New Approach to Research in Music," *Journal of Research in Music Education* 15 (Winter 1967): 305-15.

Thompson<sup>1</sup> conducted a study to establish the instructional effectiveness of a computer program that generated materials for teaching music students to sightsing phrases (n = 20). Level of difficulty of materials was determined by controls exercised by students according to their individual needs. Randomly-selected first-year music theory students worked on the same study outline at the computer for six thirty-minute instructional sessions over a period of three weeks. Analysis of results of a sightsinging pretest/posttest indicated that students who received the computer-assisted instruction exhibited significantly more improvement in sightsinging of phrases than students who received no instruction during the same time period. Analysis of results of a questionnaire that sampled student reaction to and attitude toward computer-assisted sightsinging instruction revealed: (1) favorable reaction to computer-assisted sightsinging instruction even after a "wearing off of the novelty," (2) preference for computer-assisted sightsinging instruction over both teacher/classroom and programmed text (cassette tape) sightsinging instruction, and (3) favorable response to both the mechanical operation of this particular program and the study outline (instructional sequence) used in this research.

Cooper<sup>2</sup> investigated the efficacy of computer-assisted instruction, lecture, and independent study methods of teaching beginning harmonic structure (i.e., primary triads) to college students (n = 30). Subjects in the computer-assisted group received four lessons and a mimeographed keyboard

---

<sup>1</sup>Edgar J. Thompson, "Sightsinging Constant Rhythm Pitch Phrases: a Computer Assisted Instructional System," *Dissertation Abstracts International* 34A (January 1974): 4319.

<sup>2</sup>Rose M. Cooper, "The Efficacy of Computer-Assisted Instruction Compared with Traditional Teacher-Taught and Self-Taught Methods of Teaching Beginning Music Theory," *Dissertation Abstracts International* 36A (March 1976): 5623-24.

diagram upon which to practice “playing” harmonic progressions. Results of a pretest/posttest of major scale and primary triad construction revealed that students learned equally as well with computer-assisted instruction, lecture, and independent study methods.

Vaughn,<sup>1</sup> in a study of student ability to identify auditory stimuli utilized in collegiate basic musicianship (n = 80), compared and contrasted traditional ear training instruction (lecture and textbook) with traditional ear training instruction supplemented by computer-assisted ear training instruction. Results indicated significantly more growth in identification of melodic, harmonic, and rhythmic auditory stimuli for those students who received computer-assisted instruction supplementary to traditional instruction. In addition, students in the computer-assisted group held positive attitudes regarding computer-assisted ear training and were more time-efficient in skill development.

Killam, Bales, Hamilton, and Scott<sup>2</sup> discovered that computer-assisted instruction met several unique needs with respect to aural skills training, including needs for: (1) a reliable sound source, (2) immediate repetition of sound controlled by the student, (3) immediate student reinforcement, (4) immediate student evaluation, (5) easy access to training, (6) individualization of instruction, (7) detailed and accurate records of student performance, and (8) research in how students attain, maintain, and retain aural skill proficiency.

---

<sup>1</sup>Arthur C. Vaughn, Jr., “A Study of the Contrast Between Computer Assisted Instruction and the Traditional Teacher/Learner Method of Instruction in Basic Musicianship,” *Dissertation Abstracts International* 38A (December 1977): 3357.

<sup>2</sup>Rosemary N. Killam, W. Kenton Bales, Richard L. Hamilton, and Dan W. Scott, “AMUS: The Computer in Music Instruction,” in Proceedings of the Texas Music Educators Association Conference (Houston, TX: Texas Music Educators Association College Division, 1979), 1-13.

Baczewski<sup>1</sup> analyzed data collected from first-year and second-year college student evaluations of computer-assisted ear training instruction (n = 156). The survey contained twelve Likert-type items and one open-ended item for student comments, especially concerning additional types of lessons they would like to have available in computer-assisted format. Analysis of results indicated favorable student response to computer-assisted ear training instruction, particularly aspects of self-pacing and individualization. Student-cited disadvantages included poor quality of computer-generated sound and danger of radiation from the computer screen. The researcher concluded that the difficulties encountered in establishing a fully operational computer-assisted ear training laboratory were more than offset by the relative strength of students' positive responses to the evaluation survey.

Canelos, Murphy, Blombach, and Heck,<sup>2</sup> in a study of the learning of music intervals by beginning music majors (n = 87), found that mastery learning computer-assisted instruction was a significantly better instructional strategy for learning music intervals than both programmed instruction (programmed textbook) and self-practice (textbook). The researchers concluded that both mastery learning computer-assisted instruction and programmed instruction were superior to self-practice regarding content organization, and that mastery learning computer-assisted instruction was superior to programmed instruction

---

<sup>1</sup>Philip Baczewski, "Experience and Evaluation: Ear Training CAI in Action," in Research Reports and Reports on the Ann Arbor Symposium, ed. Samuel D. Miller (San Antonio, TX: Texas Music Educators Association College Division, 1980), 1-13.

<sup>2</sup>James J. Canelos, Barbara A. Murphy, Ann K. Blombach, and William C. Heck, "Evaluation of Three Types of Instructional Strategy for Learner Acquisition of Intervals," *Journal of Research in Music Education* 28 (Winter 1980): 243-49.

regarding attainment of mastery. They also concluded that students prefer well-organized instructional strategies that present relevant information to be learned in a logical sequence.

Killam and Bales,<sup>1</sup> in a study designed to identify potential modifications and expansions of an existing computer-assisted ear training system (n = 187), discovered the need for such instruction to be more sensitive to student learning processes and preferences. They examined ten weeks of computer-assisted instruction system use with regard to: (1) student choice of hours, days, and weeks; (2) student choice of materials to study; and (3) student achievement in ear training. The researchers concluded that 24-hour laboratory availability was important for music students, who typically lead hectic lives filled with classes, practice, rehearsals, and performances. They discovered that students most often chose to work on interval and chord quality lessons—materials on which they showed most evidence of competence and for which answers required relatively less time. Students least often chose to work on harmony lessons—materials on which they showed least evidence of competence and for which answers required relatively more time. The investigators, in consideration of student laboratory use, choice of materials, and achievement, recommended reflection upon and revision of the current ear training curriculum in the interest of creating a more effective learning environment.

---

<sup>1</sup>Rosemary N. Killam and W. Kenton Bales, "Music CAI: A Model for Epistemological Research Applications," in Proceedings of the Third Canadian Symposium on Instructional Technology (Vancouver, British Columbia, CANADA: National Research Council, 1980), 417-30.

In a study similar to that by Killam, Bales, Hamilton, and Scott (1979), Placek<sup>1</sup> identified several properties of computer-assisted instruction that make it uniquely suited for application in music, including: (1) individualized paths of instruction, (2) instantaneous and confidential feedback, (3) efficient collection of data and computation of results, (4) teacher control of answers, choices, and branching, (5) provision of reinforcement, contingency responses, and personalized responses, (6) efficient access of audio and visual effects, (7) individualized student rates of progress, and (8) flexibility of alternative teaching strategies, such as drill and practice, simulation, gaming, and tutorial.

Jousse-Wilkins<sup>2</sup> initiated a study to facilitate pitch perception fluency of undergraduate students majoring in music through use of microcomputers to supplement class instruction. Following the sounding of the reference pitch A = 440, a multi-voiced pitch-producing mechanism generated pre-programmed graded and sequenced motifs of five to ten unmeasured pitches. Students then typed in the appropriate solfège syllables (Fixed Do), which appeared on a treble staff. Incorrect answers flashed on the screen as students were instructed to change them. They could hear the reference pitch and the motif once before responding again, and they had unlimited opportunities to respond correctly. Jousse-Wilkins reported demonstrable value of this microcomputer approach to solfège training and noted the need for harmonic pitch-producing capability,

---

<sup>1</sup>Robert W. Placek, "A Model for Integrating Computer-Assisted Instruction Materials into the Music Curriculum," *Journal of Computer-Based Instruction* 6 (February 1980): 99-105.

<sup>2</sup>Colette T. Jousse-Wilkins, "Report on Initial Development of Microcomputer Programs in Reading and Aural Training for Music Students," in Proceedings of the Association for the Development of Computer-Based Instructional Systems (Bellingham, WA: Western Washington University, 1980), 20-23.

use of other clefs in addition to treble, random generation of motifs, and rhythm notation capability.

Garton<sup>1</sup> investigated the efficacy of computer-based and traditional laboratory (tape-recorded) approaches to second-semester freshman ear-training instruction. Participating students (n = 56) were asked to practice a minimum of thirty minutes twice a week for five weeks in the middle of their second semester of ear training instruction (February-March during a January-May semester). Analysis of gain scores for each approach indicated significant improvement, both from pretest to posttest and from the final examination of the first semester of ear training instruction (December) to the final examination of the second semester of ear training instruction (May). Analysis of posttest mean scores revealed no significant difference. Students expressed positive reactions to and preference for computer-based ear-training.

Hofstetter,<sup>2</sup> in many studies of computer-based aural training at the college level, noted several beneficial changes in the roles of teachers and students as results of the following three attributes of computer-based learning systems: (1) individualization of instruction, (2) savings of time, and (3) sources of motivation. Regarding the first attribute, he noted that students no longer faced the tyranny of forced examinations that caused acute learning anxieties. Students were able to learn at their own pace. Regarding the second, more skilled students saved time by being able to go on to more difficult materials when they were ready instead of having to wait for the pace of instruction in the

---

<sup>1</sup>Janet C. Garton, "The Efficacy of Computer-Based and Tape-Recorded Assistance in Second-Semester Freshman Ear-Training Instruction," *Dissertation Abstracts International* 42A (May 1982): 4756-57.

<sup>2</sup>Fred T. Hofstetter, "Computer-Based Aural Training: The GUIDO System," *Journal of Computer-Based Instruction* 7 (February 1981): 84-92.

classroom to catch up with their learning abilities. Many completed course requirements in much less time than was ordinarily required. Less skilled students saved time by spending a few more weeks learning at their own pace and passing a course rather than repeating the same course in its entirety in a subsequent semester. Regarding the third, student ratings of aural skills courses were more favorable because the level of frustration had been significantly reduced for both less skilled and more skilled students alike. Peer competition, a principal means of student motivation in the traditional classroom, was minimized in the computer-based environment. Students were more apt to learn because they wanted to master material and develop skills.

Platte<sup>1</sup> conducted a study to determine the effects of a microcomputer-assisted instructional program on the ability of college choral ensemble members to sing melodic configurations at sight (n = 41). Subjects received three fifteen-minute sessions of microcomputer-assisted instruction per week for eight weeks. He reported that microcomputer-assisted instruction did not significantly improve student ability to sightsing melodic configurations. He also concluded that benefits of computer-assisted instruction were evident, including positive student attitudes toward microcomputer-assisted instruction, little need for supervision and tutoring of students, and low maintenance requirements for equipment.

---

<sup>1</sup>Jay D. Platte, "The Effects of a Microcomputer-Assisted Instructional Program on the Ability of College Choral Ensemble Members to Sing Melodic Configurations at Sight," *Dissertation Abstracts International* 42A (October 1981): 1368-69.

Gross and Griffin<sup>1</sup> conducted a five-week pilot study of computer-assisted training in aural recognition of intervals, scales, chords, melodies, and chord progressions. Sixteen students enrolled in a review class in first-year collegiate ear training were assigned to use the computer for supplementary aural skills training for a minimum of two twenty-minute sessions each week. On the basis of pretest/posttest analysis, the researchers found a positive relationship between the amount of time students spent at the computer and improvement in aural recognition of intervals and chords. Aural recognition of scales, melodies, and chord progressions was not significantly affected by time spent at the computer. Unfortunately, the investigators failed to report the reliability and validity of the pretest and posttest measures, an omission that weakens any conclusions in favor of computer-assisted aural skills training based on data from this study. Nevertheless, student responses to a post-class attitudinal survey were largely favorable, expressing overall positive attitudes toward computer use in this class.

Shannon<sup>2</sup> conducted an eight-week experiment employing computer-assisted and traditional in-class approaches to aural-visual interval recognition by first-year music theory students. He concluded that the computer-assisted approach was not as effective as the traditional approach, and that aspects of human interaction in the traditional approach may have accounted for its greater effectiveness. Shannon also concluded that students did not differ in

---

<sup>1</sup>Dorothy Gross and Wendy Griffin, "Implementation and Evaluation of a Computer-Assisted Course in Musical Aural Skills," *Association for Educational Data Systems Journal* 15 (Spring 1982): 143-50.

<sup>2</sup>Don W. Shannon, "Aural-Visual Interval Recognition in Music Instruction: A Comparison of a Computer-Assisted Approach and a Traditional In-Class Approach," *Dissertation Abstracts International* 43A (September 1982): 718.

degree of positive or negative attitude toward the two approaches. He recommended further studies to improve software for computer-assisted instruction and to compare the effectiveness of computer-assisted instruction in addition to traditional in-class instruction versus traditional in-class instruction alone.

Bowman<sup>1</sup> investigated precollege music theory remediation utilizing a multimedia learning sequence comprising a programmed music theory fundamentals text, rhythm reading tapes, and computer-assisted ear training. One of two selected equivalent-ability groups of first-year music majors in remedial sections of music theory received traditional classroom instruction. The other group received the multimedia learning sequence, including the fundamentals text used in a monitored class setting as well as rhythm reading tapes and computer-assisted ear training used independently. All students in both groups met the criterion for advancement to the next level of the music theory curriculum. She concluded that the multimedia sequence was an equally effective and more efficient instructional alternative at this level, owing to the removal from the classroom of drill in rudiments of music. Questionnaires and interviews regarding participating students' precollegiate music study revealed, in particular, neglect of aural practice in independent preparation for music theory entrance tests. With respect to this finding, Bowman concluded that computer-assisted instruction—with its capabilities of individualized instruction and independent drill—is uniquely appropriate for systematic preparation in ear training, and that it has potential to ease the transition from high school to college music study.

---

<sup>1</sup>Judith A. Bowman, "An Investigation of Two Methods of Preparation for College Level Music Theory," *Dissertation Abstracts International* 45A (September 1984): 779-80.

Bresler<sup>1</sup> investigated the impact of the use of a computer-based education system on a college-level introductory music theory class. Seventeen students voluntarily used a student-controlled program in music theory and ear training. Through analysis of extensive observations of the class and individual computer-use sessions, open-ended interviews, written materials, and responses to two sets of questionnaires, the researcher drew several conclusions. Regarding integration, computer availability had no impact on the curriculum of the class, and teacher reluctance to relinquish a position of authority hindered the integration of the computer into the curriculum. Barriers encountered by students comprised lack of on-line guidance, poor sound quality, presentation of isolated musical elements, a discouraging grading system on the computer, and system software bugs. Although the computer had substantial impact on the learning of some students, it had little impact on the learning of most students. Bresler suggested that, even when an educational innovation offers significant advantages, its adoption and use may create problems for teachers and students that make the innovation less successful than it might otherwise be. She encouraged development of curricula that fully realize the potential of the computer through its proper integration.

Polot<sup>2</sup> compared computer-assisted harmonic aural skills instruction in ear-to-pencil and keyboard ear-to-hand modes, and investigated the relative importance of kinesthetic reinforcement and aural reinforcement in the

---

<sup>1</sup>Liora Bresler, "The Role of the Computer in a Music Theory Classroom: Integration, Barriers, and Learning," *Dissertation Abstracts International* 48A (January 1988): 1689.

<sup>2</sup>Polot, "An Investigation of Aural Reinforcement and Kinesthetic Reinforcement."

keyboard mode (n = 21). In his summary of studies related to computer-assisted instruction for the development of aural skills, he concluded that computer-assisted instruction in music had matured from a state of infancy in the late 1960s to a state of relative sophistication in the late 1980s. As evidence of this maturation, he noted the following: (1) evolution of the nature of research in computer-assisted instruction in music from questions of “if” to questions of “how”; (2) increased availability and reduced cost of computer equipment; and (3) resolution of almost all shortcomings of computer-assisted instruction in music that were described or implied in the literature of the 1960s and 1970s (e.g., lack of affordable and available equipment, poor display and manipulative capabilities of computer screens, inferior sound quality of electronic instruments, lack of instantaneous access to prerecorded sounds, lack of standardization of music peripheral equipment, and difficult evaluation of instrumental music performance).

### Summary

In summary, the studies related to computer-assisted aural skills training suggest that it enhances the teaching/learning environment in the following ways: (1) it is easily and frequently accessible for training, (2) it is a reliable sound source, (3) it provides personalized responses, and (4) it provides confidential feedback.

These studies also suggest that it enhances the teaching/learning process in the following ways: (1) it enables flexibility of teaching strategies, (2) it is an effective supplement to traditional instruction, (3) it is a more efficient means of skill development, (4) it offers individualized, self-paced training, (5) it offers immediate repetition of sound controlled by the student, (6) it enables

students to work more successfully by allowing them to interrupt sequences of exercises, (7) it offers immediate reinforcement, contingency responses, and evaluation, (8) it is superior to traditional self-practice regarding content organization, (9) it maintains detailed and accurate records of student performance, and (10) it provides valuable information about how students attain, maintain, and retain aural skill proficiency.

These studies suggest that it enhances student achievement in the following ways: (1) it significantly improves identification of rhythmic, melodic, and harmonic aural stimuli, (2) it increases pitch awareness when students are required to respond by producing pitches, and (3) it significantly improves sightsinging achievement.

Finally, the studies related to computer-assisted aural skills training suggest an evolution of student attitudes and motivation during the 25-year period from 1967 to 1992. As the nature of research changed and as computer technology became more available and less cumbersome, students became much more comfortable with computer-assisted instruction in music. In consideration of these developments, it is appropriate to conclude that computer-assisted aural skills training currently enhances student attitudes and motivation in the following ways: (1) it is preferred by many students over both traditional and programmed instruction, (2) it is a unique source of motivation that reduces the level of frustration for both less skilled and more skilled students, and (3) it is uniquely appropriate for systematic preparation in ear training and, as such, has the potential to ease the transition from high school to college music study.

### Music Achievement

A review of research relevant to music achievement as delimited in this investigation yielded studies by Rohrs; Thostenson; Stone; George; Ernest; Melton; Dudd; Brown and Alley; Arenson; Leverett; Barnet; Harrison; and Harrison, Asmus, and Serpe.

These studies comprise a diversity of research. Collectively, they represent consideration of several variables in a number of settings, each hypothesized to have some impact on the music achievement of undergraduate students majoring in music. In the interest of clarity, the studies discussed are divided into two categories: (1) those with undergraduate music achievement defined as a music history, aural music theory, written music theory, or class piano outcome, and (2) those with undergraduate music achievement defined as other than a music history, aural music theory, written music theory, or class piano outcome.

Studies in the first category include those by Rohrs; Thostenson; George; Melton; Arenson; Leverett; Harrison; and Harrison, Asmus, and Serpe. Studies in the second category include those by Stone, Ernest, Dudd, Brown and Alley, and Barnet.

Music History, Aural Music Theory, Written Music  
Theory, or Class Piano Outcomes

Rohrs<sup>1</sup> investigated the prediction of academic success in a liberal arts college music education program (n = 168). The criteria were achievement (grades) in music theory, music history, music education, and applied music as well as grade point averages (GPAs) for college music and college overall. He determined that music theory achievement, college music GPA, and college overall GPA are most practically predicted by a set of measures that comprises a psychological examination score, two of nine Kuder Preference Record scores, a social adjustment inventory score, and high school GPA.

Thostenson,<sup>2</sup> in a study of 147 first-year college students majoring in music, evaluated certain problems in ear training achievement (music dictation and sightsinging). Among the relationships investigated were those of proficiency in music dictation and sightsinging to type of degree being sought, major instrument area, and amount of private instruction on major instrument. Results suggested that major instrument area and extent of training on the instrument—especially at the beginning of formal training—both are important factors in first-year music dictation and sightsinging achievement. Recommendations included: (1) the use of ear training testing at the beginning of the first year to identify those students with potentially severe problems as well as those students who can be expected to make superior progress, (2)

---

<sup>1</sup>Dennis K. Rohrs, "Predicting Academic Success in a Liberal Arts College Music Education Program," *Dissertation Abstracts International* 23A (February 1962): 2937.

<sup>2</sup>Marvin S. Thostenson, "The Study and Evaluation of Certain Problems in Eartraining Related to Achievement in Sightsinging and Music Dictation," *Bulletin of the Council for Research in Music Education* 11 (Fall 1967): 14-35.

further research comparing the effectiveness of various methods of teaching ear training, (3) further research directed toward deriving yet new methods for teaching ear training, and (4) further research to determine relationships between ear training achievement, major instrument area, and extent of precollege ear training.

In response to the fact that most previous studies of college music achievement had been of general achievement for the first semester or first year, George<sup>1</sup> investigated the significance of specific achievement criteria for predicting music education degree completion ( $n = 304$ ). Predictor variables included high school achievement; music theory and ear training entrance examinations; previous piano study; and grade point averages (GPAs) for harmony, dictation and sightreading, keyboard harmony, form and analysis, music arranging, music theory, applied piano, applied major instrument, music history and literature, music education techniques, music methods, and student teaching. He concluded that the three most important predictors of graduation from a music education degree program were high school achievement, music theory GPA, and dictation and sightreading GPA. He also concluded that non-graduates could not be identified with much accuracy.

Melton,<sup>2</sup> in a study of differences among groups of college students majoring in music ( $n = 500+$ ), reported that applied music grades had very low correlations with music grade point average (GPA), college overall GPA, and

---

<sup>1</sup>Warren E. George, "Significant Predictors for College Achievement in Specified Areas of Music Education and Identification of Potential Graduates, (Volumes One and Two)," *Dissertation Abstracts International* 30A (January 1970): 3040.

<sup>2</sup>Ellis E. Melton, Jr., "A Study of Differences Among Various Groups of Michigan State University Music Students," *Dissertation Abstracts International* 34A (June 1974): 7809.

music achievement and aptitude test scores. He also reported a weak relationship between applied music grades and aural harmony GPA. He recommended less emphasis on paper-and-pencil tests and more emphasis on student behaviors in actual musical situations when considering students for admission to undergraduate music education degree programs.

Arenson<sup>1</sup> investigated the extent to which the Scholastic Aptitude Test (SAT), the Colwell Music Achievement Test (MAT), the Ohio State University (OSU) Entrance Test Battery (in music), a rhythm-tapping test, a sightsinging test, and type of instrument played predicted freshman music theory grades in written/keyboard and music dictation/sightsinging classes (n = 192). Results included a moderate positive relationship between rhythm-tapping test score and written/keyboard theory grade, and a moderate positive relationship between OSU Battery ear training scores (six of nine subtests) and music dictation/sightsinging grade. There was very little relationship between either rhythm-tapping test or sightsinging test score and music dictation/sightsinging grade. Also, there were negligible relationships of Colwell MAT scores and type of instrument played to either music theory outcome.

Leverett<sup>2</sup> investigated relationships between completion of degree and admissions data, high school activities and honors, and music academic records for students in professional music degree programs (n = 219). Significant differences in first-semester music theory grades existed between degree program graduates and non-graduates. He found significant, positive

---

<sup>1</sup>Michael A. Arenson, "The Validity of Certain Entrance Tests as Predictors of Grades in Music Theory and Ear Training," *Bulletin of the Council for Research in Music Education* 75 (Summer 1983): 33-39.

<sup>2</sup>John M. Leverett, "Relationships Between Freshman Admissions Data and the Completion of a Bachelor of Music Degree," *Dissertation Abstracts International* 45A (September 1984): 679.

relationships between high school grade point average (GPA) and first-semester music theory grade, between Scholastic Aptitude Test (SAT) score and first-semester music theory grade, and between first-semester music theory grade and college overall GPA. He recommended that music theory placement examinations be given at entry, and that music advisors use the relationships mentioned above to suggest student potential for success in music theory and in professional degree programs.

Harrison has made several substantial contributions to the literature on prediction of college music achievement. Her efforts relevant to the proposed research questions of this dissertation are parts of a series of studies of the relative efficiency of several predictors of freshman music theory achievement, both composite and component.

In the first study of this series (n = 121), Harrison<sup>1</sup> examined factors of academic ability (Scholastic Aptitude Test score), academic achievement (high school grade point average), musical aptitude (College Musical Aptitude Profile), precollege music experience (private study and ensemble experience), principal instrument, and gender with respect to music theory grades in each of the two semesters in the freshman year. She determined that the best predictors of achievement in the first semester of freshman music theory are SAT score, high school GPA, and incidence of piano study. The best predictors of achievement in the second semester of freshman music theory are SAT score, high school GPA, being a keyboard or vocal performer, and experience on more than one instrument. Harrison recommended that, for the first semester of music theory, students with little or no piano experience should be enrolled in

---

<sup>1</sup>Carole S. Harrison, "Predicting Music Theory Grades: The Relative Efficiency of Academic Ability, Music Experience, and Musical Aptitude," *Journal of Research in Music Education* 38 (Summer 1990): 124-37.

class piano concurrently. She also recommended further investigation of the role of principal instrument and of experience on more than one instrument.

In the second study of this series (n = 160), Harrison<sup>1</sup> investigated the relationships of the predictors in the first study to four component freshman music theory grades (written, sightsinging, ear training, keyboard harmony) in each of the two semesters of the freshman year. Results revealed that music experience and musical aptitude measures are the best predictors of sightsinging and keyboard harmony grades for the first two semesters and of ear training achievement for the second semester. She determined that the single best predictor of all four components in the first semester of freshman music theory is the SAT-Math score. Also, variables representing musical aptitude and music experience are significant predictors of sightsinging, ear training, and keyboard harmony achievement. Winds/percussion instrumentalists did less well than pianists and vocalists in written and sightsinging achievement. The SAT-Math score continues to be the most significant predictor of written achievement in the second semester of freshman music theory, but is not a significant predictor of the other three components. Variables representing musical aptitude, music experience, and academic achievement are significant predictors of sightsinging, ear training, and keyboard harmony achievement. Students who have more music experience and higher scores on measures of academic ability, academic achievement, and musical aptitude earn higher grades in all components of music theory than students who do not have as much experience or as high scores. Students whose principal instrument is piano or voice and all students who have piano

---

<sup>1</sup>Carole S. Harrison, "Relationships Between Grades in the Components of Freshman Music Theory and Selected Background Variables," *Journal of Research in Music Education* 38 (Fall 1990): 175-86.

experience appear to have higher levels of achievement in all four components of music theory than do those whose principal instrument is winds/percussion/orchestral or who have no piano experience. Harrison recommended further investigation of the role of principal instrument, music experience, and other predictor variables such as motivation for music, interest in music, amount of time devoted to out-of-class study, and study strategies for each of the components of music theory.

In the third study of this series (n = 142), Harrison, Asmus, and Serpe<sup>1</sup> hypothesized that musical aptitude, academic ability, music experience, and motivation for music affected achievement in aural skills components (ear training and sightsinging) of freshman music theory coursework. Results of data analysis indicated that musical aptitude has the largest effect on ear training and sightsinging achievement. Effects of academic ability and music experience also are significant; the effect of motivation for music is not significant. The researchers concluded that ear training and sightsinging skills have sets of predictors that are distinctly different from those of other forms of music achievement, and that investigation of other indicator variables is needed.

---

<sup>1</sup>Carole S. Harrison, Edward P. Asmus, and Richard T. Serpe, "Effects of Musical Aptitude, Academic Ability, Music Experience, and Motivation on Aural Skills," *Journal of Research in Music Education* 42 (Summer 1994): 131-44.

## Other Outcomes

Stone<sup>1</sup> conducted a study of 245 students to examine predictability of achievement (grade point averages) in freshman music performance, music non-performance, and non-music courses. Predictor variables included high school percentile rank, Scholastic Aptitude Test (SAT) score, music theory placement score, and scores from six scales of the Opinion, Attitude, and Interest Survey (OAIS). Results indicated that music theory placement score is the single best predictor of achievement in both music performance and music non-performance. Stone concluded that, for freshmen music applicants, comprehensive admissions decisions should include serious consideration of music theory placement scores.

Ernest<sup>2</sup> investigated relationships between selected precollege scores, college cumulative honor point ratio (HPR), and college music honor point ratio (MHP) of college music graduates (n = 68). Results indicated that high school rank (HSR) is the best single predictor for both HPR and MHP. He recommended periodic reevaluation of the use of such measures in evaluating applicants for admission or in predicting degree of academic success.

In a longitudinal study in admissions (n = 134), Dudd<sup>3</sup> investigated pre-enrollment criteria used for selecting university music students who were

---

<sup>1</sup>Michael H. Stone, "A Study of the Relationships Between Selected Variables and the Differential Academic Achievement of Freshmen in The University of Michigan School of Music" (Ph.D. dissertation, University of Michigan, 1969).

<sup>2</sup>David J. Ernest, "The Prediction of Academic Success of College Music Majors," *Journal of Research in Music Education* 18 (Fall 1970): 273-76.

<sup>3</sup>John E. Dudd, "The Prediction of Success as Defined by Graduation Grade Point Averages, Graduation, and Music as an Occupation of Freshmen

successful in music degree programs and persisted in music as an occupation. He found non-music academic achievement variables to be the most useful predictors of college graduation grade point average (GPA), and musically-related variables to be the most useful predictors of music performance GPA and persistence in music as an occupation. Although the relationship between college graduation GPA and persistence in music as an occupation is not significant, the relationship between graduation and persistence in music as an occupation is highly significant. Dudd concluded that applicants to college music programs who are selected on the basis of academic achievement, high school music accomplishment, and personality traits have the greatest chance for success in music degree programs and in music as an occupation.

In a longitudinal study of music education student attrition and persistence through an undergraduate program of studies (n = 201), Brown and Alley<sup>1</sup> investigated predictor variables of college overall and high school grade point averages (GPAs), jury grade at end of one year of applied study on principal instrument, Aliferis-Stecklein Music Achievement Test score, desire to become a music educator, first-semester level of teaching competence, and extent of participation in music organizations. College overall GPA and first-year jury grade consistently are the strongest predictors of persistence in the music education major for freshmen and transfer students. The researchers emphasized the importance of the applied music variable in persistence

---

Enrolled in The University of Michigan School of Music in September, 1962: A Longitudinal Study in Admissions" (Ph.D. dissertation, University of Michigan, 1978).

<sup>1</sup>Amy Brown and Jayne M. Alley, "Multivariate Analysis of Degree Persistence of Undergraduate Music Education Majors," *Journal of Research in Music Education* 31 (Winter 1983): 271-81.

research and articulated an urgent need for early intervention programs for those students not meeting appropriate college standards in any component of study.

Barnet<sup>1</sup> conducted a study of prediction of music major academic success with 1,328 full-time freshmen majoring in music at seven selected institutions. He partitioned academic success (achievement) into music academic grade point average (MAGPA), music performance grade point average (MPGPA), and non-music grade point average (NMGPA). He found the Scholastic Aptitude Test (SAT) score and high school rank to be the best predictors of MAGPA, the SAT score to be the best predictor of NMGPA, and no highly effective predictors of MPGPA. The Gordon Musical Aptitude Profile (MAP) correlated best with MAGPA and least with MPGPA.

### Summary

In summary, the studies related to undergraduate music achievement categorized as a music history, aural music theory, written music theory, or class piano outcome contain the following recommendations relevant to the present study: (1) concurrent enrollment in class piano by first-semester music theory students with little or no piano experience; (2) further investigation of the roles of principal instrument; music experience; and other predictor variables such as motivation for music, interest in music, amount of time devoted to out-of-class study, and study strategies in predicting music theory composite and component (written, sightsinging, ear training, keyboard harmony) grades; (3)

---

<sup>1</sup>Richard D. Barnet, "Differential Validity and Prediction of Academic Success of Music Students," *Dissertation Abstracts International* 47A (January 1987): 2472.

use of ear training testing at the beginning of the first year to identify those students with potentially severe problems as well as those students who can be expected to make superior progress; (4) further investigation of the effectiveness of various methods of teaching ear training; new methods for teaching ear training; and relationships between ear training achievement, major instrument area, and extent of precollege ear training; and (5) investigation for the purpose of identifying other predictors of ear training and sightsinging—skills that are distinctly different from other forms of music achievement.

The studies related to undergraduate music achievement categorized as other than a music history, aural music theory, written music theory, or class piano outcome contain the following conclusions relevant to the present study: (1) periodic reevaluation of the use of selected data in college music admissions decisions and achievement predictions is necessary, (2) the applied music variable is important in persistence research, and (3) there is an urgent need for early intervention programs for those students not meeting appropriate college standards in any component of study.

### Socialization of Students Majoring in Music

A review of research relevant to socialization of students majoring in music as defined in this investigation yielded studies by Kingsbury, Casey, Wratsher, and Plasket.

Kingsbury,<sup>1</sup> in an ethnographic study of a well-known American conservatory of music, focused on the cultural dynamics of music and musical practices traditionally found in such institutions. He hypothesized that music, musical meanings, and values could not be known or understood effectively when divorced from their sociocultural contexts. For purposes of his study, Kingsbury defined musical “talent” in terms of cultural representation rather than in more traditional terms. That is, he defined musical “talent” as “. . . the attributions that link the socio-musical esteem of the person said to be talented with that of the person attributing this talent . . .” rather than as an inherent individual trait. The researcher examined the social organization of the conservatory and analyzed it in terms of pedagogical lineages and “cliques” of students (who studied either the same principal performance medium or with the same teacher). He also studied formal recitals from both soloist and audience perspectives, and analyzed them as “. . . rituals in a cult of the individual . . . that emphasize the split between individual and group . . . and sacralize highly skilled expressive behavior.” This investigation emphasized the subjective and humanist aspects of music rather than the technical and absolutist aspects, and Kingsbury’s analyses demonstrated that basic terms such as “talent,” “music,” and “musicianship” can mean different things to different people—even to those within the music profession.

Casey<sup>2</sup> explored selected characteristics of undergraduate music students at Northwestern University to develop a student profile in terms of

---

<sup>1</sup>Henry O. Kingsbury, “Music as a Cultural System: Structure and Process in an American Conservatory,” *Dissertation Abstracts International* 46A (July 1985): 190.

<sup>2</sup>Donald E. Casey, Jr., “A Profile of the Undergraduate Music Majors at Northwestern University in Terms of Attitude, Demographics, Self Concept, and

attitude, self concept, personal orientation, and demographic characteristics, and to determine the extent to which those data were predictive of student attrition, specialization, and achievement. The researcher administered six measures (three published and three investigator-constructed) to five groups of current or former undergraduate music students to gather data on self concept, personal orientation, college student satisfaction, demographic characteristics, music career attitudes, and ratings of applied instructors, respectively. In addition, he gathered data from university records on high school rank, Scholastic Aptitude Test (SAT) quantitative and verbal scores, School of Music audition score, and university grade point average (GPA) after six quarters of study. Casey examined the self concept of the entering freshman group longitudinally three times (beginning, midpoint, and conclusion of the year) by repeatedly administering appropriate subtests of the three published measures. He concluded that the typical undergraduate music student at Northwestern University could be described as bright, able, persistent, and well-satisfied with most aspects of university life, and that this typical student was most attracted to careers in performance or college-level teaching and had high regard especially for the applied instructor.

Wratcher<sup>1</sup> conducted a study (comprising a survey and a related workshop) of first-year students majoring in music at Carnegie Mellon University to assist students in adapting more easily to many changes they experienced in the transition from high school to college. She hypothesized that if first-year

---

Personal Orientation," *Dissertation Abstracts International* 47A (November 1986): 1642.

<sup>1</sup>Marcia A. Wratcher, "Helping Freshmen to Maximize Their Learning Potential," *Journal of College Student Development* 32 (July 1991): 380-81.

students knew more about themselves individually as learners, then each may adapt more easily to a college environment by maximizing factors contributing to academic success. For two consecutive years during incoming student orientation (August), the researcher administered a learning styles inventory to a total of sixty first-year students majoring in music. Results of the inventory revealed some commonalities about the students' learning styles, including strong self-motivation, strong adult-motivation, strong persistence, strong auditory preferences, moderate tactile preferences, strong preference for bright lighting, strong preference for learning alone, a need for mobility while learning, and peak energy times in late afternoon and early evening. Results of the inventory also revealed some polarities about the students' learning styles, including a need for a quiet environment, preference for a cool temperature, and preference for a formal learning design.

The related workshop was held several weeks into the fall semester of each year to enable students to become familiar with the curriculum as well as their individual needs. Although it had been believed generally that talented students with a history of academic success would succeed despite obstacles encountered during college, through initial workshop discussions Wratcher found this not to be true of first-year students in music. Obstacles to assimilation into the keenly competitive environment at Carnegie Mellon University included variety of student backgrounds, different levels of academic preparation, the need to structure time, practice requirements, and exposure to new courses. Workshop activities therefore focused on the question, "How does your learning style impact on your major, your courses, and your college experiences?" As students considered their individual learning styles and needs, they became able to analyze course content and organization, class locations, and places for study and practice as part of a process of making accommodations to maximize

their learning. Participating students also reported greater appreciation of individual differences among peers and, accordingly, better perspective regarding the competition factor of the music program. Wratsher concluded that knowledge of individual learning styles was empowering to students. Although they could not control *what* material was to be learned, they had considerable control over *how* it was to be learned. As first-year students majoring in music became aware of cognitive, affective, and environmental factors of their learning styles, they made accommodations to create better learning situations.

Plasket<sup>1</sup> conducted an interview-based case study of the New England Conservatory to determine the extent to which the institution addressed educational issues common to all first-year college students and beyond those related exclusively to training performers and developing artists. These issues comprised the need to balance time, requirements for general education, and personal development for life beyond performance. The researcher discovered that the school, with its highly competitive and performance-oriented environment, experienced difficulty in addressing these issues. She found that, even within a narrowly focused conservatory setting, fundamental differences existed concerning the interpretation of institutional goals. These differences of interpretation limited the effects of various components of the program intended to prepare students for life beyond performance. These differences also created tension and often led to conflict for students between aspects of their professional and personal development. In the absence of shared beliefs about institutional goals, the dominance of studio performance appeared to drive institutional decision-making. Students who had positive experiences in

---

<sup>1</sup>Donna J. Plasket, "Training Musicians and Developing People: Can a Music Conservatory Do It All?" *Dissertation Abstracts International* 53A (August 1992): 437.

personal development attributed them principally to close association with individual studio teachers. Plasket discovered that, while students received an excellent studio and performance-based education, they had uneven and sometimes frustrating experiences elsewhere in their conservatory education. She concluded overall that the New England Conservatory did not have an effective institutional plan for preparing professional musicians and developing people.

### Summary

In summary, the studies related to socialization of students majoring in music offer the following conclusions relevant to the present study: (1) basic terms such as “talent,” “music,” and “musicianship” can mean different things to different people—even to those within the music profession; (2) first-year students in music with a history of academic success may not successfully assimilate into a keenly competitive music environment owing to obstacles of background, different levels of academic preparation, the need to structure time, practice requirements, and exposure to new courses; (3) music students may have uneven and frustrating experiences in non-performance aspects of their education; (4) music conservatories with highly competitive and performance-oriented environments may experience difficulty in addressing student issues such as the need to balance time, requirements for general education, and personal development for life beyond performance; (5) fundamental differences concerning the interpretation of institutional goals for music conservatories may limit the effects of various components of degree programs intended to prepare music students for life beyond performance; (6) in the absence of shared beliefs about institutional goals for music conservatories, the dominance of studio

performance can drive institutional decision-making; (7) undergraduate music students at selective institutions may have high regard especially for their applied instructors; (8) music students who have positive experiences in personal development may attribute them principally to close association with individual studio teachers; and (9) awareness of cognitive, affective, and environmental factors of one's individual learning style can empower first-year music students to create better learning situations.

### Summary

This review of related research revealed several points relevant to the present study. First, performance-based aural musicianship is important to all undergraduate students majoring in music in that it is highly correlated with other aural skills, is a strong predictor of instructional effectiveness, and can be improved through training. Second, computer-assisted aural skills training enhances the teaching/learning environment, the teaching/learning process, student achievement, and student attitudes and motivation in many ways. Third, further investigation of class piano experience, principal performance medium experience, and methods of teaching ear training as they relate to music achievement is warranted. Fourth, there is an urgent need for early intervention programs for those students not meeting appropriate standards in music study. Fifth, first-year students majoring in music—regardless of their academic histories—may not successfully assimilate into a keenly competitive music environment.

Lacking in any of the studies reviewed was: (1) an examination of the relationships between performance-based aural musicianship and traditional measures of music achievement in core coursework, (2) an examination of the

relationships between traditional measures of music achievement in core coursework and socialization of first-year students majoring in music, and (3) an examination of the relationships between performance-based aural musicianship and socialization of first-year students majoring in music.

### **Comparison and Contrast of Present Study to Related Research**

The present study is similar to some of the studies reviewed in that it: (1) utilizes undergraduate students majoring in music as subjects, (2) examines relationships between performance-based aural musicianship and a number of other variables, (3) offers a computer-assisted aural skills training opportunity, and (4) explores the socialization of first-year students majoring in music.

The present study differs from studies reviewed in that it: (1) examines relationships between performance-based aural musicianship, traditional measures of music achievement in core coursework, and socialization of students majoring in music; (2) offers a computer-assisted ear-to-hand coordination training opportunity in a class piano setting; (3) offers a computer-assisted ear-to-hand coordination training opportunity that features self-initiating, self-directing, self-monitoring capabilities; and (4) defines music achievement in terms of grades in music history, aural music theory, written music theory, and class piano courses and results of a measure of ear-to-hand coordination.

## CHAPTER III

### METHODS AND PROCEDURES

#### Introduction

The purpose of this chapter is to describe the specific methods and procedures employed in the study, including: (1) design of the study, (2) selection of participants for the study, (3) procedures employed to gather student descriptive data, (4) procedures employed to gather student music achievement data, (5) the computer-assisted keyboard ear-to-hand coordination training opportunity, and (6) procedures employed to gather student socialization data.

#### Design of the Study

Quantitative research methods assume the application of an underlying empirical standard to social phenomena; qualitative research methods assume the value of understanding behavior from the perspective of participants. The “tension” between these two paradigms creates a research arena in which resolution of the question at hand requires synthesis of the results of each approach into a new perspective.<sup>1</sup>

---

<sup>1</sup>Ray C. Rist, “Overview on the Relations among Educational Research Paradigms: From Disdain to Detente,” *Anthropology & Education Quarterly* 8 (May 1977): 48.

Traditionally, quantitative methods have been judiciously applied in music education research in the interest of identifying isolated initial, middle, and final points of student progress. Qualitative methods, on the other hand, have been applied to describe entire processes of learning; researchers have taken into account many more factors than quantitative efforts would have allowed.<sup>1</sup>

Music is a social phenomenon—an inextricable part of one's culture. Accordingly, this investigation of relationships between performance-based aural musicianship, selected indices of music achievement, and socialization of first-year students employed both quantitative and qualitative methods. A blend of methodologies was needed to describe accurately and adequately the experiences of first-year students majoring in music at the University of Michigan. Quantitative methods facilitated examination of descriptive characteristics, performance-based aural musicianship skill levels, and selected indices of music achievement of first-year students majoring in music. Complementary qualitative methods enabled consideration of the socialization of students at the School of Music.

The quantitative portion of the investigation focused on relationships between performance-based aural musicianship and selected indices of music achievement for first-year students majoring in music who were enrolled in first term music theory during fall semester 1992 (N = 71). Also, effects of computer-assisted keyboard ear-to-hand coordination training were addressed for first-year students majoring in music who were enrolled in class piano during winter semester 1993 (N = 16).

---

<sup>1</sup>Jerrold Ross, "Qualitative Evaluation and Its Importance for Research in Arts Education," *Southeastern Journal of Music Education* 1 (1989): 64.

The qualitative portion of the investigation focused on relationships between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization for first-year students majoring in music with the most severe deficiencies in performance-based aural musicianship who were enrolled in class piano during winter semester 1993 ( $n = 4$ ). In particular, relationships of socio-musical self-esteem to deficiencies in instrumental ear-to-hand coordination and selected indices of music achievement were addressed.

### Selection of Participants for the Study

#### First-Year Students Majoring in Music

The study was conducted during the 1992-1993 academic year at the University of Michigan School of Music. All first-year students majoring in music who were enrolled in first term music theory during fall semester 1992 were informed of the study ( $N = 89$ ). Seventy-one of these students signed informed consent forms and agreed to authorize access to academic records for collection of student descriptive and music achievement data and to participate in testing of performance-based aural musicianship (see Appendix C).

#### Computer-Assisted Keyboard Ear-to-Hand Coordination Training Subjects

Subsequently, of the seventy-one consenting students who had been enrolled in first term music theory during fall semester 1992, sixteen were enrolled in second term class piano during winter semester 1993. All sixteen of

these students agreed to participate as subjects in a six-week exploratory computer-assisted keyboard ear-to-hand coordination training opportunity in a class piano setting.

### **Case Study Subjects**

Finally, of the sixteen ear-to-hand training subjects, the four who scored lowest in testing of performance-based aural musicianship (during first term music theory in fall semester 1992) agreed to participate as subjects in semester-long case studies of relationships between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization.

### **Procedures Employed to Gather Student Descriptive Data**

The seventy-one consenting students who were enrolled in first term music theory during fall semester 1992 were informed that data would be gathered from School of Music Admissions Office records regarding gender, ethnicity, major concentration (program), and principal performance medium.

Procedures Employed to Gather Student Music  
Achievement Data

**Music History, Aural Music Theory, Written Music  
Theory, and Class Piano**

The seventy-one consenting students who were enrolled in first term music theory during fall semester 1992 were informed that data would be gathered from School of Music Dean's Office records regarding grades in music history, aural music theory, written music theory, and class piano.

**Instrumental Ear-to-Hand Coordination**

Also, the seventy-one consenting students participated in testing of performance-based aural musicianship on their principal instrumental performance media<sup>1</sup> as measured by the "Test of Melodic Ear-to-Hand Coordination" (TMEHC), administered during the week of 16 November 1992.

This measurement served as the pretest score for the sixteen ear-to-hand training subjects. To help determine effects of computer-assisted keyboard ear-to-hand coordination training, the TMEHC was administered as a posttest to these subjects on their principal instrumental performance media during the week of 19 April 1993.

---

<sup>1</sup>The TMEHC was administered to voice students on piano.

### The Measure of Instrumental Ear-to-Hand Coordination

For purposes of this study, performance-based aural musicianship was defined by scores on the “Test of Melodic Ear-to-Hand Coordination” (TMEHC).<sup>1</sup> The TMEHC is a criterion-referenced test designed to determine a subject’s ability to perform short melodic patterns in a “listen-play what you hear” format on her or his principal instrumental performance medium. The TMEHC consists of one hundred four-beat melodic patterns arranged in nine sequences of increasing difficulty. All patterns are performed at the same tempo to an accompanying beat. The test was produced with a synthesizer and is recorded on cassette tape.

The TMEHC emphasizes common intervallic patterns that include ascending and descending stepwise melodic patterns and major, minor, diminished, and augmented triads and tetrachords. The range does not exceed one octave. Intervals include minor seconds through perfect fifths. The melodic patterns begin with a repeated unison pitch and proceed to more complex triadic and diatonic melodic patterns. Rhythmic complexity is limited with an emphasis on melodic patterns.

At the beginning of the TMEHC, the subject is engaged in a sequence of eight practice exercises after a short verbal explanation of the program. The starting concert pitch is given before each sequence begins.

Scoring of the TMEHC requires an adjudicator to evaluate each pattern as having been replicated correctly or incorrectly by the subject with a scoring sheet provided for this purpose (see Appendix D). One hundred percent

---

<sup>1</sup>James O. Froseth, “Test of Melodic Ear-to-Hand Coordination (TMEHC)” (unpublished diagnostic test, 1982).

melodic accuracy is a “correct” response; one or more melodic errors is an “incorrect” response. Rhythmic accuracy is not evaluated. Administration of the TMEHC requires approximately thirteen minutes.

Test reliability of the TMEHC has been established in a number of studies. Humphreys,<sup>1</sup> Froseth,<sup>2</sup> and Kuehn<sup>3</sup> reported split-half reliability coefficients of .98, .98, and .97, respectively, for the current one hundred-item version of the test. Investigating the original 132-item version of the test, Sang<sup>4</sup> also reported a split-half reliability coefficient of .98. The TMEHC also has

---

<sup>1</sup>Jere T. Humphreys, “An Investigation of an Experimental Harmonic Audiation Skills Testing and Training Program for Instrumental Music Education Majors” (Ph.D. dissertation, University of Michigan, 1984), 81.

<sup>2</sup>James O. Froseth, “A Longitudinal Study of the Relationship Between Melodic Ear-to-Hand Coordination and Selected Indices of Musical Achievement at the University of Michigan School of Music” (unpublished research report, University of Michigan, 1985), 4.

<sup>3</sup>John W. Kuehn, “A Three-Year Study of the Relationship Between Freshman Melodic Ear-to-Hand Scores and Standard Indicators of Musical Achievement at Indiana University of Pennsylvania Department of Music,” *PMEA News* (May 1990): 14-15.

<sup>4</sup>Richard C. Sang, “Modified Path Analysis of a Skills-Based Instructional Effectiveness Model for Beginning Teachers in Instrumental Music Education” (Ph.D. dissertation, University of Michigan, 1982), 113.

strong predictive validity, based on its use in studies by Sang,<sup>1</sup> Humphreys,<sup>2</sup> Froseth,<sup>3</sup> Markovich,<sup>4</sup> Wilder,<sup>5</sup> and Kuehn.<sup>6</sup>

The TMEHC was administered individually in a room with a Marantz variable pitch audio cassette tape machine, amplifier, and speakers. Care was taken to ensure that the tuning of each student's principal performance instrument was compatible with the tape playback machine.

The researcher conducted all administrations of the TMEHC. The researcher: (1) attempted to create a relaxed atmosphere; (2) supplied the student's name, principal performance instrument, and date on the scoring sheet; (3) stopped the tape after the eight practice exercises to offer clarification if there was confusion; and (4) did not stop the tape after sequence one was begun. The researcher also briefly explained to each student that she or he: (1) would hear one hundred items arranged in nine sequences of increasing difficulty, (2) should echo what is heard on the tape, and (3) should try not to become frustrated if many items are missed since the test is designed to discriminate.

<sup>1</sup>Ibid.

<sup>2</sup>Jere T. Humphreys, "An Investigation of an Experimental Harmonic Audiation Skills Testing and Training Program."

<sup>3</sup>James O. Froseth, "A Longitudinal Study."

<sup>4</sup>Victor A. Markovich, "An Investigation of the Effects of Matching Timbre and Training on Melodic Ear-to-Hand Coordination of College Music Majors" (Ph.D. dissertation, University of Michigan, 1985).

<sup>5</sup>Michael D. Wilder, "An Investigation of the Relationship Between Melodic Ear-to-Hand Coordination and Written and Aural Theory Skills within an Undergraduate Music Theory Context" (Ph.D. dissertation, University of Michigan, 1988).

<sup>6</sup>John W. Kuehn, "A Three-Year Study."

### The Computer-Assisted Keyboard Ear-to-Hand Coordination Training Opportunity

Of the seventy-one consenting students who had been enrolled in first term music theory during fall semester 1992, sixteen were enrolled in second term class piano during winter semester 1993. All sixteen of these students agreed to participate as subjects in a six-week exploratory computer-assisted keyboard ear-to-hand coordination training opportunity. The purpose was to determine effects of computer-assisted keyboard ear-to-hand coordination training on the nature of relationships between instrumental ear-to-hand coordination and selected indices of music achievement.

#### **The Computer-Assisted Training Groups**

Subjects were assigned randomly to one of two computer-assisted groups—Group A or Group B—to experience self-initiated, self-directed, self-monitored keyboard ear-to-hand coordination training.<sup>1</sup> Members of each group had 24-hour access during their respective six-week periods to one of three electronic media rooms at the School of Music dedicated to the present study. Each of these rooms contained a Macintosh Plus computer, a Casio Pro-200 electronic keyboard, and instructions for participation in the computer-assisted training program (see Appendix E). The researcher maintained all

---

<sup>1</sup>Subjects were assigned randomly to one of two computer-assisted groups owing to availability of facilities at the School of Music. The researcher determined that the three electronic media rooms available for use in this portion of the study would most appropriately meet the training needs of eight students at a time rather than sixteen. Members of Group A participated in computer-assisted keyboard ear-to-hand coordination training from 18 January-28 February 1993; members of Group B participated from 08 March-18 April 1993.

equipment, implemented the training exercise sequence and calendar (see Appendix F), and was available for consultation with subjects regarding hardware or software issues on a daily basis during the computer-assisted training portion of the present study.

### The Computer-Assisted Training Content

The computer-assisted keyboard ear-to-hand coordination training content reinforced the class piano curriculum. Sets of practice and test exercises were generated by the researcher that were compatible with the textbook used in the class piano course.<sup>1</sup> Exercises were adapted from content in the MLR Melodic Ear-to-Hand Skills Program<sup>2</sup> and the MLR Harmonic Ear-to-Hand Skills Program.<sup>3</sup> The melodic exercises were limited to those employing a stationary hand position with the right thumb anchored on middle C. The harmonic exercises were limited to those employing primary chords (tonic, subdominant, and dominant) in a stationary hand position with either the right thumb anchored on middle C or the left little finger anchored on C one octave below middle C (see Appendix G).

---

<sup>1</sup>Hilley, Martha, and Lynn Freeman Olson, PDM I: Piano for the Developing Musician, 2d ed. (New York: West, 1985).

<sup>2</sup>James O. Froseth, MLR Melodic Ear-to-Hand Skills Program (Chicago: G.I.A., 1985).

<sup>3</sup>James O. Froseth, MLR Harmonic Ear-to-Hand Skills Program (Chicago: G.I.A., 1985).

## The Computer-Assisted Training Delivery

Subjects used *Instant Replay*,<sup>1</sup> a MIDI-based ear-training program for the Macintosh computer that engages students in melodic and harmonic ear-to-hand coordination training and testing. This software provides instantaneous, individualized aural feedback and features extensive record-keeping, including student registrations, diaries, test scores, and test items (see Appendix H).

In “by item” mode (used for practice sets in the present study), *Instant Replay* performs a programmed exercise, records the student’s keyboard response, compares the computer-generated presentation with the student’s keyboard response, and informs the student whether a response is “Correct” or “Incorrect.”<sup>2</sup> If a response is “Incorrect,” the student is allowed to select from among: “Hear Your Response,” “Hear the Item,” “Try Again,” or “Go On.” This mode enables the student to develop her or his own diagnostic tools and encourages her or him to keep trying until an item is performed correctly. The student may work on practice sets as many times as desired.

In “continuous” mode (used for test sets in the present study), *Instant Replay* performs each programmed exercise without interruption, allowing the student exactly enough time to play back what she or he has heard before advancing to the next item. After completing all items in a set, *Instant Replay* evaluates the student’s performance. This mode permits the student only one

---

<sup>1</sup>James O. Froseth and Barton Polot, *Instant Replay: An Authoring System for Performance-based Ear-training Version 1.0* (Chicago: G.I.A., 1991).

<sup>2</sup>Exercises are evaluated as either all correct or incorrect, and rhythmic content is not evaluated.

attempt at each item; the student must wait until the end of the last item to learn the results. The student may work on test sets only once.

The sets of exercises were generated with *Teacher Create*,<sup>1</sup> an instructional authoring system for *Instant Replay* that supports any combination of melodic and harmonic items. With *Teacher Create*, the researcher used a Macintosh SE/30 computer and a Casio Pro-200 electronic keyboard to create, edit, and organize sets of practice and test exercises. The software has extensive customization features that provided the researcher with the means to control the content, sequence, presentation, and record-keeping features of *Instant Replay*.

#### Procedures Employed to Gather Student Socialization Data

Of the sixteen ear-to-hand training subjects, the four who scored lowest in testing of performance-based aural musicianship (during first term music theory in fall semester 1992) agreed to participate as subjects in semester-long case studies of relationships between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization. Specifically, the case study subjects were those individuals for whom a severe deficiency in performance-based aural musicianship, as substantiated by their test scores, was likely to have negatively affected their music achievement, socialization, and, ultimately, chances for success as undergraduate students majoring in music.

---

<sup>1</sup>James O. Froseth and Barton Polot, *Teacher Create: Melodic and Harmonic Ear-to-Hand Training at the Keyboard Version 1.0* (Chicago: G.I.A., 1991).

## The Case Study Method

The case study method was employed to document the socialization of these four students, who experienced stress and trauma associated with severe deficiencies in aural musicianship. This methodology enabled personalized, detailed investigation of the nature of the relationships between computer-assisted keyboard ear-to-hand coordination training; achievement in music history, aural music theory, written music theory, and class piano courses; and socio-musical self-esteem.

According to LeCompte and Goetz, certain characteristics of the case study method account for the strong reliability and validity of this approach.<sup>1</sup> To optimize reliability, five factors must be included in any report based on this qualitative technique: (1) identification and description of the researcher role; (2) description and background of the participants; (3) descriptions of settings in which observations take place; (4) identification of methods for data collection and analysis; and (5) explanation and outline of the theoretical framework guiding the study. Validity is claimed to be a major strength of qualitative research, since data collection through interviews, observations, and journals allows the researcher flexibility to examine the knowledge and meanings construed by the participants.

---

<sup>1</sup>Margaret D. LeCompte and Judith Preissle Goetz, "Problems of Reliability and Validity in Ethnographic Research," *Review of Educational Research* 52 (Spring 1982): 31-60.

### Interviews, Observations, and Journals

The researcher gathered data regarding the four case study subjects throughout the semester of the computer-assisted keyboard ear-to-hand coordination training opportunity (winter 1993). Data gathering included weekly meetings of the researcher and each student as well as periodic meetings of the researcher and the major applied music instructor of each student.

The weekly meetings featured researcher interviews and observations of students and student sharing of day-to-day personal journal entries. Interviews occurred in a graduate student teaching assistant office; observations occurred in an electronic media room. The periodic meetings occurred in the major applied instructor's studio and featured discussion of the instructor's perceptions of any relationships between melodic and harmonic ear-to-hand coordination training, selected indices of music achievement, and socialization with respect to her or his student participant.

In the context of these semester-long case studies, the researcher collected data for the purposes of describing student experiences with computer-assisted keyboard ear-to-hand coordination training and documenting relationships between this training, selected indices of music achievement, and socialization at the School of Music.

From interview, observation, and personal journal data, the researcher developed a descriptive profile of each case study subject. These descriptive profiles represent first-person, day-to-day narratives of the experiences of students with severe deficiencies in aural musicianship in a rigorous musical, academic, and social environment.

**CHAPTER IV**  
**PRESENTATION AND INTERPRETATION OF THE DATA**

**Descriptive Data for First-Year Students Majoring  
in Music**

Eighty-nine first-year students majoring in music were enrolled in first term music theory during fall semester 1992. Seventy-one of these students signed informed consent forms and agreed to authorize access to academic records for collection of student descriptive and music achievement data and to participate in testing of performance-based aural musicianship.

Descriptive statistics regarding gender, ethnicity, major concentration (program), and grouped principal performance medium of the seventy-one consenting students are presented in Tables 3-6.

**TABLE 3. GENDER OF FIRST-YEAR STUDENTS MAJORING IN MUSIC  
(N = 71)**

| <b><u>Gender</u></b> | <b><u>N</u></b> | <b><u>%</u></b> |
|----------------------|-----------------|-----------------|
| <b>Male</b>          | <b>36</b>       | <b>50.70</b>    |
| <b>Female</b>        | <b>35</b>       | <b>49.30</b>    |
| <b>Total</b>         | <b>71</b>       | <b>100.00</b>   |

TABLE 4. ETHNICITY OF FIRST-YEAR STUDENTS MAJORING IN MUSIC  
(N = 71)

| <u>Ethnicity</u>  | <u>N</u> | <u>%</u> |
|-------------------|----------|----------|
| African-American  | 3        | 4.23     |
| Asian-American    | 5        | 7.04     |
| Hispanic-American | 1        | 1.41     |
| White             | 56       | 78.87    |
| Not Reported      | 6        | 8.45     |
| Total             | 71       | 100.00   |

TABLE 5. MAJOR CONCENTRATION (PROGRAM) OF FIRST-YEAR  
STUDENTS MAJORING IN MUSIC  
(N = 71)

| <u>Major Concentration (Program)</u> | <u>N</u> | <u>%</u> |
|--------------------------------------|----------|----------|
| Music Composition                    | 2        | 2.82     |
| Music Education                      | 14       | 19.72    |
| Music History                        | 1        | 1.41     |
| Music Performance                    | 47       | 66.19    |
| Music Technology                     | 5        | 7.04     |
| Music Theory                         | 2        | 2.82     |
| Total                                | 71       | 100.00   |

**TABLE 6. GROUPEd PRINCIPAL PERFORMANCE MEDIUM OF FIRST-YEAR  
STUDENTS MAJORING IN MUSIC  
(N = 71)**

| <b><u>Grouped Principal<br/>Performance Medium</u></b> | <b><u>N</u></b> | <b><u>%</u></b> |
|--------------------------------------------------------|-----------------|-----------------|
| Brass                                                  | 9               | 12.68           |
| Keyboard                                               | 17              | 23.94           |
| Percussion                                             | 5               | 7.04            |
| Stringed                                               | 19              | 26.76           |
| Voice                                                  | 8               | 11.27           |
| Woodwind                                               | 13              | 18.31           |
| Total                                                  | 71              | 100.00          |

**Instrumental Ear-to-Hand Coordination Data for  
First-Year Students Majoring in Music**

“Test of Melodic Ear-to-Hand Coordination” (TMEHC) mean scores by grouped principal performance medium of the seventy-one consenting students are presented in Table 7.

**TABLE 7. "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)  
MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE MEDIUM OF  
FIRST-YEAR STUDENTS MAJORING IN MUSIC  
(N = 71)**

| <u>Medium</u>      | <u>N</u> | <u>Minimum Score</u> | <u>Maximum Score</u> | <u>Mean</u> | <u>S.D.</u> |
|--------------------|----------|----------------------|----------------------|-------------|-------------|
| Brass              | 7        | 33                   | 79                   | 55.6        | 18.5        |
| Keyboard           | 17       | 31                   | 100                  | 75.4        | 20.0        |
| Percussion         | 5        | 10                   | 95                   | 45.2        | 35.6        |
| Stringed           | 16       | 18                   | 94                   | 65.9        | 24.5        |
| Voice <sup>a</sup> | 7        | 35                   | 84                   | 51.1        | 18.4        |
| Woodwind           | 11       | 26                   | 93                   | 49.5        | 20.7        |
| Missing            | 8        | --                   | --                   | --          | --          |
| Total              | 71       | 10                   | 100                  | 61.2        | 24.2        |

<sup>a</sup>administered on keyboard

Keyboard students had the highest average score (75.4), which can be interpreted as a "strong" level of ear-to-hand coordination (see Appendix B for score interpretation guidelines). Woodwind students and percussion students had the lowest average scores (49.5 and 45.2, respectively), each of which can be interpreted as a "limited" level of ear-to-hand coordination. On average, string students scored 65.9, which can be interpreted as a "substantial" level of ear-to-hand coordination. Brass students' and voice students' average scores were 55.6 and 51.1, respectively, each of which can be interpreted as a "moderate" level of ear-to-hand coordination.

Data in Table 7 represent a remarkably broad range of ability in melodic ear-to-hand coordination and, accordingly, a remarkably broad range of potential for success in music degree programs. As in the 1982 and 1991 research cited in Chapter I, the higher mean score of keyboard students suggests advantages inherent to keyboard instruments with respect to ear-to-hand coordination, although there is no direct evidence to confirm such a speculation.

Analysis of variance (ANOVA) was employed to compare mean scores by grouped principal performance medium of the seventy-one consenting students. Results are presented in Table 8.

TABLE 8. ANALYSIS OF VARIANCE (ANOVA) FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE MEDIUM OF FIRST-YEAR STUDENTS MAJORING IN MUSIC (N = 71)

| <u>Source of Variance</u> | <u>df</u> | <u>Sum of Squares</u> | <u>Mean Square</u> | <u>F-test</u> | <u>p</u> |
|---------------------------|-----------|-----------------------|--------------------|---------------|----------|
| Between Groups            | 5         | 7487.113              | 1497.423           | 2.962         | .0191*   |
| Within Groups             | 57        | 28817.966             | 505.578            |               |          |
| Total                     | 62        | 36305.079             |                    |               |          |

| <u>Comparison</u>   | <u>Mean Difference</u> | <u>Fisher PLSD</u> | <u>Scheffé F-test</u> | <u>Dunnett t</u> |
|---------------------|------------------------|--------------------|-----------------------|------------------|
| Keyboard/Stringed   | 9.537                  | 15.685             | 0.297                 | 1.218            |
| Keyboard/Brass      | 19.840                 | 20.223             | 0.772                 | 1.965            |
| Keyboard/Voice      | 24.269                 | 20.223*            | 1.155                 | 2.403            |
| Keyboard/Woodwind   | 25.866                 | 17.425*            | 1.768                 | 2.973            |
| Keyboard/Percussion | 30.212                 | 22.909*            | 1.395                 | 2.641            |
| Stringed/Brass      | 10.304                 | 20.406             | 0.205                 | 1.011            |
| Stringed/Voice      | 14.732                 | 20.406             | 0.418                 | 1.446            |
| Stringed/Woodwind   | 16.330                 | 17.637             | 0.688                 | 1.854            |
| Stringed/Percussion | 20.675                 | 23.071             | 0.644                 | 1.795            |
| Brass/Voice         | 4.429                  | 24.070             | 0.027                 | 0.368            |
| Brass/Woodwind      | 6.026                  | 21.772             | 0.061                 | 0.554            |
| Brass/Percussion    | 10.371                 | 26.367             | 0.124                 | 0.788            |
| Voice/Woodwind      | 1.597                  | 21.772             | 0.004                 | 0.147            |
| Voice/Percussion    | 5.943                  | 26.367             | 0.041                 | 0.451            |
| Woodwind/Percussion | 4.345                  | 24.287             | 0.026                 | 0.358            |

\* Significant at 95%

Results in Table 8 indicate statistically significant differences in melodic ear-to-hand coordination skills between keyboard students and voice students, keyboard students and woodwind students, and keyboard students and percussion students ( $p \leq .05$ ). That is, in fall semester 1992, twenty-three (voice, woodwind, and percussion) of seventy-one students—32.39%, or one-third of the first-year class—began music degree programs with significant disadvantages in potential for success.

Statistics in Tables 7 and 8 confirm the continued existence of significant disparities in performance-based aural musicianship as measured by the “Test of Melodic Ear-to-Hand Coordination” (TMEHC) for first-year students according to grouped principal performance medium. This is a phenomenon that was first observed in 1982 and again in 1991 by Froseth (as cited in Chapter I). Data from the present study substantiate the persistence, over an eleven-year period, of a serious problem—that of large differences in potential for music achievement among first-year students majoring in music.

First Term Music History, Aural Music Theory,  
Written Music Theory, and Class Piano Achievement  
Data for First-Year Students Majoring In Music

Frequency distributions of first term grades in music history, aural music theory, written music theory, and class piano of the seventy-one consenting students are presented in Table 9.

**TABLE 9. FIRST TERM MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF FIRST-YEAR STUDENTS MAJORING IN MUSIC  
(N = 71)**

| <b>Grade</b> | <b>Music History</b> |          | <b>Aural Music Theory</b> |          | <b>Written Music Theory</b> |          | <b>Class Piano</b> |          |
|--------------|----------------------|----------|---------------------------|----------|-----------------------------|----------|--------------------|----------|
|              | <b>N</b>             | <b>%</b> | <b>N</b>                  | <b>%</b> | <b>N</b>                    | <b>%</b> | <b>N</b>           | <b>%</b> |
| A (4.0)      | 20                   | 28.17    | 22                        | 30.09    | 18                          | 25.35    | 1                  | 1.41     |
| A- (3.7)     | 3                    | 4.22     | 13                        | 18.31    | 10                          | 14.10    | 4                  | 5.63     |
| B+ (3.3)     | 4                    | 5.63     | 2                         | 2.82     | 8                           | 11.27    | 6                  | 8.45     |
| B (3.0)      | 25                   | 35.21    | 18                        | 25.35    | 18                          | 25.35    | 4                  | 5.63     |
| B- (2.7)     | 2                    | 2.82     | 4                         | 5.63     | 3                           | 4.22     | 3                  | 4.22     |
| C+ (2.3)     | 1                    | 1.41     | 2                         | 2.82     | 3                           | 4.22     | 2                  | 2.82     |
| C (2.0)      | 1                    | 1.41     | 4                         | 5.63     | 4                           | 5.63     | 1                  | 1.41     |
| C- (1.7)     | 1                    | 1.41     | 2                         | 2.82     | 3                           | 4.22     | 0                  | 0.00     |
| D+ (1.3)     | 0                    | 0.00     | 0                         | 0.00     | 2                           | 2.82     | 1                  | 1.41     |
| D (1.0)      | 0                    | 0.00     | 1                         | 1.41     | 0                           | 0.00     | 1                  | 1.41     |
| D- (0.7)     | 0                    | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                  | 0.00     |
| F+ (0.3)     | 0                    | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                  | 0.00     |
| F (0.0)      | 0                    | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                  | 0.00     |
| Not Enrolled | 14                   | 19.72    | 0                         | 0.00     | 0                           | 0.00     | 48                 | 67.61    |
| Missing      | 0                    | 0.00     | 3                         | 4.22     | 2                           | 2.82     | 0                  | 0.00     |
| Total        | 71                   | 100.00   | 71                        | 100.00   | 71                          | 100.00   | 71                 | 100.00   |
|              | Mean = B+ (3.3)      |          | Mean = B+ (3.3)           |          | Mean = B (3.2)              |          | Mean = B (2.9)     |          |
|              | S.D. = 0.57          |          | S.D. = 0.72               |          | S.D. = 0.74                 |          | S.D. = 0.76        |          |

Music history data in Table 9 suggest a very limited use of a thirteen-point grade scale. The distribution of music history grades has a moderate negative skew, and there is low variability of individual grades. Aural music theory data suggest a very limited use of a thirteen-point grade scale. The

distribution of aural music theory grades has an extreme negative skew, and there is only moderate variability of individual grades. Written music theory data suggest a limited use of a thirteen-point grade scale. The distribution of written music theory grades has an extreme negative skew, and there is only moderate variability of individual grades. Class piano data suggest a moderate use of a thirteen-point grade scale. The distribution of class piano grades has an extreme negative skew, and there is moderate variability of individual grades.

Relationships Between Instrumental Ear-to-Hand  
Coordination and Achievement in First Term Music  
History, Aural Music Theory, Written Music Theory,  
and Class Piano for First-Year Students Majoring  
in Music

Pearson product-moment correlation coefficients for ear-to-hand coordination scores and first term grades in music history, aural music theory, written music theory, and class piano of the seventy-one consenting students are presented in Table 10.

TABLE 10. PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS  
FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)  
SCORES AND FIRST TERM GRADES IN MUSIC HISTORY, AURAL MUSIC  
THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO OF FIRST-YEAR  
STUDENTS MAJORING IN MUSIC  
(N = 71)

| <u>Course</u>                                    | <u>Correlation with TMEHC</u> |
|--------------------------------------------------|-------------------------------|
| Music History<br>N = 57                          | .30*                          |
| Aural Music Theory<br>N = 68                     | .76***                        |
| Written Music Theory<br>N = 69                   | .29*                          |
| Class Piano<br>N = 23                            | .29                           |
| * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$ |                               |

There is a moderately weak positive, statistically significant relationship between instrumental ear-to-hand coordination and first term music history achievement ( $r = .30$ ,  $p \leq .05$ ). Statistical significance can be attributed to the large population ( $N = 57$ ). Data in Table 10 suggest that instrumental ear-to-hand coordination and the intellectual content of first term music history are relatively independent of one another.

There is a strong positive, statistically significant relationship between instrumental ear-to-hand coordination and first term aural music theory achievement ( $r = .76$ ,  $p \leq .001$ ). This suggests that instrumental ear-to-hand coordination can be generalized to the sightsinging and rhythmic, melodic, and harmonic dictation skills associated with first term aural music theory.

There is a moderately weak positive, statistically significant relationship between instrumental ear-to-hand coordination and first term written music theory achievement ( $r = .29, p \leq .05$ ). Statistical significance can be attributed to the large population ( $N = 69$ ). Data in Table 10 suggest that instrumental ear-to-hand coordination and the intellectual content of first term written music theory are relatively independent of one another.

There is a moderately weak positive relationship between instrumental ear-to-hand coordination and first term class piano achievement ( $r = .29$ ). The content of first term class piano comprises the following: (1) reading, analyzing, performing, and memorizing repertoire from the course text; (2) developing facility and fluency with technical exercises; (3) harmonizing melodies using primary chords (tonic, subdominant, and dominant); (4) transposing; (5) developing ear-to-hand skills; and (6) playing by ear and improvising.<sup>1</sup> An anomaly exists in that, given the content of first term class piano, one might expect a stronger positive relationship between ear-to-hand coordination and class piano achievement. The correlation coefficient suggests that first term class piano is graded more heavily—if not exclusively—on reading, analyzing, performing, memorizing, developing facility and fluency, harmonizing melodies, and transposing from visual (notated) rather than aural (by ear) modes of music.

### Descriptive Data for Ear-to-Hand Training Subjects

Of the seventy-one consenting students who had been enrolled in first term music theory during fall semester 1992, sixteen were enrolled in second

---

<sup>1</sup>University of Michigan School of Music, "Class Piano Course Syllabus and Examination Requirements" (unpublished document, 1992-1993).

term class piano during winter semester 1993. In addition to authorizing access to academic records for collection of student descriptive and music achievement data and participating in testing of performance-based aural musicianship, these sixteen students agreed to participate as subjects in a six-week exploratory computer-assisted keyboard ear-to-hand coordination training opportunity in a class piano setting.

Descriptive statistics regarding gender, ethnicity, major concentration (program), and grouped principal performance medium of the sixteen ear-to-hand training subjects are presented in Tables 11-14.

**TABLE 11. GENDER OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)**

| <u>Gender</u> | <u>N</u> | <u>%</u> |
|---------------|----------|----------|
| Male          | 8        | 50.00    |
| Female        | 8        | 50.00    |
| Total         | 16       | 100.00   |

TABLE 12. ETHNICITY OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)

| <u>Ethnicity</u>  | <u>N</u> | <u>%</u> |
|-------------------|----------|----------|
| African-American  | 0        | 0.00     |
| Asian-American    | 0        | 0.00     |
| Hispanic-American | 0        | 0.00     |
| White             | 16       | 100.00   |
| Total             | 71       | 100.00   |

TABLE 13. MAJOR CONCENTRATION (PROGRAM) OF EAR-TO-HAND  
TRAINING SUBJECTS  
(N = 16)

| <u>Major Concentration (Program)</u> | <u>N</u> | <u>%</u> |
|--------------------------------------|----------|----------|
| Music Composition                    | 0        | 0.00     |
| Music Education                      | 7        | 43.75    |
| Music History                        | 0        | 0.00     |
| Music Performance                    | 9        | 56.25    |
| Music Technology                     | 0        | 0.00     |
| Music Theory                         | 0        | 0.00     |
| Total                                | 16       | 100.00   |

**TABLE 14. GROUPED PRINCIPAL PERFORMANCE MEDIUM OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)**

| <b><u>Grouped Principal Performance Medium</u></b> | <b><u>N</u></b> | <b><u>%</u></b> |
|----------------------------------------------------|-----------------|-----------------|
| Brass                                              | 3               | 18.75           |
| Keyboard <sup>a</sup>                              | 0               | 0.00            |
| Percussion                                         | 1               | 6.25            |
| Stringed                                           | 4               | 25.00           |
| Voice                                              | 3               | 18.75           |
| Woodwind                                           | 5               | 31.25           |
| Total                                              | 16              | 100.00          |

<sup>a</sup>The absence of keyboard majors in the ear-to-hand training group is owing to the fact that training was offered in the context of class piano, a course that keyboard majors are not required to take.

**Pre-Training Instrumental Ear-to-Hand Coordination**  
**Data for Ear-to-Hand Training Subjects**

“Test of Melodic Ear-to-Hand Coordination” (TMEHC) pretest mean scores by grouped principal performance medium of the sixteen ear-to-hand training subjects are presented in Table 15.

**TABLE 15. "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)  
PRETEST MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE  
MEDIUM OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)**

| <u>Medium</u>      | <u>N</u> | <u>Minimum Score</u> | <u>Maximum Score</u> | <u>Mean</u> | <u>S.D.</u> |
|--------------------|----------|----------------------|----------------------|-------------|-------------|
| Brass              | 3        | 33                   | 68                   | 44.7        | 20.2        |
| Keyboard           | 0        | --                   | --                   | --          | --          |
| Percussion         | 1        | 54                   | 54                   | 54.0        | --          |
| Stringed           | 4        | 27                   | 91                   | 63.2        | 30.6        |
| Voice <sup>a</sup> | 3        | 37                   | 45                   | 40.0        | 4.4         |
| Woodwind           | 5        | 26                   | 73                   | 46.6        | 18.7        |
| Total              | 16       | 26                   | 91                   | 49.6        | 20.4        |

<sup>a</sup>administered on keyboard

As expected, in the absence of any keyboard majors in the ear-to-hand training group, string students had the highest average score (63.2); this can be interpreted as a "substantial" level of ear-to-hand coordination (see Appendix B for score interpretation guidelines). Brass students, woodwind students, and voice students had the lowest average scores (44.7, 46.6, and 40.0, respectively), each of which can be interpreted as a "limited" level of ear-to-hand coordination. Unexpected was the percussion student's score of 54.0, which can be interpreted as a "moderate" level of ear-to-hand coordination. This is not representative of percussion students' average score (45.2) in the group of seventy-one consenting music majors, which was interpreted as a "limited" level of ear-to-hand coordination.

Analysis of variance (ANOVA) was employed to compare pretest mean scores by grouped principal performance medium of the sixteen ear-to-hand training subjects. Results are presented in Table 16.

**TABLE 16. ANALYSIS OF VARIANCE (ANOVA) FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) PRETEST MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE MEDIUM OF EAR-TO-HAND TRAINING SUBJECTS (N = 16)**

| <u>Source of Variance</u> | <u>df</u> | <u>Sum of Squares</u> | <u>Mean Square</u> | <u>F-test</u> | <u>p</u> |
|---------------------------|-----------|-----------------------|--------------------|---------------|----------|
| Between Groups            | 4         | 1159.133              | 289.783            | 0.629         | .6516    |
| Within Groups             | 11        | 5064.617              | 460.420            |               |          |
| Total                     | 15        | 6223.750              |                    |               |          |

| <u>Comparison</u>   | <u>Mean Difference</u> | <u>Fisher PLSD</u> | <u>Scheffé F-test</u> | <u>Dunnett t</u> |
|---------------------|------------------------|--------------------|-----------------------|------------------|
| Stringed/Percussion | 9.250                  | 52.808             | 0.037                 | 0.386            |
| Stringed/Woodwind   | 16.650                 | 31.685             | 0.335                 | 1.157            |
| Stringed/Brass      | 18.583                 | 36.075             | 0.321                 | 1.134            |
| Stringed/Voice      | 23.250                 | 36.075             | 0.503                 | 1.419            |
| Percussion/Woodwind | 7.400                  | 51.741             | 0.025                 | 0.315            |
| Percussion/Brass    | 9.333                  | 54.540             | 0.035                 | 0.377            |
| Percussion/Voice    | 14.000                 | 54.540             | 0.080                 | 0.565            |
| Woodwind/Brass      | 1.933                  | 34.494             | 0.004                 | 0.123            |
| Woodwind/Voice      | 6.600                  | 34.494             | 0.044                 | 0.421            |
| Brass/Voice         | 4.667                  | 38.565             | 0.018                 | 0.266            |

Results in Table 16 indicate no statistically significant differences in melodic ear-to-hand coordination skills between string, percussion, woodwind, brass, or voice students prior to their participation in computer-assisted keyboard ear-to-hand coordination training. The lack of statistical significance can be attributed to the small population ( $N = 16$ ).

However, these differences in mean scores by grouped principal performance medium have practical significance—of primary importance to the validity of this study. A simple comparison of mean scores for voice (40.0), brass (44.7), woodwind (46.6), percussion (54.0), and string (63.2) students indicates a range of over 23.0 points in ear-to-hand coordination, which spans skill levels from “limited” (68.75% of subjects) to “moderate” (6.25% of subjects) to “substantial” (25.00% of subjects). This range represents considerable disparities in potential for success in music degree programs; it can be translated generally into lower music achievement and specifically into lower aural music theory grades for three-fourths (75.00%) of the first-year class.

First Term (Pre-Training) Music History, Aural  
Music Theory, Written Music Theory, and Class Piano  
Achievement Data for Ear-to-Hand Training Subjects

Frequency distributions of first term (pre-training) grades in music history, aural music theory, written music theory, and class piano of the sixteen ear-to-hand training subjects are presented in Table 17.

**TABLE 17. FIRST TERM (PRE-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)**

| <b>Grade</b>        | <b>Music History</b>   |          | <b>Aural Music Theory</b> |          | <b>Written Music Theory</b> |          | <b>Class Piano</b>    |          |
|---------------------|------------------------|----------|---------------------------|----------|-----------------------------|----------|-----------------------|----------|
|                     | <b>N</b>               | <b>%</b> | <b>N</b>                  | <b>%</b> | <b>N</b>                    | <b>%</b> | <b>N</b>              | <b>%</b> |
| <b>A (4.0)</b>      | 4                      | 25.00    | 5                         | 31.25    | 3                           | 18.75    | 1                     | 6.25     |
| <b>A- (3.7)</b>     | 2                      | 12.50    | 1                         | 6.25     | 1                           | 6.25     | 1                     | 6.25     |
| <b>B+ (3.3)</b>     | 0                      | 0.00     | 0                         | 0.00     | 2                           | 12.50    | 3                     | 18.75    |
| <b>B (3.0)</b>      | 6                      | 37.50    | 6                         | 37.50    | 6                           | 37.50    | 0                     | 0.00     |
| <b>B- (2.7)</b>     | 0                      | 12.50    | 1                         | 6.25     | 2                           | 12.50    | 2                     | 12.50    |
| <b>C+ (2.3)</b>     | 0                      | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 2                     | 12.50    |
| <b>C (2.0)</b>      | 0                      | 0.00     | 1                         | 6.25     | 1                           | 6.25     | 0                     | 0.00     |
| <b>C- (1.7)</b>     | 0                      | 0.00     | 1                         | 6.25     | 0                           | 0.00     | 0                     | 0.00     |
| <b>D+ (1.3)</b>     | 0                      | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                     | 0.00     |
| <b>D (1.0)</b>      | 0                      | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                     | 0.00     |
| <b>D- (0.7)</b>     | 0                      | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                     | 0.00     |
| <b>F+ (0.3)</b>     | 0                      | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                     | 0.00     |
| <b>F (0.0)</b>      | 0                      | 0.00     | 0                         | 0.00     | 0                           | 0.00     | 0                     | 0.00     |
| <b>Not Enrolled</b> | 2                      | 12.50    | 0                         | 0.00     | 0                           | 0.00     | 7                     | 43.75    |
| <b>Missing</b>      | 0                      | 0.00     | 1                         | 6.25     | 1                           | 6.25     | 0                     | 0.00     |
| <b>Total</b>        | 16                     | 100.00   | 16                        | 100.00   | 16                          | 100.00   | 16                    | 100.00   |
|                     | <b>Mean = B+ (3.3)</b> |          | <b>Mean = B (3.2)</b>     |          | <b>Mean = B (3.2)</b>       |          | <b>Mean = B (3.1)</b> |          |
|                     | <b>S.D. = 0.52</b>     |          | <b>S.D. = 0.74</b>        |          | <b>S.D. = 0.56</b>          |          | <b>S.D. = 0.60</b>    |          |

Music history data in Table 17 suggest a very limited use of a thirteen-point grade scale. The distribution of grades has a mild positive skew, and there is low variability of individual grades. The sixteen ear-to-hand training subjects are very similar to the seventy-one consenting music majors with

respect to achievement in first term (pre-training) music history. They exhibit nearly identical homogeneity of variance in grades.

Aural music theory data suggest a limited use of a thirteen-point grade scale. The distribution of grades has a moderate negative skew, and there is moderate variability of individual grades. The sixteen ear-to-hand training subjects are very similar to the seventy-one consenting music majors with respect to achievement in first term (pre-training) aural music theory. They exhibit nearly identical moderate variance in grades.

Written music theory data suggest a limited use of a thirteen-point grade scale. The distribution of grades has a mild negative skew, and there is low variability of individual grades. The sixteen ear-to-hand training subjects are similar to the seventy-one consenting music majors with respect to achievement in first term (pre-training) written music theory. They exhibit even more homogeneity of variance in grades.

Class piano data suggest a limited use of a thirteen-point grade scale. The distribution of grades has a mild positive skew, and there is moderately low variability of individual grades. The sixteen ear-to-hand training subjects are similar to the seventy-one consenting music majors with respect to achievement in first term (pre-training) class piano. They exhibit even more homogeneity of variance in grades.

Relationships Between Instrumental Ear-to-Hand  
Coordination (Pretest Score) and Achievement in  
First Term (Pre-Training) Music History, Aural  
Music Theory, Written Music Theory, and Class  
Piano for Ear-to-Hand Training Subjects

Pearson product-moment correlation coefficients for ear-to-hand coordination pretest scores and first term (pre-training) grades in music history,

aural music theory, written music theory, and class piano of the sixteen ear-to-hand training subjects are presented in Table 18.

**TABLE 18. PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) PRETEST SCORES AND FIRST TERM (PRE-TRAINING) GRADES IN MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO OF EAR-TO-HAND TRAINING SUBJECTS (N = 16)**

| <u>Course</u>                  | <u>Correlation with TMEHC Pretest</u> |
|--------------------------------|---------------------------------------|
| Music History<br>N = 14        | .15                                   |
| Aural Music Theory<br>N = 15   | .70**                                 |
| Written Music Theory<br>N = 15 | .05                                   |
| Class Piano<br>N = 9           | .37                                   |
| * $p \leq .05$ ** $p \leq .01$ |                                       |

There is a weak positive relationship between instrumental ear-to-hand coordination and first term (pre-training) music history achievement ( $r = .15$ ). This relationship for the sixteen ear-to-hand training subjects is similar to that for the seventy-one consenting music majors.

There is a strong positive, statistically significant relationship between instrumental ear-to-hand coordination and first term (pre-training) aural music theory achievement ( $r = .70$ ,  $p \leq .01$ ). This relationship for the sixteen ear-to-hand training subjects is nearly identical to that for the seventy-one consenting music majors.

There is almost no relationship between instrumental ear-to-hand coordination and first term (pre-training) written music theory achievement ( $r = .05$ ). This relationship for the sixteen ear-to-hand training subjects is similar to that for the seventy-one consenting music majors.

There is a moderate positive relationship between instrumental ear-to-hand coordination and first term (pre-training) class piano achievement ( $r = .37$ ). This relationship for the sixteen ear-to-hand training subjects is very similar to that for the seventy-one consenting music majors.

### Effects of Computer-Assisted Keyboard Ear-to-Hand Training

#### **“Test of Melodic Ear-to-Hand Coordination” (TMEHC) Pretest, Posttest, and Gain Scores**

“Test of Melodic Ear-to-Hand Coordination” (TMEHC) pretest, posttest, and gain scores of each of the sixteen ear-to-hand training subjects are presented in Table 19 in decreasing order of gain score.

TABLE 19. "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)  
PRETEST, POSTTEST, AND GAIN SCORES OF EAR-TO-HAND TRAINING  
SUBJECTS  
(N = 16)

| <u>Case Number</u> | <u>TMEHC Pretest</u> | <u>TMEHC Posttest</u> | <u>TMEHC Gain</u> |
|--------------------|----------------------|-----------------------|-------------------|
| 27                 | 33                   | 82                    | 49                |
| 79                 | 37                   | 76                    | 39                |
| 11                 | 33                   | 67                    | 34                |
| 68                 | 27                   | 51                    | 24                |
| 37                 | 32                   | 52                    | 20                |
| 69                 | 54                   | 73                    | 19                |
| 31                 | 38                   | 56                    | 18                |
| 29                 | 49                   | 65                    | 16                |
| 39                 | 68                   | 83                    | 15                |
| 55                 | 45                   | 60                    | 15                |
| 60                 | 73                   | 87                    | 14                |
| 43                 | 55                   | 69                    | 14                |
| 88                 | 47                   | 56                    | 09                |
| 25                 | 86                   | 94                    | 08                |
| 05                 | 91                   | 96                    | 05                |
| 82                 | 26                   | 28                    | 02                |
| Mean               | 49.62                | 68.44                 | 18.81             |
| S.D.               | 20.37                | 17.96                 | 12.51             |

Data in Table 19 suggest a broad range of “Test of Melodic Ear-to-Hand Coordination” (TMEHC) pretest scores—from a minimum of 26 to a maximum of 91. The distribution of scores has a moderate positive skew, and there is high variability of individual scores.

Data in Table 19 suggest a broad range of “Test of Melodic Ear-to-Hand Coordination” (TMEHC) posttest scores—from a minimum of 28 to a maximum of 96. The distribution of scores has a slight negative skew, and there is high variability of individual scores.

Data in Table 19 suggest a broad range of “Test of Melodic Ear-to-Hand Coordination” (TMEHC) gain scores—from a minimum of 2 to a maximum of 49. The distribution of scores has an extreme positive skew, and there is moderate variability of individual scores.

Of practical significance is the fact that each ear-to-hand training subject experienced a gain in “Test of Melodic Ear-to-Hand Coordination” (TMEHC) score after participating in computer-assisted keyboard ear-to-hand coordination training.

**“Test of Melodic Ear-to-Hand Coordination” (TMEHC)  
Pretest and Posttest Mean Scores**

A *t*-test was employed to compare “Test of Melodic Ear-to-Hand Coordination” (TMEHC) pretest and posttest mean scores of ear-to-hand training subjects. Results are presented in Table 20.

**TABLE 20. *t*-TEST FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) PRETEST AND POSTTEST MEAN SCORES OF EAR-TO-HAND TRAINING SUBJECTS (N = 16)**

| <u>Test</u>                                                          | <u>Mean</u> | <u>S.D.</u> | <u>t</u> | <u>p</u>  |
|----------------------------------------------------------------------|-------------|-------------|----------|-----------|
| TMEHC Pretest                                                        | 49.62       | 20.37       | -6.01    | .0001**** |
| TMEHC Posttest                                                       | 68.44       | 17.96       |          |           |
| * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$ **** $p \leq .0001$ |             |             |          |           |

Results in Table 20 indicate statistically significant differences between "Test of Melodic Ear-to-Hand Coordination" (TMEHC) pretest and posttest mean scores for computer-assisted keyboard ear-to-hand skills training subjects ( $p \leq .0001$ ). These data suggest that, on average, subjects significantly improved instrumental ear-to-hand coordination during the semester as measured by the "Test of Melodic Ear-to-Hand Coordination" (TMEHC). This improvement likely can be attributed in part to participation in computer-assisted keyboard ear-to-hand coordination training.

**"Test of Melodic Ear-to-Hand Coordination" (TMEHC)  
Posttest Mean Scores by Grouped Principal Performance  
Medium**

"Test of Melodic Ear-to-Hand Coordination" (TMEHC) posttest mean scores by grouped principal performance medium of the sixteen ear-to-hand training subjects are presented in Table 21.

**TABLE 21. "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)  
POSTTEST MEAN SCORES BY GROUPED PRINCIPAL PERFORMANCE  
MEDIUM OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)**

| <u>Medium</u> | <u>N</u> | <u>Minimum Score</u> | <u>Maximum Score</u> | <u>Mean</u> | <u>S.D.</u> |
|---------------|----------|----------------------|----------------------|-------------|-------------|
| Brass         | 3        | 67                   | 83                   | 77.3        | 9.0         |
| Keyboard      | 0        | --                   | --                   | --          | --          |
| Percussion    | 1        | 73                   | 73                   | 73.0        | --          |
| Stringed      | 4        | 51                   | 96                   | 76.5        | 22.1        |
| Voice         | 3        | 56                   | 76                   | 64.0        | 10.6        |
| Woodwind      | 5        | 28                   | 87                   | 58.4        | 21.8        |
| Total         | 16       | 28                   | 96                   | 68.4        | 18.0        |

Brass students, string students, and the percussion student had the highest average scores (77.3, 76.5, and 73.0, respectively), each of which can be interpreted as a "strong" level of ear-to-hand coordination (see Appendix B for score interpretation guidelines). Woodwind students had the lowest average score (58.4), which can be interpreted as a "moderate" level of ear-to-hand coordination. Voice students' average score was 64.0, which can be interpreted as a "substantial" level of ear-to-hand coordination.

Analysis of variance (ANOVA) was employed to compare posttest mean scores by grouped principal performance medium of the sixteen ear-to-hand training subjects. Results are presented in Table 22.

**TABLE 22. ANALYSIS OF VARIANCE (ANOVA) FOR "TEST OF MELODIC  
EAR-TO-HAND COORDINATION" (TMEHC) POSTTEST MEAN SCORES BY  
GROUPED PRINCIPAL PERFORMANCE MEDIUM OF EAR-TO-HAND  
TRAINING SUBJECTS  
(N = 16)**

| <u>Source of<br/>Variance</u> | <u>df</u> | <u>Sum of<br/>Squares</u> | <u>Mean<br/>Square</u> | <u>F-test</u> | <u>p</u> |
|-------------------------------|-----------|---------------------------|------------------------|---------------|----------|
| Between Groups                | 4         | 1081.071                  | 270.268                | 0.792         | .5544    |
| Within Groups                 | 11        | 3754.867                  | 341.352                |               |          |
| Total                         | 15        | 4835.938                  |                        |               |          |

| <u>Comparison</u>   | <u>Mean<br/>Difference</u> | <u>Fisher<br/>PLSD</u> | <u>Scheffé<br/>F-test</u> | <u>Dunnett t</u> |
|---------------------|----------------------------|------------------------|---------------------------|------------------|
| Brass/Stringed      | 0.833                      | 31.062                 | 0.001                     | 0.059            |
| Brass/Percussion    | 4.333                      | 46.961                 | 0.010                     | 0.203            |
| Brass/Voice         | 13.333                     | 33.206                 | 0.195                     | 0.884            |
| Brass/Woodwind      | 18.933                     | 29.701                 | 0.492                     | 1.403            |
| Stringed/Percussion | 3.500                      | 45.470                 | 0.007                     | 0.169            |
| Stringed/Voice      | 12.500                     | 31.062                 | 0.196                     | 0.886            |
| Stringed/Woodwind   | 18.100                     | 27.282                 | 0.533                     | 1.460            |
| Percussion/Voice    | 9.000                      | 46.961                 | 0.044                     | 0.422            |
| Percussion/Woodwind | 14.600                     | 44.551                 | 0.130                     | 0.721            |
| Voice/Woodwind      | 5.600                      | 29.701                 | 0.043                     | 0.415            |

Results in Table 22 indicate no statistically significant differences in melodic ear-to-hand coordination skills between brass, string, percussion, voice, or woodwind students following their participation in computer-assisted

keyboard ear-to-hand coordination training. The lack of statistical significance may be attributable to the small population ( $N = 16$ ).

More importantly, however, these post-training differences in mean scores by grouped principal performance medium have practical significance. A simple comparison of mean scores for woodwind (58.4), voice (64.0), percussion (73.0), string (76.5), and brass (77.3) students indicates a range of almost 19.0 points in melodic ear-to-hand coordination, less disparate than that of pre-training scores. This range spans skill levels from “moderate” (31.25% of subjects) to “substantial” (18.75% of subjects) to “strong” (50.00% of subjects)—an increase of at least one skill level for every participant in the six-week computer-assisted keyboard ear-to-hand coordination training. These data represent the improvement of 68.75% of subjects from a “limited” to either a “moderate,” “substantial,” or “strong” skill level, and the improvement of the remaining 31.25% of subjects from either a “moderate” or “substantial” to a “strong” skill level—dramatic positive shifts in melodic ear-to-hand coordination.

**Relationships Between Instrumental Ear-to-Hand  
Coordination (Posttest Score) and Achievement in  
Second Term (Post-Training) Music History, Aural  
Music Theory, Written Music Theory, and Class  
Piano for Ear-to-Hand Training Subjects**

Frequency distributions of second term (post-training) grades in music history, aural music theory, written music theory, and class piano of the sixteen ear-to-hand training subjects are presented in Table 23.

**TABLE 23. SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL  
MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES  
OF EAR-TO-HAND TRAINING SUBJECTS  
(N = 16)**

| <u>Grade</u> | Music History   |        | Aural Music Theory |        | Written Music Theory |        | Class Piano    |        |
|--------------|-----------------|--------|--------------------|--------|----------------------|--------|----------------|--------|
|              | N               | %      | N                  | %      | N                    | %      | N              | %      |
| A (4.0)      | 1               | 6.25   | 2                  | 12.50  | 3                    | 18.75  | 1              | 6.25   |
| A- (3.7)     | 1               | 6.25   | 2                  | 12.50  | 1                    | 6.25   | 4              | 25.00  |
| B+ (3.3)     | 0               | 0.00   | 2                  | 12.50  | 3                    | 18.75  | 3              | 18.75  |
| B (3.0)      | 5               | 31.25  | 0                  | 0.00   | 5                    | 31.25  | 5              | 31.25  |
| B- (2.7)     | 2               | 12.50  | 2                  | 12.50  | 2                    | 12.50  | 2              | 12.50  |
| C+ (2.3)     | 1               | 6.25   | 1                  | 6.25   | 0                    | 0.00   | 0              | 0.00   |
| C (2.0)      | 3               | 18.75  | 4                  | 25.00  | 0                    | 0.00   | 1              | 6.25   |
| C- (1.7)     | 1               | 6.25   | 1                  | 6.25   | 0                    | 0.00   | 0              | 0.00   |
| D+ (1.3)     | 0               | 0.00   | 1                  | 6.25   | 0                    | 0.00   | 0              | 0.00   |
| D (1.0)      | 0               | 0.00   | 0                  | 0.00   | 0                    | 0.00   | 0              | 0.00   |
| D- (0.7)     | 0               | 0.00   | 0                  | 0.00   | 0                    | 0.00   | 0              | 0.00   |
| F+ (0.3)     | 0               | 0.00   | 0                  | 0.00   | 0                    | 0.00   | 0              | 0.00   |
| F (0.0)      | 0               | 0.00   | 0                  | 0.00   | 1                    | 6.25   | 0              | 0.00   |
| Not Enrolled | 2               | 12.50  | 0                  | 0.00   | 0                    | 0.00   | 0              | 0.00   |
| Missing      | 0               | 0.00   | 1                  | 6.25   | 1                    | 6.25   | 0              | 0.00   |
| Total        | 16              | 100.00 | 16                 | 100.00 | 16                   | 100.00 | 16             | 100.00 |
|              | Mean = B- (2.7) |        | Mean = B- (2.7)    |        | Mean = B (3.0)       |        | Mean = B (3.2) |        |
|              | S.D. = 0.67     |        | S.D. = 0.89        |        | S.D. = 0.96          |        | S.D. = 0.50    |        |

Music history data in Table 23 suggest a slightly limited use of a thirteen-point grade scale. The distribution of grades has a mild positive skew, and there is moderately low variability of individual grades. On average, music

history grades of ear-to-hand training subjects dropped slightly from first term (B+) to second term (B–) and exhibited slightly more variability.

Aural music theory data suggest a slightly limited use of a thirteen-point grade scale. The distribution of grades has a mild positive skew, and there is high variability of individual grades. On average, aural music theory grades of ear-to-hand training subjects dropped slightly from first term (B) to second term (B–) and exhibited more variability.

Written music theory data suggest a very limited use of a thirteen-point grade scale. The distribution of grades has a mild negative skew, and there is low variability of individual grades. On average, written music theory grades of ear-to-hand training subjects remained the same from first term (B) to second term (B) and exhibited the same variability.

Class piano data suggest a limited use of a thirteen-point grade scale. The distribution of grades has a moderate negative skew, and there is low variability of individual grades. On average, class piano grades of ear-to-hand training subjects remained the same from first term (B) to second term (B) and exhibited slightly less variability.

Pearson product-moment correlation coefficients for ear-to-hand coordination posttest scores and second term (post-training) grades in music history, aural music theory, written music theory, and class piano of the sixteen ear-to-hand training subjects are presented in Table 24.

**TABLE 24. PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS FOR "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) POSTTEST SCORES AND SECOND TERM (POST-TRAINING) GRADES IN MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO OF EAR-TO-HAND TRAINING SUBJECTS (N = 16)**

| <u>Course</u>                  | <u>Correlation with TMEHC Posttest</u> |
|--------------------------------|----------------------------------------|
| Music History<br>N = 14        | -.20                                   |
| Aural Music Theory<br>N = 15   | .73**                                  |
| Written Music Theory<br>N = 15 | .15                                    |
| Class Piano<br>N = 16          | -.12                                   |
| * $p \leq .05$ ** $p \leq .01$ |                                        |

There is a weak negative relationship between instrumental ear-to-hand coordination and second term (post-training) music history achievement ( $r = -.20$ ). As demonstrated in analyses of first term (pre-training) data, music history achievement is practically unrelated to instrumental ear-to-hand coordination.

There is a strong positive, statistically significant relationship between instrumental ear-to-hand coordination and second term (post-training) aural music theory achievement ( $r = .73, p \leq .01$ ). As demonstrated in analyses of first term (pre-training) data, aural music theory achievement is strongly statistically and practically related to instrumental ear-to-hand coordination.

There is a weak positive relationship between instrumental ear-to-hand coordination and second term (post-training) written music theory achievement

( $r = .15$ ). As demonstrated in analyses of first term (pre-training) data, written music theory achievement is practically unrelated to instrumental ear-to-hand coordination.

There is a weak negative relationship between instrumental ear-to-hand coordination and second term (post-training) class piano achievement ( $r = -.12$ ). As demonstrated in analyses of first term (pre-training) data, class piano achievement is practically unrelated to instrumental ear-to-hand coordination.

Computer-assisted keyboard ear-to-hand coordination training had no effect on the relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, or class piano. That is, second term (post-training) relationships were nearly identical to first term (pre-training) relationships. In this study, the only such relationship of any significance—both statistical and practical—continues to be that of instrumental ear-to-hand coordination and aural music theory achievement.

### Descriptive Data for Case Study Subjects

#### Christopher

Christopher majored in music education with trumpet as his principal performance medium. He was an in-state (MI) resident who came to the University of Michigan from a public high school at which he earned a 2.8 grade point average (GPA). His admission to the University of Michigan School of Music was contingent upon satisfactory improvement of his academic record and ear-to-hand coordination. He chose to pursue this admission regardless of the fact that he was offered a full scholarship to major in music education at Western Michigan University. During his first year at the University of Michigan,

he studied trumpet with Professor Armando Ghitalla and performed in the Symphony Band and Philharmonia Orchestra.

### Joanna

Joanna majored in music education with double bass as her principal performance medium. She was an in-state (MI) resident who came to the University of Michigan from a public high school at which she earned a 3.9 grade point average (GPA). Her admission to the University of Michigan School of Music was contingent upon satisfactory improvement of her ear-to-hand coordination. During her first year she studied double bass with Professor Stuart Sankey and performed in the Philharmonia Orchestra.

### Kelly

Kelly majored in music performance with voice as her principal performance medium. She was an in-state (MI) resident who came to the University of Michigan from a public high school at which she earned a 3.0 grade point average (GPA). She also was accepted to major in music at Central Michigan University and Hope College. During her first year at the University of Michigan, she studied voice with Professor Leslie Guinn and performed in the Chamber Choir.

### Carrie

Carrie double-majored in Spanish and music performance with flute as her principal performance medium. She was an in-state (MI) resident who

came to the University of Michigan from a public high school at which she earned a 3.9 grade point average (GPA). She also applied to Northwestern University to double-major in Spanish and music. During her first year at the University of Michigan, she studied flute with Graduate Student Teaching Assistant Gina Hart-Kemper and performed in the Concert Band.

**Instrumental Ear-to-Hand Coordination Data for  
Case Study Subjects**

“Test of Melodic Ear-to-Hand Coordination” (TMEHC) pretest, posttest, and gain scores of case study subjects are presented in Table 25.

**TABLE 25. “TEST OF MELODIC EAR-TO-HAND COORDINATION” (TMEHC)  
PRETEST, POSTTEST, AND GAIN SCORES OF CASE STUDY SUBJECTS  
(n = 4)**

| <b><u>Subject</u></b> | <b><u>TMEHC Pretest</u></b> | <b><u>TMEHC Posttest</u></b> | <b><u>TMEHC Gain</u></b> |
|-----------------------|-----------------------------|------------------------------|--------------------------|
| Christopher           | 33                          | 67                           | 34                       |
| Joanna                | 27                          | 51                           | 24                       |
| Kelly                 | 37                          | 76                           | 39                       |
| Carrie                | 26                          | 28                           | 02                       |

Statistics in Table 25 indicate practically significant positive differences in “Test of Melodic Ear-to-Hand Coordination” (TMEHC) scores for three of four case study subjects. Christopher improved his skill level from “weak” (33) to “substantial” (67), an increase of three skill levels (see Appendix B for score interpretation guidelines). Joanna improved her skill level from “extremely

weak" (27) to "moderate" (51), an increase of three skill levels. Kelly improved her skill level from "weak" (37) to "strong" (76), an increase of four skill levels. Although Carrie's skill level of "extremely weak" did not change, she did improve her score (from 26 to 28).

Music History, Aural Music Theory, Written Music  
Theory, and Class Piano Achievement Data for Case  
Study Subjects

First term (pre-training) and second term (post-training) grades in music history, aural music theory, written music theory, and class piano of case study subjects are presented in Tables 26-29.

Christopher

TABLE 26. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF CHRISTOPHER

| <u>Course</u>             | <u>First Term<br/>Grade</u> | <u>Second Term<br/>Grade</u> |
|---------------------------|-----------------------------|------------------------------|
| Music History             | A- (3.7)                    | C- (1.7)                     |
| Aural Music Theory        | B (3.0)                     | C+ (2.3)                     |
| Written Music Theory      | C (2.0)                     | F (0.0)                      |
| Class Piano               | B- (2.7)                    | C (2.0)                      |
| Grade Point Average (GPA) | 2.57                        | 1.50                         |

Data in Table 26 suggest that Christopher experienced a precipitous decline in core music curriculum achievement from first term to second term.

Joanna

TABLE 27. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF JOANNA

| <u>Course</u>             | <u>First Term Grade</u> |       | <u>Second Term Grade</u> |       |
|---------------------------|-------------------------|-------|--------------------------|-------|
| Music History             | B                       | (3.0) | B                        | (3.0) |
| Aural Music Theory        | C                       | (2.0) | C                        | (2.0) |
| Written Music Theory      | B                       | (3.0) | B                        | (3.0) |
| Class Piano               | A                       | (4.0) | B+                       | (3.3) |
| Grade Point Average (GPA) |                         | 3.00  |                          | 2.82  |

Data in Table 27 suggest that Joanna experienced a slight decline in core music curriculum achievement from first term to second term.

Kelly

**TABLE 28. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF KELLY**

| <u>Course</u>             | <u>First Term Grade</u> | <u>Second Term Grade</u> |
|---------------------------|-------------------------|--------------------------|
| Music History             | A (4.0)                 | B (3.0)                  |
| Aural Music Theory        | A (4.0)                 | A (4.0)                  |
| Written Music Theory      | A (4.0)                 | A (4.0)                  |
| Class Piano               | Not Enrolled            | A (4.0)                  |
| Grade Point Average (GPA) | 4.00                    | 3.75                     |

Data in Table 28 suggest that Kelly experienced a slight decline in core music curriculum achievement from first term to second term.

## Carrie

**TABLE 29. FIRST TERM (PRE-TRAINING) AND SECOND TERM (POST-TRAINING) MUSIC HISTORY, AURAL MUSIC THEORY, WRITTEN MUSIC THEORY, AND CLASS PIANO GRADES OF CARRIE**

| <u>Course</u>             | <u>First Term Grade</u> | <u>Second Term Grade</u> |
|---------------------------|-------------------------|--------------------------|
| Music History             | Not Enrolled            | Not Enrolled             |
| Aural Music Theory        | Withdrew                | Not Enrolled             |
| Written Music Theory      | Withdrew                | Not Enrolled             |
| Class Piano               | C+ (2.3)                | B (3.0)                  |
| Grade Point Average (GPA) | 2.30                    | 3.00                     |

Data in Table 29 suggest that Carrie experienced slight improvement in class piano achievement from first term to second term.

**Interviews, Observations, and Journals of Case Study Subjects**

Following are representative excerpts of: (1) researcher interviews and observations of each case study subject, (2) entries in case study subject journals, and (3) researcher interviews of the major applied music instructor of each subject. The excerpts for each case study subject are presented in chronological order—from beginning to end of winter semester 1993. The excerpts for the major applied music instructor of each subject are from the culminating interview at the end of winter semester 1993.

**Christopher**

**"My trumpet teacher says that the worst part of my playing is my ear. That's motivation for me because there is always someone way ahead of me to keep chasing."**

**"My trumpet teacher says that I should do something with my ear to improve my intonation—that the thing that is holding me back is my ear."**

**"Ear-training seems to be more effective when it relates to day-in, day-out experiences with music; it generalizes to everything you do as a music major."**

**"Ear-training the way it is taught here should be more performance-based because it relates to everything I do."**

**"I didn't really care at the beginning of the year about ear training, but now it's really bothering me."**

**"Dictation drives me nuts and written theory is insane. I don't see any application to anything."**

**"I'm thinking of transferring to the New England Conservatory because of their ear training program, but I don't want to leave the University of Michigan as an institution."**

**Professor Armando Ghitalla**

**"I didn't think Chris would make it into the School of Music, but he worked incredibly hard over the summer."**

**"Solfège is not even offered here, so my students have three options: (1) private instruction with a local teacher outside the School of Music, (2) the Burge perfect pitch program,<sup>1</sup> or (3) solfège independent study."**

---

<sup>1</sup>David L. Burge, Perfect Pitch: Color Hearing for Expanded Musical Awareness (Presque Isle, MI: American Educational Music Publications, 1983).

**"During each one-hour lesson I spend ten minutes on rhythm and ten minutes on pitch. Sometimes I'm at my wit's end because I have to spend too much time on rhythm and pitch. I'm unsure of my ability to deal with deficient students."**

**"To have some aural skills self-help available for students would be wonderful."**

**Joanna**

**"I have tried practicing ear training on my own, but it never works."**

**"I went to the theory teaching assistant for help when I was getting Ds in dictation, but he was not that helpful. He said to '. . . sit down at the piano, play a note in the key of C, guess what it is, then see if you are right.'"**

**"I am totally afraid of 'ear-to-hand'; I never did anything like it in my life."**

**"My solfège grade is going up—from a B– to a B. I have more confidence now, especially with minor."**

**"This may be odd. I don't know if this work has affected my dictation abilities, but I seem to be really progressing in my sightsinging. I have become one of the better sightsingers in my class, especially true sightsinging."**

**"My ear training has been improving. I am feeling much more confident about it after my experiences with 'The Computer.'"**

**"My aural music experiences haven't been that great. I was never taught dictation or solfège before coming to the University of Michigan. I did have a little bit of theory with a few of my piano teachers, but that was mostly just learning the circle of fifths, etc. One of my bass teachers had me sing my part every once in a while, but I didn't use syllables. [Professor] Sankey asks me to sing a note every now and then so he knows that I have the pitch in my ears, but I have never thought about intervals. My solfège has been improving; I am feeling much more confident about even in minor. Also, in written theory, I have brought my grade up to an A from a B. I have been using the piano when I write out my theory in hopes that it will stick in my ear. I have also tried studying dictation with a friend. We played things we knew that are relatively easy and do dictation. I have also tried practicing intervals on their own, but so far nothing has worked. What is also**

odd is that I can get some very hard intervals but can't seem to identify seconds and thirds. I don't know if this has any relevance, but I am very good at telling whether things are in tune usually. When I began playing, the most important thing was to be in tune. It seems that is not necessarily the best way to learn because I had to learn to be expressive and to not care whether I hit a specific note or not but to continue and make it musical. In the beginning of last semester [Fall 1992], I believe that was why I was so shy and unwilling in my solfègeing. Every once in a while, I have a flash of musical brilliance and can identify a note in a musical piece I am hearing. It won't be that I thought of it in relation to a key. I will hear a note and say that it is a C, and when I play that note on the keyboard, it is."

### Professor Stuart Sankey

"Joanna tells me that she practices about an hour-and-a-half a day. I consider an acceptable minimum to be two-and-a-half to three hours, with four-and-a-half to five hours being necessary to compete as a performance major."

"She must learn to hear small intervals so that she can distinguish for intonation; that should be the focus of ear training."

"I encourage singing in lessons, and also playing a particular passage on piano."

"Success with aural skills has to do with starting age and memory. Piano and string players typically start much earlier; singers start much later."

"Aural skills are essential for jazz musicians to replicate melodies, but I'm not so sure of their usefulness for 'legit' musicians. Stravinsky, Stokowski, and Koussevitzky couldn't hear wrong notes. The Mitropoulos Conducting Competition once included a dictation test for the twenty finalists. The results were horrible; Claudio Abbado scored lowest. The judging committee decided to throw out the scores."

### Kelly

"We had a review session in aural skills this evening and I was really worried that I would do badly. I am having some trouble

distinguishing chord qualities in harmonic dictation. I have been writing out the letter names of chord pitches, but now we're modulating and it's getting too complicated for me to handle like that."

"The theory teaching assistant is helpful with dictation, but the practice dictation tapes are not helpful."

"In Chamber Choir it is difficult to sing correctly with mistakes around you. I have trouble sightreading; I find that I have to do a lot of repetition on my own."

"In studio lessons I am frustrated with pitches, but [Professor] Guinn wants only technique."

"I was asked by a composition student to sing in a quintet. The music is in free counterpoint, and I couldn't follow the conductor because the meter was changing every measure and I had to find pitches. It is very intimidating. The instrumentalists don't seem to understand that I just can't press a key for a note to come out. It is a very humbling experience."

"I'm starting to hear chord qualities in aural skills class—a big step!"

"I'm happy to report that my means of finding chord progressions has changed. I'm learning to use the idioms to determine what fits in certain contexts. Notes are starting to jump out at me here and there. Sometimes I don't have to try and figure out intervals. I just trust my instincts and I can figure out what works."

"Also, today in choir I noticed that I was singing the correct pitches in the songs when others kept screwing it up. I realized that I was improving not only my skills, but also my confidence."

"In my first year here at the University of Michigan, I experienced quite a bit of 'trauma' as I discovered that my ear training skills were not as solid as I thought. I was completely baffled that I was first asked to take dictation for my sightsinging class. As hard as I tried, I couldn't seem to grasp that concept. In high school, I was always considered to have the best 'ear' in my class. It frustrated me that I had to get help. Eventually, with the help of your program, I learned dictation quite well. In fact, I was able to learn a Hindemith work for choir quickly because the modes reminded me of the modal exercises that you had programmed for us."

"The other problem I experienced was in my voice lesson. My professor asked me to have three songs prepared each week. I had an accompanist to meet with for a half-hour each week, but, basically, I had to learn songs on my own. Even after I thought I knew them, I would still mess up some of the intervals. Oh sure, I

knew intervals well, but sometimes they were hard for me to pick out within a key. I think my professor started to get annoyed that I kept screwing up in my lessons. I started to think that he believed I wasn't practicing even though I practiced a lot!"

**Professor Leslie Guinn**

"Kelly comes from an 'unsophisticated' background (musically and otherwise)—she is the first person in her family to attend postsecondary school."

"It is interesting to watch changes in students' self-awareness during the first year."

**Carrie**

"I'm really desperate for aural skills help."

"If you wanted a worst-case scenario, I'm it!"

"I have lots of technique, but a weak ear and embouchure. I have a lot of problems with sightreading."

"The only aural focus I ever had in four years of All-State at Interlochen was intonation. Right now I'm not doing any ear activities except intonation in my lessons."

"Well, here I am. It's almost one o'clock, and now I know why I procrastinated to get here. I missed them all except the first one. This is embarrassing."

"I'm sorry, but I don't hear any difference between my response and the computer. Now it is almost two o'clock; I'm sorry, but I have to leave. I don't think I'm doing myself any good getting frustrated. I'm getting nearly every one wrong, and aural repetition doesn't help. Can there be some visual or textual explanation? I probably could have gotten more right if I wasn't so frustrated with the ones I got wrong."

"I really shouldn't have messed up as many as I did—I wasn't concentrating enough."

..

.

**"I am learning to listen more and a lot better. Now when the piano class teaching assistant does ear-to-hand, I can get it a lot more easily—before I didn't."**

**"One of the biggest benefits for me with this program is having to deal with modes in performance. I have to take a few shots at it before I get it."**

**"Now when I do ear training, I can get it a lot more easily. Before this program, I didn't."**

**"My School of Music friends are so disappointing—they have a bit of an attitude."**

**"I know I need to do this again, but I have to move on."**

**Graduate Student Teaching Assistant Gina Hart-Kemper**

**"Carrie has lots of technique, but a weak ear and embouchure."**

**"Professor Bryan did not accept her because of problems with sightreading and hearing (musical)."**

**"She was not very disciplined last semester [Fall 1992], and she has no adviser at the School of Music. We had a long talk in her lesson about what she needs to do to continue as a music major."**

**"She has a 'complex' against sightreading, but she's getting better. She gets together with another flute student to sightread each week. Each one is getting more confident—it could be social."**

**Relationships Between Deficiencies in Instrumental  
Ear-to-Hand Coordination: Achievement in Music  
History, Aural Music Theory, Written Music Theory,  
and Class Piano; and Socio-Musical Self-Esteem of  
Case Study Subjects**

**Interpretation of the descriptive and achievement data gathered from  
School of Music records; the instrumental ear-to-hand coordination data**

gathered from pre-training and post-training testing; and the narratives compiled from interviews, observations, and journals of each case study subject reveals four unique profiles of relationships between performance-based aural musicianship, selected indices of music achievement, and socialization.

### Christopher

Christopher experienced a gain of 34 points (from 33 to 67) in ear-to-hand coordination as measured on trumpet by the “Test of Melodic Ear-to-Hand Coordination” (TMEHC)—the third-largest gain of the sixteen ear-to-hand training subjects. This gain represents improvement of three levels in ear-to-hand coordination—from “weak” to “substantial” (see Appendix B for score interpretation guidelines).

As indicated in Table 35, his achievement in first term music history, aural music theory, written music theory, and class piano yielded a fall semester 1992 grade point average (GPA) of 2.57 (for those courses only). His GPA plummeted to 1.50 for winter semester 1993; he earned nothing higher than a grade of C+ in any of these courses. Christopher’s improvement in ear-to-hand coordination was inversely related to his core music curriculum achievement during his first year. However, his second term aural music theory grade (C+) was the highest of those he earned during that term for the four core music curriculum courses of interest in the present study.

A review of the comments in his narrative suggests that he entered school as a music major not fully aware of the importance of highly developed aural skills to success in his chosen field. As he became aware, it seems that his lack of aural ability began to bother him and prompted expressions of

dissatisfaction with music theory study in particular and with the School of Music in general.

Christopher's motivation to improve his ear-to-hand coordination likely came from his contingency admission to the School of Music and his relationship with Professor Ghitalla. Once Christopher qualified for admission to the School of Music and membership in the Symphony Band and Philharmonia Orchestra, Professor Ghitalla reinforced his successful efforts by offering him three structured courses of action for continued aural skills improvement. It is likely that Christopher's improvement in ear-to-hand coordination can be attributed in part to one of these courses of action as well as to his participation in computer-assisted keyboard ear-to-hand coordination training.

Although he experienced a relatively large gain in ear-to-hand coordination, the excerpts from his interview, observation, and journal data indicate that Christopher experienced considerable musical, academic, and social stress during his first year as a music major. It is likely that Christopher's severe core music curriculum achievement decline during his first year contributed to his relatively low socio-musical self-esteem, and, ultimately, to his articulation of a desire to transfer to another institution.

### Joanna

Joanna experienced a gain of 24 points (from 27 to 51) in ear-to-hand coordination as measured on double bass by the "Test of Melodic Ear-to-Hand Coordination" (TMEHC)—the fourth-largest gain of the sixteen ear-to-hand training subjects. This gain represents improvement of three levels in ear-to-

hand coordination—from “extremely weak” to “moderate” (see Appendix B for score interpretation guidelines).

As indicated in Table 36, her achievement in first term music history, aural music theory, written music theory, and class piano yielded a fall semester 1992 grade point average (GPA) of 3.00 (for those courses only). Her GPA dropped slightly to 2.82 for the winter semester 1993; this can be attributed to a drop in the class piano grade (from A to B+). Joanna's improvement in ear-to-hand coordination was inversely related to her core music curriculum achievement during her first year. This improvement had no apparent relationship to her aural music theory achievement; she earned a grade of C each semester—her lowest grade in both first and second term for the four core music curriculum courses of interest in the present study.

A review of the comments in her narrative suggests that, during her first year, she began to discover by trial-and-error the positive results of certain approaches to aural skills practice. She began the year in a state of being “afraid of ‘ear-to-hand’” and of unsuccessfully practicing aural skills on her own. She progressed to a state of using piano and voice to reinforce her aural skills practice, of successfully practicing with a partner, and, ultimately, of improving her sightsinging, dictation, and double bass performance.

It is likely that Joanna's improvement in ear-to-hand coordination can be attributed in part to her trial-and-error discovery of successful approaches to aural skills practice as well as to her participation in computer-assisted keyboard ear-to-hand coordination training. The excerpts from her interview, observation, and journal data suggest that the confidence she derived from her perceived improvement in aural music theory and double bass performance contributed to Joanna's realized improvement in socio-musical self-esteem.

**Kelly**

Kelly experienced a gain of 39 points (from 37 to 76) in ear-to-hand coordination as measured on piano by the “Test of Melodic Ear-to-Hand Coordination” (TMEHC)—the second-largest gain of the sixteen ear-to-hand training subjects. This gain represents improvement of four levels in ear-to-hand coordination—from “weak” to “strong” (see Appendix B for score interpretation guidelines).

As indicated in Table 37, her achievement in first term music history, aural music theory, and written music theory yielded a fall semester 1992 grade point average (GPA) of 4.00 (for those courses only). Her GPA dropped slightly to 3.75 for the winter semester 1993; this can be attributed to a drop in the music history grade (from A to B). Kelly’s improvement in ear-to-hand coordination occurred in the context of consistently high achievement in the core music curriculum during her first year. She earned a grade of A in aural music theory each semester—one of her highest grades in both first term and second term for the four core music curriculum courses of interest in the present study.

A review of the comments in her narrative suggests that, during her first year, she entered school as a music major well aware of the importance of aural skills to success in her chosen field. She maintained a high level of concern for and dedication to her aural skills progress throughout the year; she consistently exercised her ear in music theory classes, Chamber Choir rehearsals, studio voice lessons, and solo and small ensemble performance opportunities.

It is likely that Kelly’s improvement in ear-to-hand coordination can be attributed in part to her participation in computer-assisted keyboard ear-to-hand coordination training. The excerpts from her interview, observation, and journal data indicate that she began the year somewhat intimidated, frustrated, and

confused. However, Kelly quickly assumed control of her aural skills development and, in the process, strengthened her socio-musical self-esteem.

### Carrie

Carrie experienced a gain of 2 points (from 26 to 28) in ear-to-hand coordination as measured on flute by the “Test of Melodic Ear-to-Hand Coordination” (TMEHC)—the smallest gain of the sixteen ear-to-hand training subjects. This gain represents practically no improvement in ear-to-hand coordination from an initial level that can be described as “extremely weak” (see Appendix B for score interpretation guidelines).

As indicated in Table 38, she achieved a grade of C+ (2.3) in class piano during fall semester 1992 and a grade of B (3.0) in class piano during winter semester 1993. Owing to the demands of her double major, she was not enrolled in music history and withdrew from aural music theory and written music theory during fall semester 1992; she was not enrolled in any of these courses during winter semester 1993. In the opinion of this researcher, this is an incomprehensible situation for a student attempting to major in the highly complex, specialized, skill-oriented field of music. Carrie’s improvement in class piano during her first year had no apparent relationship to her level of ear-to-hand coordination.

A review of the comments in her narrative suggests that she was well aware of the fact that she entered school at a considerable disadvantage as a music major, that is, with a potentially serious deficiency in performance-based aural musicianship. Evidence gathered during ear-to-hand coordination testing and from her major applied music instructor, Ms. Hart-Kemper, indicates that these circumstances were sustained throughout Carrie’s first year. Her lack of

aural ability greatly frustrated her, although she expressed satisfaction with the occasional small advances that she experienced with ear-to-hand exercises in class piano.

Carrie's interview, observation, and journal data include her expressions of extreme anxiety regarding her upcoming flute and piano juries, her perception of herself as an "outsider" in relation to School of Music students, and her articulation of a desire to drop music as a major field of study. The musical, academic, and social stress and trauma that Carrie experienced during her first year as a music major likely contributed to her very low socio-musical self-esteem.

## **CHAPTER V**

### **SUMMARY AND CONCLUSIONS**

#### **Purpose of the Study**

**The purpose of this study was to investigate relationships between performance-based aural musicianship, selected indices of music achievement, and socialization of first-year music majors.**

#### **Problems of the Study**

**The specific problems of the study were to investigate: (1) relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano for first-year students majoring in music who were enrolled in first term music theory during fall semester 1992 (N = 71); (2) relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano for first-year students majoring in music who were enrolled in class piano during winter semester 1993 (N = 16); (3) the effect of computer-assisted keyboard ear-to-hand training on "Test of Melodic Ear-to-Hand Coordination" (TMEHC) scores for first-year students majoring in music who were enrolled in class piano during winter semester 1993 (N = 16); (4) effects of computer-assisted keyboard ear-to-hand training on relationships between instrumental ear-to-hand coordination and achievement in music**

history, aural music theory, written music theory, and class piano for first-year students majoring in music who were enrolled in class piano during winter semester 1993 ( $N = 16$ ); and (5) relationships between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization for first-year students majoring in music with the most severe deficiencies in performance-based aural musicianship who were enrolled in class piano during winter semester 1993 ( $n = 4$ ).

### Design of the Study

This investigation of relationships between performance-based aural musicianship, selected indices of music achievement, and socialization of first-year students employed both quantitative and qualitative methods. Quantitative methods facilitated examination of descriptive characteristics, performance-based aural musicianship skill levels, and selected indices of music achievement of first-year students majoring in music. In particular, effects of computer-assisted keyboard ear-to-hand coordination training on "Test of Melodic Ear-to-Hand Coordination" (TMEHC) scores and on relationships between performance-based aural musicianship and selected indices of music achievement were addressed. Complementary qualitative methods enabled consideration of the socialization of students at the School of Music. In particular, relationships of socio-musical self-esteem to deficiencies in performance-based aural musicianship and selected indices of music achievement were addressed.

### Selection of Participants for the Study

The study was conducted during the 1992-1993 academic year at the University of Michigan School of Music. All first-year students majoring in music who were enrolled in first term music theory during fall semester 1992 were informed of the study (N = 89). Seventy-one of these students signed informed consent forms and agreed to authorize access to academic records for collection of student descriptive and music achievement data and to participate in testing of performance-based aural musicianship.

Subsequently, of the seventy-one consenting students who had been enrolled in first term music theory during fall semester 1992, sixteen were enrolled in second term class piano during winter semester 1993. All sixteen of these students agreed to participate as subjects in a six-week exploratory computer-assisted keyboard ear-to-hand coordination training opportunity in a class piano setting.

Finally, of the sixteen ear-to-hand training subjects, the four who scored lowest in testing of performance-based aural musicianship (during first term music theory in fall semester 1992) agreed to participate as subjects in semester-long case studies of relationships between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization.

### Procedures Employed to Gather Student Descriptive and Music Achievement Data

Data regarding gender, ethnicity, major concentration (program), and principal performance medium were gathered from School of Music Admissions

Office records. Data regarding grades in music history, aural music theory, written music theory, and class piano were gathered from School of Music Dean's Office records.

### Procedures Employed to Gather Student Instrumental Ear-to-Hand Coordination Data

Data regarding instrumental ear-to-hand coordination were gathered through two administrations of the "Test of Melodic Ear-to-Hand Coordination" (TMEHC). The TMEHC was first administered to the seventy-one consenting students enrolled in first term music theory on their principal instrumental performance media during the week of 16 November 1992 . This measurement served as the pretest score for the sixteen ear-to-hand training subjects who subsequently enrolled in second term class piano during winter semester 1993. The TMEHC then was administered as a posttest to the sixteen ear-to-hand training subjects on their principal instrumental performance media during the week of 19 April 1993.

The TMEHC is a criterion-referenced test designed to determine a subject's ability to perform short melodic patterns in a "listen-play what you hear" format on her or his principal instrumental performance medium (piano for voice students). The TMEHC consists of one hundred four-beat melodic patterns arranged in nine sequences of increasing difficulty. All patterns are performed at the same tempo to an accompanying beat. The test was produced with a synthesizer and is recorded on cassette tape.

The TMEHC emphasizes common intervallic patterns that include ascending and descending stepwise melodic patterns and major, minor, diminished, and augmented triads and tetrachords. The range does not exceed

one octave. Intervals include minor seconds through perfect fifths. The melodic patterns begin with a repeated unison pitch and proceed to more complex triadic and diatonic melodic patterns. Rhythmic complexity is limited with an emphasis on melodic patterns.

### The Computer-Assisted Keyboard Ear-to-Hand Coordination Training Opportunity

Of the seventy-one consenting students enrolled in first term music theory, sixteen subsequently enrolled in second term class piano and agreed to participate as subjects in a six-week exploratory computer-assisted keyboard ear-to-hand coordination training opportunity. The purpose was to determine effects of computer-assisted keyboard ear-to-hand coordination training on the nature of relationships between instrumental ear-to-hand coordination and selected indices of music achievement.

Subjects were assigned randomly to one of two computer-assisted groups to experience self-initiated, self-directed, self-monitored keyboard ear-to-hand coordination training. The training content reinforced the class piano curriculum. Sets of practice and test exercises were generated by the researcher that were compatible with the class piano textbook and that were adapted from content in the MLR Melodic Ear-to-Hand Skills Program and the MLR Harmonic Ear-to-Hand Skills Program.

Subjects used *Instant Replay*, a MIDI-based ear-training program for the Macintosh computer that engages students in melodic and harmonic ear-to-hand coordination training and testing. This software provides instantaneous, individualized aural feedback and features extensive record-keeping, including student registrations, diaries, test scores, and test items.

The sets of exercises were generated with *Teacher Create*, an instructional authoring system for *Instant Replay* that supports any combination of melodic and harmonic items. The software has extensive customization features that provided the researcher with the means to control the content, sequence, presentation, and record-keeping features of *Instant Replay*.

### Procedures Employed to Gather Student Socialization Data

Of the sixteen ear-to-hand training subjects, the four who scored lowest in fall semester 1992 testing of performance-based aural musicianship agreed to participate as subjects in semester-long case studies of relationships between performance-based aural musicianship, selected indices of music achievement, and socialization. Specifically, the case study subjects were those individuals for whom a deficiency in performance-based aural musicianship, as substantiated by their test scores, was likely to have negatively affected their music achievement, socialization, and, ultimately, chances for success as undergraduate students majoring in music.

The case study method was employed to document the socialization of these four students, who experienced stress and trauma associated with severe deficiencies in aural musicianship. The researcher gathered data regarding the four case study subjects throughout the semester of training (winter 1993) by means of interviews, observations, and journals.

Weekly meetings of the researcher and each student featured researcher interviews and observations of students and student sharing of day-to-day personal journal entries. Periodic meetings of the researcher and the major applied music instructor of each student featured discussion of the instructor's

perceptions of any relationships between melodic and harmonic ear-to-hand coordination training, selected indices of music achievement, and socialization with respect to her or his student participant.

From interview, observation, and journal data, the researcher developed a descriptive profile of each case study subject. These descriptive profiles represent first-person, day-to-day narratives of the experiences of students with severe deficiencies in aural musicianship in a rigorous musical, academic, and social environment.

### Results

In order to interpret instrumental ear-to-hand coordination data for the large group of first-year students majoring in music ( $N = 71$ ), "Test of Melodic Ear-to-Hand Coordination" (TMEHC) mean scores by grouped principal performance medium were compared through analysis of variance (ANOVA). Differences between keyboard students and voice students, keyboard students and woodwind students, and keyboard students and percussion students were statistically significant ( $p \leq .05$ ) in favor of keyboard students. This evidence substantiated the advantages possibly inherent to keyboard instruments with respect to ear-to-hand coordination. This evidence also confirmed the continued existence—over an eleven-year period—of significant disparities in performance-based aural musicianship as measured by the "Test of Melodic Ear-to-Hand Coordination" (TMEHC) for first-year students according to grouped principal performance medium.

Analyses of frequency distributions of first term grades in music history, aural music theory, written music theory, and class piano for the large group of first-year students majoring in music ( $N = 71$ ) revealed very limited to moderate

uses of a thirteen-point grade scale, moderate to extreme negative skews, and low to moderate variability of individual grades.

Analyses of relationships between instrumental ear-to-hand coordination and achievement in first term music history, aural music theory, written music theory, and class piano for the large group of first-year students majoring in music ( $N = 71$ ) were performed using Pearson product-moment correlation coefficients. Analyses revealed no substantive relationships between instrumental ear-to-hand coordination and achievement in first term music history, written music theory, or class piano. Analyses revealed a strong positive, statistically significant ( $p \leq .001$ ) relationship between instrumental ear-to-hand coordination and achievement in first term aural music theory. This evidence suggests that instrumental ear-to-hand coordination can be generalized to the sightsinging and rhythmic, melodic, and harmonic dictation skills associated with first term aural music theory.

In order to interpret pre-training instrumental ear-to-hand coordination data for the smaller group of ear-to-hand training subjects ( $N = 16$ ), TMEHC pretest mean scores by grouped principal performance medium were compared through analysis of variance (ANOVA). Results indicated no statistically significant differences in melodic ear-to-hand coordination skills between string, percussion, woodwind, brass, or voice students prior to their participation in ear-to-hand training. However, a simple comparison of mean scores revealed differences of practical significance. A range of over 23.0 points in ear-to-hand coordination spanned skill levels from "limited" to "moderate" to "substantial," and represented considerable disparities in potential for success in music degree programs for over three-fourths (75.00%) of the first-year class. It was determined that, in the absence of any keyboard majors as ear-to-hand training subjects, the pre-training instrumental ear-to-hand coordination of ear-to-hand

training subjects was representative of that of the larger group of first-year students majoring in music.

Analyses of frequency distributions of first term (pre-training) grades in music history, aural music theory, written music theory, and class piano for the smaller group of ear-to-hand training subjects ( $N = 16$ ) revealed very limited to limited uses of a thirteen-point grade scale, moderate negative to mild positive skews, and low to moderate variability of individual grades. It was determined that the achievement in pre-training music history, aural music theory, written music theory, and class piano of ear-to-hand training subjects was very similar to that of the larger group of first-year students majoring in music.

Analyses of pre-training relationships between instrumental ear-to-hand coordination and achievement in first term music history, aural music theory, written music theory, and class piano for the smaller group of ear-to-hand training subjects ( $N = 16$ ) were performed using Pearson product-moment correlation coefficients. Analyses revealed no substantive relationships between instrumental ear-to-hand coordination and achievement in first term music history, written music theory, and class piano. Analyses revealed a strong positive, statistically significant ( $p \leq .01$ ) relationship between instrumental ear-to-hand coordination and achievement in first term aural music theory. It was determined that the nature of each of these pre-training relationships for ear-to-hand training subjects was very similar to that for the larger group of first-year students majoring in music.

In order to examine effects of computer-assisted keyboard ear-to-hand training, TMEHC gain scores were examined for the smaller group of ear-to-hand training subjects ( $N = 16$ ). Of practical significance was the fact that each ear-to-hand training subject experienced a gain in TMEHC score after participating in computer-assisted keyboard ear-to-hand coordination training.

In order to examine effects of computer-assisted keyboard ear-to-hand training on TMEHC scores, TMEHC pretest and posttest mean scores were compared for the smaller group of ear-to-hand training subjects (N = 16). Results of a *t*-test indicated that the posttest mean score was significantly higher than the pretest mean score ( $p \leq .0001$ ). This evidence confirmed the findings of other researchers that melodic ear-to-hand coordination can be improved through training.

In order to examine effects of computer-assisted keyboard ear-to-hand training on TMEHC scores by grouped principal performance medium for the smaller group of ear-to-hand training subjects (N = 16), TMEHC posttest mean scores by grouped principal performance medium were compared through analysis of variance (ANOVA). Results indicated no statistically significant differences in melodic ear-to-hand coordination between brass, string, percussion, voice, or woodwind students following their participation in ear-to-hand training. However, a simple comparison of mean scores revealed differences of practical significance. A range of almost 19.0 points in ear-to-hand coordination—less disparate than that of pre-training scores—spanned skill levels from “moderate” to “substantial” to “strong,” an increase of at least one skill level on average for every participant in the six-week computer-assisted keyboard ear-to-hand coordination training. These data represent dramatic positive shifts in melodic ear-to-hand coordination. It was determined that, owing in part to computer-assisted keyboard ear-to-hand coordination training, pre-training disparities in potential for success in music degree programs for three-fourths (75.00%) of the first-year class were attenuated.

Analyses of frequency distributions of second term (post-training) grades in music history, aural music theory, written music theory, and class piano for the smaller group of ear-to-hand training subjects (N = 16) revealed very limited

to slightly limited uses of a thirteen-point grade scale, moderate negative to mild positive skews, and low to high variability of individual grades. It was determined that achievement in music history and aural music theory of ear-to-hand training subjects dropped slightly from first term to second term, and that achievement in written music theory and class piano remained the same from first term to second term.

Analyses of the effect of computer-assisted keyboard ear-to-hand coordination training on post-training relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano for the smaller group of ear-to-hand training subjects ( $N = 16$ ) were performed using Pearson product-moment correlation coefficients. Analyses revealed no changes in relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano. That is, no substantive relationships were observed between instrumental ear-to-hand coordination and achievement in music history, written music theory, or class piano, and a strong positive, statistically significant ( $p \leq .01$ ) relationship between instrumental ear-to-hand coordination and achievement in aural music theory was observed. It was determined that, in this study, the only such relationship of any significance—both statistical and practical—was that of instrumental ear-to-hand coordination to achievement in aural music theory.

In order to examine the relationship between deficiencies in performance-based aural musicianship, selected indices of music achievement, and socialization for case study subjects ( $n = 4$ ), data regarding instrumental ear-to-hand coordination; achievement in music history, aural music theory, written music theory, and class piano; and socio-muical self-esteem were analyzed. Analyses revealed four unique profiles of the experiences of

students with severe deficiencies in aural musicianship in a rigorous musical, academic, and social environment.

Christopher experienced a gain of 34 points in ear-to-hand coordination as measured on trumpet during the computer-assisted training semester; this gain represented improvement of skills from “weak” to “substantial.” His music achievement declined severely from first term (2.57 GPA) to second term (1.50 GPA). As he became aware of the importance of highly developed aural skills to success in the field of music, Christopher began to express frustration regarding his lack of aural ability. Although he experienced a relatively large gain in ear-to-hand coordination, it was evident from his interview, observation, and journal data that he also experienced considerable musical, academic, and social stress during his first year as a music major. This resulted in Christopher’s relatively low socio-musical self-esteem and, ultimately, in his desire to transfer to another institution.

Joanna experienced a gain of 24 points in ear-to-hand coordination as measured on double bass during the computer-assisted training semester; this gain represented improvement of skills from “extremely weak” to “moderate.” Her music achievement declined slightly from first term (3.00 GPA) to second term (2.82 GPA). Joanna began her first year as a music major in a state of being “afraid of ‘ear-to-hand’” and of unsuccessfully practicing aural skills on her own. She progressed to a state of using piano and voice to reinforce her aural skills practice, of successfully practicing with a partner, and, ultimately, of improving her sightsinging, dictation, and double bass performance. She experienced a relatively large gain in ear-to-hand coordination, and it was evident from her interview, observation, and journal data that the confidence she derived from her perceived improvement in aural music theory and double

bass performance contributed to Joanna's realized improvement in socio-musical self-esteem.

Kelly experienced a gain of 39 points in ear-to-hand coordination as measured on piano during the computer-assisted training semester; this gain represented improvement of skills from "weak" to "strong." Her music achievement declined slightly from first term (4.00 GPA) to second term (3.75 GPA). Kelly began the her first year as a music major somewhat intimidated, frustrated, and confused. She experienced a relatively large gain in ear-to-hand coordination, and it was evident from her interview, observation, and journal data that Kelly quickly assumed control of her aural skills development and, in the process, strengthened her socio-musical self-esteem.

Carrie experienced a gain of 2 points in ear-to-hand coordination as measured on flute during the computer-assisted training semester; this gain represented no practical improvement of "extremely weak" skills. Her class piano achievement improved slightly from first term (grade of C+) to second term (grade of B). Carrie entered school well aware of the fact that she was at a considerable disadvantage as a music major—with a potentially serious deficiency in performance-based aural musicianship. It was evident from her interview, observation, and journal data that this situation was sustained throughout her first year. She experienced considerable musical, academic, and social stress, which resulted in Carrie's very low socio-musical self-esteem and, ultimately, in her desire to drop music as a major field of study.

### Conclusions

In consideration of the specific characteristics of the university, school of music, and participants involved in this study, evidence from this investigation suggests that:

1. Large proportions of first-year classes of students majoring in music are beginning college music studies with potentially serious deficiencies in performance-based aural musicianship and, consequently, potentially serious threats to success in music degree programs.

2. Instrumental ear-to-hand coordination, as measured by the TMEHC, can be improved through systematic training.

3. The content of the MLR Melodic Ear-to-Hand Skills Program and the MLR Harmonic Ear-to-Hand Skills Program, as adapted for computer-assisted keyboard training, is effective in training ear-to-hand skills in a class piano setting for first-year students majoring in music.

4. Keyboard ear-to-hand coordination training improves performance-based aural musicianship, as measured by the TMEHC, regardless of one's principal instrumental performance medium.

5. Computer-assisted keyboard ear-to-hand coordination training not only positively affects individual TMEHC scores, but also eliminates significant disparities in instrumental ear-to-hand coordination by grouped principal performance medium as measured by the TMEHC.

6. An aural orientation to instrumental performance can be generalized to the sightsinging and rhythmic, melodic, and harmonic dictation skills associated with aural music theory coursework.

7. An aural orientation to instrumental performance and music history coursework are mutually independent.

8. An aural orientation to instrumental performance and written music theory coursework are mutually independent.

9. An aural orientation to instrumental performance and class piano coursework are mutually independent.

10. Computer-assisted keyboard ear-to-hand coordination training has no effect on relationships between instrumental ear-to-hand coordination and achievement in music history, aural music theory, written music theory, and class piano.

11. Severe deficiencies in performance-based aural musicianship appear to affect negatively socio-musical self-esteem.
12. Improvement of severe deficiencies in performance-based aural musicianship appears to affect positively socio-musical self-esteem.
13. Complementary quantitative and qualitative research methods constitute a valid approach to the investigation of relationships between performance-based aural musicianship, selected indices of music achievement, and socialization of first-year students majoring in music.

### Implications for Music Education

1. Performance-based aural musicianship training should be a required component of all undergraduate music curricula.
2. A criterion level of performance-based aural musicianship should be required of all undergraduate students majoring in music.
3. Achievement of a criterion level of performance-based aural musicianship should have a significant bearing on determination of satisfactory completion of undergraduate music degree programs.
4. Instrumental ear-to-hand coordination may function as an effective predictor of achievement in aural music theory and, as such, related data may be potentially useful to both students and faculty in the important task of advising undergraduate students majoring in music.
5. Computer-assisted keyboard ear-to-hand coordination training significantly lessens the potential for low achievement in aural music theory of first-year students majoring in music.
6. Utilization of the keyboard for the development of instrumental ear-to-hand coordination of first-year students majoring in music has great potential. All participants in computer-assisted keyboard training—regardless of principal instrumental performance media—experienced a gain in instrumental ear-to-hand coordination as measured by the TMEHC on their principal instrumental performance media.
7. Faculty in music education and music theory should work cooperatively to determine and implement maximally effective methods of aural music theory instruction.
8. School of Music admissions counselors and faculty who continue to ignore the existence of significant disparities in performance-based aural musicianship as measured by the TMEHC for first-year students despite

compelling evidence of its strong positive relationship to potential for success in music degree programs are doing a disservice to students.

### Recommendations for Further Research

1. Replication of this study as a means of verifying these results for a larger or more diverse population of first-year students majoring in music is needed.
2. In consideration of the strong positive relationship between instrumental ear-to-hand coordination and achievement in aural music theory, further studies of instrumental ear-to-hand coordination and its relationship to specific components of aural music theory coursework, such as sightsinging and rhythmic, melodic, and harmonic dictation, are needed.
3. Further studies of instrumental ear-to-hand coordination to investigate the cause of consistently higher "Test of Melodic Ear-to-Hand " (TMEHC) scores of keyboard majors are needed.
4. In consideration of the suggested advantages of ear-to-hand coordination training with keyboard as a medium, further studies of keyboard ear-to-hand coordination and its relationship to specific components of class piano coursework, such as harmonizing melodies, transposing, playing by ear, and improvising, are needed.
5. Studies for the purpose of comparing and contrasting effects of computer-assisted and non-computer-assisted formats of instrumental ear-to-hand coordination training are needed.
6. Further studies of computer-assisted ear-to-hand coordination training to investigate effects of self-initiated, self-directed, and self-monitored modes of training are needed.
7. Further studies of computer-assisted ear-to-hand coordination training to investigate the potential of advances in computer technology to improve delivery of computer-assisted ear-to-hand coordination training are needed.
8. Further studies of performance-based aural musicianship for the purpose of early identification of students with severe deficiencies so that longer training programs can be offered are needed.
9. Longitudinal studies of performance-based aural musicianship to investigate long-term effects of severe deficiencies on socialization of students majoring in music are needed.

Finally, a primary purpose of all research in music education is to increase knowledge of music teaching and learning. Because music is principally an aural phenomenon, further research on the cultivation of performance-based aural musicianship skills is both justified and necessary. Such research has the potential to improve all aspects of music education.

## **APPENDICES**

**APPENDIX A**  
**APPLICATION FOR HUMAN SUBJECTS REVIEW**

The University of Michigan  
School of Education

**APPLICATION FOR HUMAN SUBJECTS REVIEW**

Investigator's Name \_\_\_\_\_ Molly A. Weaver \_\_\_\_\_ Date \_\_\_\_\_ 06 January 1993 \_\_\_\_\_

Address \_\_\_\_\_ 2735 Windwood Drive #95; Ann Arbor, MI 48105 \_\_\_\_\_

Phone \_\_\_\_\_ (313) 994-8066 \_\_\_\_\_

School of Education Program  
or other University affiliation \_\_\_\_\_ Ph.D. candidate in Music Education \_\_\_\_\_

Title of Study \_\_\_\_\_ An Investigation of the Relationships Between Performance-Based Aural  
Musicianship, Music Achievement, and Socialization of First-Year Music Majors \_\_\_\_\_

**--FOR STUDENT RESEARCH--**

Check the appropriate designation: \_\_\_\_\_X\_\_\_\_\_ doctoral dissertation (see note below)  
\_\_\_\_\_ master's thesis  
\_\_\_\_\_ course project  
\_\_\_\_\_ independent research project  
\_\_\_\_\_ other (please explain in space at left)

Name and affiliation of advisor  
or dissertation committee chair \_\_\_\_\_ Dr. James O. Froseth, Professor of Music (Music Education) \_\_\_\_\_

Signature of advisor or  
dissertation committee chair \_\_\_\_\_

Names and affiliation of dissertation committee members:

Professor Duane F. Alwin, Sociology

Professor Judith Becker, Ethnomusicology

Professor Paul R. Lehman, Music Education

Assistant Professor Barton Polot, Music Education

If dissertation, date of approval of proposal \_\_\_\_\_ Winter 1992 \_\_\_\_\_

-----

**NOTE:** Before applying for human subjects review, School of Education doctoral candidates must have on file in the Office of Student Services an approved doctoral dissertation committee and an approved doctoral dissertation proposal. Forms are available from the Office of Student Services, 1033 School of Education Building.

**SEVEN** copies of this form and supporting material as described in the application form should be submitted to Ms. Margaret Meadows, Administrative Services, 1111 School of Education Building (764-6493), at least one week before the meeting at which the application is to be considered.

9/90

- I. **Summary of Study.** To assist the Human Subjects Review Board in evaluating your proposal, describe as clearly as possible the purpose and rationale for the study and the experimental design to be used. Describe the potential benefits of the study.

### **Rationale**

One of the most meaningful outcomes of a 1983 School of Music project was student testimony to the positive relationship of improvement in aural skill proficiency with improvement in both principal instrument performance and academic studies in the School of Music. Students reported improvements in listening skills, melodic interval recognition, harmonic progression recognition, dictation skills, memorization skills, intonation skills, sightreading skills, and improvisation skills—abilities necessary for success as a music major.

Although positive, enthusiastic student responses substantiated the benefits realized by some, several other student assessments of the experience revealed frustration over inability to monitor one's progress in performance-based aural musicianship training. In response to students' expressed frustrations over lack of feedback in performance-based aural skills training, a computer-assisted instructional program was developed to provide aural skills training with immediate, individualized aural feedback.

### **Purpose**

In consideration of previously identified positive effects of performance-based aural musicianship practice and training on selected indices of music achievement, a more comprehensive study of these relationships regarding first-year students is warranted. Specifically, the researcher will investigate effects of computer-assisted keyboard ear-to-hand coordination training on music achievement for students in the class piano setting.

### **Design**

This investigation will be conducted in The University of Michigan School of Music. Participants in the study will be all consenting fall 1992 entering first-year music students ( $n = 120\pm$ ). All participants will be asked to sign a release form that will authorize the researcher to gather data from student records. The researcher will collect information for the purposes of describing student characteristics and analyzing relationships between measures of performance-based aural musicianship and music achievement.

A subsample of first-year students—those who are placed in class piano ( $n \leq 72$ )—will participate in a training opportunity that will occur during winter semester 1993. Specifically, participants will be randomly assigned to one of two computer-assisted groups to experience self-administered/self-monitored keyboard ear-to-hand coordination training that will reinforce the class piano curriculum. The computer-assisted format of training will be offered to one group for the first half of the winter semester and to the other group for the second half of the winter semester.

The "Test of Melodic Ear-to-Hand Coordination" (TMEHC) will function as both pretest and posttest. It is a fifteen-minute diagnostic tool that comprises one hundred tape-recorded melodic patterns organized into nine sequences of progressive difficulty.

### **Potential Benefits**

Identification of methods by which to strengthen performance-based aural musicianship may improve music achievement and student socialization for music majors from the beginning of their degree programs. Investigation of the relationships between these facets of life as a music major will contribute to optimum undergraduate experiences for music students at The University of Michigan.

## II. Participation of human subjects.

- A. Describe the subjects to be used in the study. Include age range and criteria for selection or exclusion.

Participants in the study will be all consenting fall 1992 entering first-year music students ( $n = 120\pm$ ). A subsample of first-year students—those who are placed in class piano ( $n \leq 72$ )—will participate in a training opportunity that will occur during winter semester 1993. Specifically, participants will be randomly assigned to one of two computer-assisted groups to experience self-administered/self-monitored ear-to-hand coordination training that will reinforce the class piano curriculum. The computer-assisted format of training will be offered to one group for the first half of the winter semester and to the other group for the second half of the winter semester.

- B. Describe specifically what subjects will be asked to do and how much time will be involved. Include with the application copies of questionnaires, standardized tests, interview schedules, and other materials which are already prepared. Describe any equipment to be used. If materials and/or equipment are still being designed, describe them as fully as possible. (NOTE: Whenever materials are prepared after approval for a project has been granted, a copy should be forwarded to the chair of the Human Subjects Review Board to be included with the file for that project.)

A subsample of first-year students—those who are placed in class piano ( $n \leq 72$ )—will be randomly assigned to one of two computer-assisted groups to experience self-administered/self-monitored ear-to-hand coordination training that will reinforce the class piano curriculum. The exercises, which will reinforce the class piano curriculum, will be generated from the course text for both groups. As part of class piano requirements, participants will focus on these exercises for an average of twenty minutes daily. The "Test of Melodic Ear-to-Hand Coordination" (TMEHC), administered to each student prior to School of Music enrollment and again as part of class piano juries at the end of each semester, will function as both pretest and posttest. It is a fifteen-minute diagnostic tool that comprises one hundred tape-recorded melodic patterns organized into nine sequences of progressive difficulty.

- C. Describe the setting in which data will be collected. If data are collected under the auspices of an agency such as a school system, clinic, government office, professional association, etc., attach a letter of permission from an authorized representative of that agency.

This investigation will be conducted in The University of Michigan School of Music. All participants will be asked to sign a release form that will authorize the researcher to gather data periodically from student records for the purposes of describing student characteristics and analyzing relationships between measures of performance-based aural musicianship and music achievement.

### III. Protection of human subjects.

It is the responsibility of the Human Subjects Review Board to determine for each activity as planned and conducted whether: (a) The costs and risks to the subject are so outweighed by the sum of the benefit to the subject and the importance of the knowledge to be gained as to warrant a decision to allow the subject to accept those costs and risks; (b) The rights and welfare of any such subject will be adequately protected; and (c) Legally effective informed consent will be obtained by adequate and appropriate methods.

- A. Describe any potential costs or risks to the subjects. Costs should include both monetary and time factors; risks include possible physical, psychological, social, or legal risks to the subject.

Participants will invest an average of twenty minutes daily. The "Test of Melodic Ear-to-Hand Coordination" (TMEHC), administered to each student prior to School of Music enrollment and again as part of class piano juries at the end of each semester, is a fifteen-minute diagnostic tool. They will not incur any monetary costs or physical, psychological, social, or legal risks.

- B. Describe the procedures by which you will do the following:

1. ensure voluntary participation by subjects.

Participants in the study will be all consenting fall 1992 entering first-year music students ( $n = 120\pm$ ). All participants will be asked to sign a release form that will authorize the researcher to gather data from student records. See appended letter of informed consent.

2. protect subjects' identity and confidentiality of records.

Participants in the study will be informed that any information gathered will be held in strict confidence; names will not be used in data analyses or research reports. See appended letter of informed consent.

3. minimize costs and risks to the subjects.

Participants in the study will not incur any monetary costs or physical, psychological, social, or legal risks.

4. ensure that the subject is fully informed about the purpose of the experiment, the duration of his/her participation, the procedures to be followed, and the possibility of risk or discomfort.

See appended letter of informed consent.

- IV. Informed consent. Using language which will be understandable to the subject or his/her representative, prepare an informed consent form, using the guidelines presented in the document "Basic Elements of Informed Consent" which is appended to this application. (We have included a set of sample informed consent forms/cover letters with the application material which you may find helpful in preparing a consent form or cover letter.)

Written informed consent must be obtained from either the subject or his/her authorized representative. A parent or legal guardian must sign for all subjects under 18 years of age. It is suggested, but not required, that children who are old enough to read and understand the consent form be given an opportunity to sign it as well.

In the case of survey research, where the subject's only participation consists of returning a questionnaire anonymously, and no identification of the subject is possible, the purpose of the study and the procedures for protection of human subjects may be explained in a cover letter and the subject may demonstrate consent by returning the questionnaire. The cover letter should accompany the human subjects application.

### BASIC ELEMENTS OF INFORMED CONSENT\*

Informed consent in the policy of the University of Michigan means the knowing consent of an individual or his/her legally authorized representative, so situated as to be able to exercise free power of choice without undue inducement or any element of force, fraud, deceit, duress, or other forms of constraint or coercion. The written informed consent statement shall be in language which is understandable to the subject or his/her representative.

The basic elements of information necessary to such consent include:

1. A statement that the study involves research, an explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures to be followed, and identification of any procedures which are experimental or novel.
2. A description of any reasonable foreseeable risks or discomforts to the subject.
3. A description of any benefits to the subject or to others which may reasonably be expected from the research.
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subjects.
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained. (In the case of protocols relating to the Federal Food and Drug Administration Regulations [1981 Federal Register, Vol. 46, No. 17, pg 8951], this statement will also note the possibility that the Food and Drug Administration may inspect the records.)
6. For research involving more than minimal risk of physical harm, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained.

In general, if there is a chance of physical harm to persons who take part in a project, the following statement must be used (in accordance with 1978 Federal regulations) when requesting the consent of the subjects:

"I understand that the University will provide first aid medical treatment in the unlikely event of physical injury resulting from research procedures. Additional medical treatment will be provided in accordance with the University's determination of its responsibility to do so. The University does not, however, provide compensation to a person who is injured while participating as a subject in research."

7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject.
8. A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

When appropriate, one or more of the following additional elements of information for consent shall also be provided to each subject.

1. A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable.
2. Anticipated circumstances under which the subject's participation may be terminated by the investigator without regard to the subject's consent.
3. Any additional costs to the subject that may result from participation in the research.
4. The consequences of the subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject.
5. A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject.
6. The approximate number of subjects involved in the study.

#### Retention of Consent

The investigator, where appropriate, shall retain in his/her file a complete set of written consent forms signed by the subject(s) or his/her (their) authorized representative(s). This treatment of informed consent records may be altered when written consent may be more appropriately retained in clinical files. A copy of the written consent form shall be given by the investigator to all persons who will be signing it.

\*This information is taken from The University of Michigan's General Institutional Assurance of Compliance with Regulations of the Department of Health and Human Services for the Protection of Human Research Subjects dated June 17, 1983.

## **APPENDIX B**

### **GUIDELINES FOR INTERPRETATION OF "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) SCORES**

## GUIDELINES FOR INTERPRETATION OF "TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC) SCORES

James O. Froseth

**Test Score: 0-19**

- Test results in this range represent a virtual absence of aural orientation to instrumental performance.

Interpretation: Extreme aural deficiency; may have difficulty discerning whether melodic patterns are ascending or descending; little—if any—comprehension of melodic and harmonic structures in tonal music; student unlikely to respond to remedial aural skills training.

Prognosis: Unlikely to succeed in subjects requiring musical discrimination skills and applied aural musicianship.

**Test Score: 20-39**

- Test results in this range represent an extremely weak (20) to weak (39) aural orientation to instrumental performance.

Interpretation: Serious aural deficiency; very limited to limited comprehension of melodic and harmonic structures in tonal music; only the most highly motivated and self-disciplined student likely to respond to remedial aural skills training.

Prognosis: Highly questionable to questionable likelihood for success in subjects requiring musical discrimination skills and applied aural musicianship.

**Test Score: 40-59**

- Test results in this range represent a limited (40) to moderate (59) aural orientation to instrumental performance.

Interpretation: Moderate aural deficiency to moderate aural proficiency; moderate comprehension of melodic and harmonic structures in tonal music; motivated and self-disciplined student likely to make satisfactory progress in aural skills training.

Prognosis: Moderate likelihood for success in subjects requiring musical discrimination skills and applied aural musicianship.

**Test Score: 60-79**

- Test results in this range represent a substantial (60) to strong (79) aural orientation to instrumental performance.

Interpretation: Considerable aural proficiency; above average to very good comprehension of melodic and harmonic structures in tonal music; student likely to make steady progress in aural skills training and to benefit from creative music studies.

Prognosis: Very good to excellent likelihood for success in subjects requiring musical discrimination skills and applied aural musicianship.

**Test Score: 80-100**

- Test results in this range represent a direct and unencumbered aural orientation to instrumental performance.

Interpretation: Extraordinary aural proficiency; outstanding comprehension of melodic and harmonic structures in tonal music; student likely to make rapid progress with minimal effort in aural skills training; excellent candidate for independent and creative music studies.

Prognosis: Very likely to experience great success—especially in subjects requiring musical discrimination skills and applied aural musicianship.

**APPENDIX C**  
**PARTICIPANT CONSENT**

09 November 1992

To: Freshman students in the Musicianship core

From: Professor Ralph B. Lewis, Chair of Music Theory  
 Professor Walter Everett, Department of Music Theory  
 Professor James O. Froseth, Chair of Music Education  
 Molly A. Weaver, Research Assistant in Music Education

Re: An Aural Skills Testing Program for the 1992 Freshman Class

The purpose of this letter is to solicit your support and participation as a member of the 1992 freshman class in a special testing program which will continue the investigation of the relationships between aural skills and success as a music student.

The 1982 freshman class was the first participation group in this study. We investigated the relationships between music theory placement, music theory grades, aural skills, and professional placement in music as a career—and learned some ways to aid students and to aid faculty in admission and placement.

Continuing investigation holds considerable promise! And we wish to make the 1992 class the second participation group in a modest testing program (held during the week of 16 November) and long-term analysis that will require the use of academic records. The information gathered will be held in strict confidence; names WILL NOT be used in data analyses of research reports. Your cooperation is vital. Please complete this form and return it to Professor Everett today.

Print name: \_\_\_\_\_

I hereby authorize access to my School of Music records. I understand that my identity will not be revealed and that my authorization is restricted to the research described.

I will volunteer to take a 15-minute "Ear to Hand" aural skills test if I have not already done so as an applicant. I will sign up for a 15-minute time slot on the door of Room 1045 or 1047 at least 24 hours in advance of the scheduled test and bring my principal instrument to my appointment.

Sign name: \_\_\_\_\_ Student ID# \_\_\_\_\_

xc: Professor Paul Boylan, Dean, School of Music  
 Professor David Crawford, Associate Dean for Undergraduate Studies

**APPENDIX D**

**"TEST OF MELODIC EAR-TO-HAND COORDINATION" (TMEHC)  
SCORING SHEET**

..

Scoring Sheet

MLR TEST OF MELODIC EAR-TO-HAND COORDINATION  
(A Test of Performance-Based Aural Musicianship)

James O. Froseth

Name\_\_\_\_\_

Score\_\_\_\_\_

Principal instrument\_\_\_\_\_

Instrument for this test\_\_\_\_\_

Test administered by\_\_\_\_\_

Date\_\_\_\_\_

(Circle the number for each pattern performed correctly)

|                   |    |    |    |    |    |    |    |    |    |
|-------------------|----|----|----|----|----|----|----|----|----|
| PRACTICE EXAMPLES | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |    |
| Sequence 1:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|                   | 10 | 11 | 12 | 13 | 14 | 15 | 16 |    |    |
| Sequence 2:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|                   | 10 | 11 | 12 |    |    |    |    |    |    |
| Sequence 3:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|                   | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Sequence 4:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |    |
| Sequence 5:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |    |
| Sequence 6:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|                   | 10 |    |    |    |    |    |    |    |    |
| Sequence 7:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |    |
| Sequence 8:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|                   | 10 | 11 | 12 |    |    |    |    |    |    |
| Sequence 9:       | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |    |

**APPENDIX E**

**COMPUTER-ASSISTED KEYBOARD EAR-TO-HAND COORDINATION  
TRAINING PARTICIPANT INSTRUCTIONS**

## **Instructions . . .**

### **for your participation in Computer-Assisted Keyboard Ear-to-Hand Coordination Training**

1. Sign up for practice time on the door of the room to which you are assigned (1043, 1045, or 1047). It is important to use your designated room because your records are being stored on the hard drive of that particular computer.
2. Go to Room 1168—the Piano Key Room—and get a key for your room. The attendant has a list of all students participating in this program; you may have a key at any time in exchange for your student i.d. card.
3. Once in your designated room, turn on the main power switch (red) on the power strip under the table. Then, if necessary, turn on the power to the keyboard, the hard drive under the computer, and the computer itself. The keyboard has an automatic “power off” function after approximately 6 minutes of inactivity. If this happens, simply turn it off and on again.
4. While the hard drive is booting up, set the CHORD SELECTOR on the keyboard (to the immediate right of the POWER SWITCH) to “OFF.”
5. If necessary, adjust the MAIN VOLUME on the keyboard (to the immediate right and slightly below the CHORD SELECTOR).
6. Double-click on the *Instant Replay* icon.
7. Select your name from the list, or click “New” to register (as demonstrated in class).
8. Enter your password; follow the prompts on the screen until the list of folders on the hard drive appears.
9. Double-click on the “Piano 112” folder.
10. Proceed through all files in numerical order. You need to complete all practice and test sets each week. Remember—the amount of time you may invest each week is open-ended—it is definitely to your advantage to practice frequently so that you may achieve aural mastery.
11. When you are done, “QUIT” Instant Replay and go to the “SPECIAL” menu to “SHUT DOWN” the computer. Turn off the main power switch and return the room key.

## **Thank you . . .**

### **for your participation in Computer-Assisted Keyboard Ear-to-Hand Coordination Training**

If there are ANY problems, I need to know about them. Soon. You may leave a message for me or call me at any time (really—it's never too late or too early): Music Education Office 764-5429; Home 994-8066

**APPENDIX F**

**COMPUTER-ASSISTED KEYBOARD EAR-TO-HAND COORDINATION  
TRAINING EXERCISES SEQUENCE AND CALENDAR**

| <b>COMPUTER-ASSISTED KEYBOARD EAR-TO-HAND<br/>COORDINATION TRAINING EXERCISES</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                         |                   |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------|
| <b>SEQUENCE</b>                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>CALENDAR</b>         |                   |
| <b>FILE</b>                                                                       | <b>SET</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>GROUP A</b>          | <b>GROUP B</b>    |
| Diagnostic Tests                                                                  | Major Triads-Mel<br>Minor Triads-Mel<br>Diminished Triads-Mel<br>Augmented Triads-Mel<br>Mixed Triads-Mel<br>Mixed Chords<br>Major Chord Prog<br>Minor Chord Prog<br>Major Pentascales<br>Minor Pentascales                                                                                                                                                                                                                                                                                                                                                                                                                        | 18 January-31 January   | 08 March-21 March |
| Pentascales and Chords                                                            | Pentascade Pretest 1<br>Pentascade Practice A<br>Pentascade Practice B<br>Pentascade Posttest 1<br>Pentascade Challenge E<br>Pentascade Challenge F<br>Pentascade Challenge G<br>Pentascade Challenge H<br>Pentascade Challenge I<br>Pentascade Challenge J<br><br>Pentascade Pretest 2<br>Pentascade Practice C<br>Pentascade Practice D<br>Pentascade Posttest 2<br>Pentascade Challenge K<br>Pentascade Challenge L<br>Pentascade Challenge M<br>Pentascade Challenge N<br>Pentascade Challenge O<br>Pentascade Challenge P<br><br>Chord Pretest<br>Chord Practice Q<br>Chord Practice R<br>Chord Posttest<br>Chord Challenge S | 01 February-14 February | 22 March-04 April |
| Harmonizing Melodies                                                              | Preliminary Exercises 1<br>Pretest 1<br>Practice A<br>Practice B<br>Posttest 1<br><br>Preliminary Exercises 2<br>Pretest 2<br>Practice C<br>Practice D<br>Posttest 2<br><br>Preliminary Exercises 3<br>Pretest 3<br>Practice E<br>Practice F<br>Posttest 3                                                                                                                                                                                                                                                                                                                                                                         | 15 February-28 February | 05 April-18 April |

**APPENDIX G**  
**REPRESENTATIVE KEYBOARD EAR-TO-HAND COORDINATION TRAINING**  
**EXERCISES**

File: Diagnostic Test-Long Form

Set: 1-Major Triads

Practice Exercise 1                      Practice Exercise 2

1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2

File: Diagnostic Test–Long Form  
Set: 7–Major Chord Progressions

Practice Exercise 1

Practice Exercise 2

Practice Exercise 3

1

2

3

4

5

6

7

8

9

10

11

12

The image displays a musical score for 12 major chord progressions, each on a single staff. The progressions are numbered 1 through 12. Each progression consists of a sequence of chords connected by a line, with a double bar line and repeat sign at the end. The chords are written in treble clef. The first three progressions are labeled 'Practice Exercise 1', 'Practice Exercise 2', and 'Practice Exercise 3' respectively. The remaining nine progressions are numbered 1 through 12. Each progression is a sequence of major chords in a specific order, with a double bar line and repeat sign at the end. The chords are written in treble clef. The first three progressions are labeled 'Practice Exercise 1', 'Practice Exercise 2', and 'Practice Exercise 3' respectively. The remaining nine progressions are numbered 1 through 12. Each progression is a sequence of major chords in a specific order, with a double bar line and repeat sign at the end. The chords are written in treble clef.

## Practice Exercise 2

Practice Exercise 3

Practice Exercise 4

The second system of the exercise consists of measures 4 and 5. Measure 4 is marked with a square box containing the number '4'. Measure 5 is marked with a square box containing the number '5'. The notation continues with eighth notes and rests, ending with a double bar line.

File: Pentascales and Chords

Set: 1-Pentastale Pretest 1

The image displays three staves of musical notation, each representing a different pentastale. Each staff begins with a treble clef and a key signature of one sharp (F#). The notation includes various musical symbols such as eighth notes, quarter notes, and rests. Above the staves, there are numbered boxes (1, 2, 3, 4, 5, 6) and the number '2' indicating specific measures or chords. The notation is presented in a clear, black-and-white format.

## File: Pentascales and Chords

## Set: 5-Pentascale Challenge Exercises E

The image displays a musical score for 12 pentascale exercises, numbered 1 through 12. Each exercise is written on a single staff in treble clef. The exercises are organized into six rows of two staves each. Exercises 1 through 12 are numbered in boxes above the staves. Each exercise consists of a pentascale (a five-note scale) followed by a double bar line and then a second pentascale. The second pentascale is often marked with a '2' above it, indicating a second ending or a specific fingering. The exercises are written in various keys, including major and minor scales, and some include accidentals (sharps and flats) to indicate specific notes. The notation includes eighth and sixteenth notes, as well as rests.

File: Pentascales and Chords  
Set: 11-Pentascale Pretest 2

The image displays three staves of musical notation for Set 11-Pentascale Pretest 2. Each staff contains a pentascale and a chord. The first staff is labeled with a box containing the number 1, and the second staff with a box containing the number 3. The third staff is labeled with a box containing the number 5. Each staff also features a box containing the number 2, indicating a second measure or a specific note. The notation includes treble clefs, key signatures, and various musical symbols such as notes, rests, and bar lines.

File: Pentascales and Chords

Set: 15-Pentascale Challenge Exercises K

12 Pentascale Challenge Exercises K

Exercises 1 through 12 are displayed, each consisting of a pentascale in a specific key signature, indicated by the number of flats or sharps. The exercises are arranged in six staves, with two exercises per staff. Each exercise is numbered and includes a key signature change symbol (sharp or flat) at the beginning. The exercises are: 1 (0 flats), 2 (1 flat), 3 (2 flats), 4 (3 flats), 5 (4 flats), 6 (5 flats), 7 (1 sharp), 8 (2 sharps), 9 (3 sharps), 10 (4 sharps), 11 (5 sharps), and 12 (6 sharps). Each exercise is an 8-measure phrase with a repeat sign at the end. The notation includes treble clef, key signature, and various note values (quarter, eighth, and sixteenth notes). Some exercises have a '2' above the staff, indicating a second ending or a specific fingering.

File: Pentascales and Chords  
Set: 21-Chord Pretest

1 2 2

3 2 4 2

5 2 6 2



File: Harmonizing Melodies  
Set: 1-Preliminary Exercises 1

Exercise 1

Exercise 1 consists of six measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a whole note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. The third measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a whole note chord of F2 and C3. The fifth measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The sixth measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. Fingerings are indicated by the number 2 above the treble clef notes and below the bass clef notes.

Exercise 2

Exercise 2 consists of six measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a whole note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. The third measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a whole note chord of F2 and C3. The fifth measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The sixth measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. Fingerings are indicated by the number 2 above the treble clef notes and below the bass clef notes.

Exercise 3

Exercise 3 consists of six measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a whole note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. The third measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a whole note chord of F2 and C3. The fifth measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The sixth measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. Fingerings are indicated by the number 2 above the treble clef notes and below the bass clef notes.

Exercise 4

Exercise 4 consists of six measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a whole note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. The third measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a whole note chord of F2 and C3. The fifth measure has a treble clef with a quarter note B4 and a bass clef with a whole note chord of F2 and C3. The sixth measure has a treble clef with a quarter note A4 and a bass clef with a whole note chord of F2 and C3. Fingerings are indicated by the number 2 above the treble clef notes and below the bass clef notes.

File: Harmonizing Melodies

Set: 2-Pretest 1

1

Exercise 1, measures 1-3. Treble clef: C4, D4, E4, F4, G4, A4, B4, C5. Bass clef: F2, C3, F3, C4, F4, C5, F5, C6. Measure 3 ends with a double bar line and a repeat sign.

2

Exercise 2, measures 1-3. Treble clef: C4, D4, E4, F4, G4, A4, B4, C5. Bass clef: F2, C3, F3, C4, F4, C5, F5, C6. Measure 3 ends with a double bar line and a repeat sign.

3

Exercise 3, measures 1-3. Treble clef: C4, D4, E4, F4, G4, A4, B4, C5. Bass clef: F2, C3, F3, C4, F4, C5, F5, C6. Measure 3 ends with a double bar line and a repeat sign.

4

Exercise 4, measures 1-3. Treble clef: C4, D4, E4, F4, G4, A4, B4, C5. Bass clef: F2, C3, F3, C4, F4, C5, F5, C6. Measure 3 ends with a double bar line and a repeat sign.

File: Harmonizing Melodies

Set: 2-Pretest 1



File: Harmonizing Melodies  
Set: 6-Preliminary Exercises 2

Exercise 1

Exercise 1 consists of six measures. Measures 1-2 are in C major, and measures 3-6 are in D minor. The melody in the right hand is a simple line of notes, and the bass line in the left hand provides harmonic support with chords and single notes. Measure numbers 1, 2, 2, and 2 are indicated above the staff.

Exercise 3

Exercise 3 consists of six measures. Measures 1-2 are in C major, and measures 3-6 are in D minor. The melody in the right hand is a simple line of notes, and the bass line in the left hand provides harmonic support with chords and single notes. Measure numbers 2, 4, and 2 are indicated above the staff.

Exercise 5

Exercise 5 consists of six measures. Measures 1-2 are in C major, and measures 3-6 are in D minor. The melody in the right hand is a simple line of notes, and the bass line in the left hand provides harmonic support with chords and single notes. Measure numbers 2, 6, and 2 are indicated above the staff.

Exercise 7

Exercise 7 consists of six measures. Measures 1-2 are in C major, and measures 3-6 are in D minor. The melody in the right hand is a simple line of notes, and the bass line in the left hand provides harmonic support with chords and single notes. Measure numbers 2, 8, and 2 are indicated above the staff.

File: Harmonizing Melodies

Set: 7-Pretest 2

1

Exercise 1, measures 1-3. The melody in the treble clef consists of quarter notes: C4, D4, E4, F4, G4, A4, B4, C5. The bass line consists of chords: C4-E3, D3-F2, E3-G2, F3-A2, G3-B2, A3-C3, B2-D2, C3-E2. The final measure shows a double bar line with a fermata over the final notes.

2

Exercise 2, measures 1-3. The melody in the treble clef consists of quarter notes: C4, D4, E4, F4, G4, A4, B4, C5. The bass line consists of chords: C4-E3, D3-F2, E3-G2, F3-A2, G3-B2, A3-C3, B2-D2, C3-E2. The final measure shows a double bar line with a fermata over the final notes.

3

Exercise 3, measures 1-3. The melody in the treble clef consists of quarter notes: C4, D4, E4, F4, G4, A4, B4, C5. The bass line consists of chords: C4-E3, D3-F2, E3-G2, F3-A2, G3-B2, A3-C3, B2-D2, C3-E2. The final measure shows a double bar line with a fermata over the final notes.

4

Exercise 4, measures 1-3. The melody in the treble clef consists of quarter notes: C4, D4, E4, F4, G4, A4, B4, C5. The bass line consists of chords: C4-E3, D3-F2, E3-G2, F3-A2, G3-B2, A3-C3, B2-D2, C3-E2. The final measure shows a double bar line with a fermata over the final notes.

File: Harmonizing Melodies

Set: 7-Pretest 2



File: Harmonizing Melodies  
Set: 11-Preliminary Exercises 3

Exercise 1

Exercise 1 consists of four measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a half note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a half note chord of G2 and D3. The third measure has a treble clef with a quarter note B4 and a bass clef with a half note chord of A2 and E3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a half note chord of B2 and F3. The key signature has one flat (Bb). The exercise is marked with a '1' in a box above the first measure and a '2' in a box above the third measure.

Exercise 2

Exercise 2 consists of four measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a half note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a half note chord of G2 and D3. The third measure has a treble clef with a quarter note B4 and a bass clef with a half note chord of A2 and E3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a half note chord of B2 and F3. The key signature has one flat (Bb). The exercise is marked with a '3' in a box above the first measure and a '4' in a box above the third measure.

Exercise 3

Exercise 3 consists of four measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a half note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a half note chord of G2 and D3. The third measure has a treble clef with a quarter note B4 and a bass clef with a half note chord of A2 and E3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a half note chord of B2 and F3. The key signature has one flat (Bb). The exercise is marked with a '5' in a box above the first measure and a '6' in a box above the third measure.

Exercise 4

Exercise 4 consists of four measures. The first measure has a treble clef with a quarter note G4 and a bass clef with a half note chord of F2 and C3. The second measure has a treble clef with a quarter note A4 and a bass clef with a half note chord of G2 and D3. The third measure has a treble clef with a quarter note B4 and a bass clef with a half note chord of A2 and E3. The fourth measure has a treble clef with a quarter note C5 and a bass clef with a half note chord of B2 and F3. The key signature has one flat (Bb). The exercise is marked with a '7' in a box above the first measure and an '8' in a box above the third measure.

File: Harmonizing Melodies

Set: 12-Pretest 3

1

2

2

Detailed description: This musical exercise is in 4/4 time. The melody in the treble clef starts on a whole note G4, followed by quarter notes A4, B4, and C5. The bass line consists of a whole note chord of G4-B4-D5 in the first measure, and a whole note chord of G4-B4-D5 in the second measure. The final measure contains a whole note chord of G4-B4-D5 with a fermata over it. The number '1' is in a box above the first measure, and '2' is above the final measure.

2

2

2

Detailed description: This musical exercise is in 4/4 time. The melody in the treble clef starts on a whole note G4, followed by quarter notes A4, B4, and C5. The bass line consists of a whole note chord of G4-B4-D5 in the first measure, and a whole note chord of G4-B4-D5 in the second measure. The final measure contains a whole note chord of G4-B4-D5 with a fermata over it. The number '2' is in a box above the first measure, and '2' is above the final measure.

3

4

4

Detailed description: This musical exercise is in 4/4 time. The melody in the treble clef starts on a whole note G4, followed by quarter notes A4, B4, and C5. The bass line consists of a whole note chord of G4-B4-D5 in the first measure, and a whole note chord of G4-B4-D5 in the second measure. The final measure contains a whole note chord of G4-B4-D5 with a fermata over it. The number '3' is in a box above the first measure, and '4' is above the final measure.

4

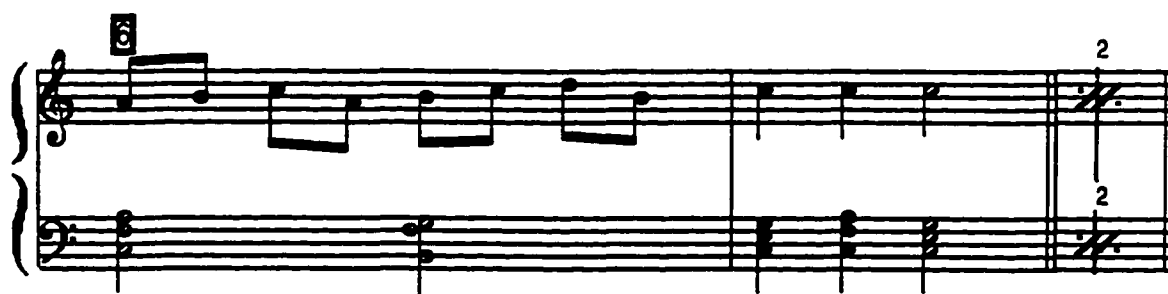
2

2

Detailed description: This musical exercise is in 4/4 time. The melody in the treble clef starts on a whole note G4, followed by quarter notes A4, B4, and C5. The bass line consists of a whole note chord of G4-B4-D5 in the first measure, and a whole note chord of G4-B4-D5 in the second measure. The final measure contains a whole note chord of G4-B4-D5 with a fermata over it. The number '4' is in a box above the first measure, and '2' is above the final measure.

File: Harmonizing Melodies

Set: 12-Pretest 3



**APPENDIX H**

***INSTANT REPLAY* SAMPLE RECORD REPORTS:**

**STUDENT REGISTRATION  
STUDENT DIARY  
TEST SCORES  
TEST ITEMS**

**INSTANT•Replay™**  
**Sample Student Registration Report**  
(as students registered)

| NAME               | STUDENT ID | PASSWORD (encrypted) |
|--------------------|------------|----------------------|
| Bazzy, Zadda       | 4879814187 | 551012992            |
| knoll, brian       | 3749621930 | 337028261            |
| lerner, jackie     | 087689967  | 341193509            |
| McAllister, Tim    | 6290343989 | -1965680988          |
| MORTON, CHRISTY    | 0345069744 | 551012992            |
| ollis, asya        | 3867438118 | -1623573248          |
| Palant, Jonathan   | 4382950661 | 560884704            |
| Spirtas, John      | 238179228  | 560236704            |
| stoffan, george    | 0467057716 | 546355685            |
| Wamke, Kelly       | 3719470295 | -644767069           |
| Weibel, Virginia   | 3869446453 | 541676960            |
| Wheadon, Carrie R. | 3700457346 | 538562597            |
| Wuellner, Jason    | 3719231896 | 1756674720           |

# **INSTANT•Replay™**

## **Sample Student Diary Report**

**NAME: HUNTER, ADAM**

**Registered: Mon, Apr 5, 1993 at 1:39 PM**

**OPEN FILE: 1 Major Triads-Melodic** Logged on: Mon, Apr 5, 1993 at 1:43 PM

**OPEN FILE: 1 Major Triads-Melodic**

- 1:47 PM – Practice Exercises #1 [elapsed time 2:09]

- 1:48 PM – Practice Exercises #1 [elapsed time 0:38] ✓ Mastery

**OPEN FILE: 2 Minor Triads-Melodic**

- 1:49 PM – Practice Exercises #1 [elapsed time 0:45] ✓ Mastery

**OPEN FILE: 3 Diminished Triads-Melodic**

- 1:51 PM – Practice Exercises [elapsed time 1:02]

**OPEN FILE: 4 Augmented Triads-Melodic**

- 1:53 PM – Practice Exercises [elapsed time 0:56] ✓ Mastery

**OPEN FILE: 5 Mixed Triads-Melodic**

- 1:55 PM – Practice Exercises [elapsed time 1:26] ✓ Mastery

**OPEN FILE: 6 Chords-Maj,Min,Dim,Aug**

- 1:57 PM – Practice Exercises [elapsed time 1:42] ✓ Mastery

**OPEN FILE: 7 Major Chord Progressions**

- 2:00 PM – Practice Exercises [elapsed time 1:33] ✓ Mastery

**OPEN FILE: 8 Minor Chord Progressions**

- 2:05 PM – Practice Exercises [elapsed time 4:15]

**OPEN FILE: 9 Major Pentascale Patterns**

- 2:08 PM – Practice Exercises [elapsed time 1:43] ✓ Mastery

**OPEN FILE: 10 Minor Pentascale Patterns**

- 2:10 PM – Practice Exercises [elapsed time 1:37] ✓ Mastery

**OPEN FILE: 1 Major Triads-Melodic**

- 2:17 PM – Diagnostic Test [elapsed time 4:46]

**OPEN FILE: 2 Minor Triads-Melodic**

- 2:22 PM – Diagnostic Test [elapsed time 4:01]

**OPEN FILE: 3 Diminished Triads-Melodic**

- 2:27 PM – Diagnostic Test [elapsed time 4:07]

**OPEN FILE: 4 Augmented Triads-Melodic**

- 2:33 PM – Diagnostic Test [elapsed time 4:07]

**OPEN FILE: 5 Mixed Triads-Melodic**

- 2:38 PM – Diagnostic Test [elapsed time 4:03]

**OPEN FILE: 6 Chords-Maj,Min,Dim,Aug**

- 2:43 PM – Diagnostic Test [elapsed time 4:03]

**OPEN FILE: 7 Major Chord Progressions**

- 2:49 PM – Diagnostic Test [elapsed time 5:22]

**OPEN FILE: 8 Minor Chord Progressions**

- 2:55 PM – Diagnostic Test [elapsed time 5:00]

**OPEN FILE: 9 Major Pentascale Patterns**

- 3:01 PM – Diagnostic Test [elapsed time 4:21]

**OPEN FILE: 10 Minor Pentascale Patterns**

- 3:07 PM – Diagnostic Test [elapsed time 5:10]

**OPEN FILE: 6 Chords-Maj,Min,Dim,Aug**

**OPEN FILE: 8 Minor Chord Progressions**

**Logged off: Mon, Apr 5, 1993 at 3:09 PM**

# **INSTANT•Replay™**

## **Sample Test Scores Report**

**FILE: Diagnostic Test—Long Form**  
**SET: Major Triads—Melodic**

**3719470295 Warnke, Kelly**  
**Monday, January 25, 1993 8:21 PM**  
 • Item score: 16 correct, 0 incorrect, 100 percent  
 • Note accuracy: 59 correct, 0 incorrect, 100 percent

**3719231896 Wuellner, Jason**  
**Saturday, January 30, 1993 2:20 PM**  
 • Item score: 16 correct, 0 incorrect, 100 percent  
 • Note accuracy: 59 correct, 0 incorrect, 100 percent

**3700457346 Wheadon, Carrie R.**  
**Sunday, January 31, 1993 2:04 PM**  
 • Item score: 15 correct, 1 incorrect, 94 percent  
 • Note accuracy: 55 correct, 4 incorrect, 93 percent

**238179228 Spirtas, John**  
**Sunday, January 31, 1993 4:00 PM**  
 • Item score: 16 correct, 0 incorrect, 100 percent  
 • Note accuracy: 59 correct, 0 incorrect, 100 percent

**4879814187 Bazzy, Zadda**  
**Monday, February 1, 1993 3:06 PM**  
 • Item score: 15 correct, 1 incorrect, 94 percent  
 • Note accuracy: 56 correct, 3 incorrect, 95 percent

**6290343989 McAllister, Tim**  
**Tuesday, February 2, 1993 3:14 PM**  
 • Item score: 16 correct, 0 incorrect, 100 percent  
 • Note accuracy: 59 correct, 0 incorrect, 100 percent

**4382950661 Palant, Jonathan**  
**Wednesday, February 3, 1993 4:06 PM**  
 • Item score: 16 correct, 0 incorrect, 100 percent  
 • Note accuracy: 59 correct, 0 incorrect, 100 percent

**0345069744 MORTON, CHRISTY**  
**Friday, February 5, 1993 3:50 PM**  
 • Item score: 16 correct, 0 incorrect, 100 percent  
 • Note accuracy: 59 correct, 0 incorrect, 100 percent

## **INSTANT•Replay™**

### **Sample Test Items Report**

**FILE: Diagnostic Test—Long Form**  
**SET: Major Triads—Melodic**

|            |                                 |
|------------|---------------------------------|
| 3661355130 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 282523830  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 0354430393 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 |
| 3641554316 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 0937894715 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 0467057716 | 1 1 1 0 1 1 1 1 0 1 1 1 1 1 1 1 |
| 364028242  | 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 |
| 3730489071 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 3708651000 | 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 |
| 141603154  | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 3779226014 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 123456789  | 1 1 1                           |
| 3718813762 | 0 0 0 0 0 0 1 0 1 1 0 0 0 0 0 0 |
| 3819434531 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 |
| 3869446453 | 1 1 1 1 1 1 1 1 0 1 0 1 1 1 1 1 |
| 0786895376 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 3867438118 | 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 2207896673 | 1 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 |
| 3649431864 | 1 0 0 1 1 0 1 1 1 1 1 1 1 1 1 1 |

**FILE: Diagnostic Test—Long Form**  
**SET: Mixed Triads—Melodic**

|            |                                 |
|------------|---------------------------------|
| 3661355130 | 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 |
| 282523830  | 1 1 1 0 1 1 1 1 0 0 0 1 1 1 1 1 |
| 0354430393 | 1 0 1 1 1 1 1 1 1 1 0 0 0 1 1 1 |
| 0937894715 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| 3641554316 | 1 1 1 1 0 1 1 1 0 1 1 1 1 0 0   |
| 3708651000 | 1 1 1 1 1 0 1 1 0 1 1 1 1 1 1 1 |
| 364028242  | 1 1 x 0 0 1 1 1 0 0 1 0 0 1 1 0 |
| 3730489071 | 1 1 0 1 1 0 0 1 1 1 1 0 1 1 1 1 |
| 3869446453 | 0 1 0 0 0 0 1 0 1 0 0 0 1 1 1 0 |
| 3819434531 | 0 1 0 0 0 1 0 0 1 1 0 0 1 0 1 1 |
| 3867438118 | 1 1 1 1 1 0 1 1 1 0 1 1 1 1 1 0 |
| 2207896673 | 1 1 1 1 1 0 1 1 0 1 1 1 1 1 1 1 |

## BIBLIOGRAPHY

## BIBLIOGRAPHY

- Abacus Concepts. StatView™ Version 512+. Calabasas, CA: BrainPower, 1986.
- Arenson, Michael A. "The Validity of Certain Entrance Tests as Predictors of Grades in Music Theory and Ear Training." *Bulletin of the Council for Research in Music Education* 75 (Summer 1983): 33-39.
- Baczewski, Philip. "Experience and Evaluation: Ear Training CAI in Action." In Research Reports and Reports on the Ann Arbor Symposium, ed. Samuel D. Miller, 1-13. San Antonio, TX: Texas Music Educators Association College Division, 1980.
- Barnet, Richard D. "Differential Validity and Prediction of Academic Success of Music Students." *Dissertation Abstracts International* 47A (January 1987): 2472.
- Bowman, Judith A. "An Investigation of Two Methods of Preparation for College Level Music Theory." *Dissertation Abstracts International* 45A (September 1984): 779-80.
- Bresler, Liora. "The Role of the Computer in a Music Theory Classroom: Integration, Barriers, and Learning." *Dissertation Abstracts International* 48A (January 1988): 1689.
- Brown, Amy, and Jayne M. Alley. "Multivariate Analysis of Degree Persistence of Undergraduate Music Education Majors." *Journal of Research in Music Education* 31 (Winter 1983): 271-81.
- Burge, David L. Perfect Pitch: Color Hearing for Expanded Musical Awareness. Presque Isle, MI: American Educational Music Publications, 1983.
- Canelos, James J., Barbara A. Murphy, Ann K. Blombach, and William C. Heck. "Evaluation of Three Types of Instructional Strategy for Learner Acquisition of Intervals." *Journal of Research in Music Education* 28 (Winter 1980): 243-49.
- Casey, Donald E., Jr. "A Profile of the Undergraduate Music Majors at Northwestern University in Terms of Attitude, Demographics, Self Concept, and Personal Orientation." *Dissertation Abstracts International* 47A (November 1986): 1642.
- Cooper, Rose M. "The Efficacy of Computer-Assisted Instruction Compared with Traditional Teacher-Taught and Self-Taught Methods of Teaching Beginning Music Theory." *Dissertation Abstracts International* 36A (March 1976): 5623-24.

- Dudd, John E. "The Prediction of Success as Defined by Graduation Grade Point Averages, Graduation, and Music as an Occupation of Freshmen Enrolled in The University of Michigan School of Music in September, 1962: A Longitudinal Study in Admissions." Ph.D. dissertation, University of Michigan, 1978.
- Ernest, David J. "The Prediction of Academic Success of College Music Majors." *Journal of Research in Music Education* 18 (Fall 1970): 273-76.
- Froseth, James O. "Guidelines for Interpretation of 'Test of Melodic Ear-to-Hand Coordination (TMEHC)' Scores." Unpublished document, 1982.
- \_\_\_\_\_. "Test of Melodic Ear-to-Hand Coordination (TMEHC)." Unpublished diagnostic test, 1982.
- \_\_\_\_\_. "A Longitudinal Study of the Relationship Between Melodic Ear-to-Hand Coordination and Selected Indices of Musical Achievement at the University of Michigan School of Music." Unpublished research report, University of Michigan, 1985.
- \_\_\_\_\_. MLR Harmonic Ear-to-Hand Skills Program. Chicago: G.I.A., 1985.
- \_\_\_\_\_. MLR Melodic Ear-to-Hand Skills Program. Chicago: G.I.A., 1985.
- Froseth, James O., and Barton Polot. Instant Replay: An Authoring System for Performance-based Ear-training Version 1.0. Chicago: G.I.A., 1991.
- Froseth, James O., and Barton Polot. Teacher Create: Melodic and Harmonic Ear-to-Hand Training at the Keyboard Version 1.0. Chicago: G.I.A., 1991.
- Garton, Janet C. "The Efficacy of Computer-Based and Tape-Recorded Assistance in Second-Semester Freshman Ear-Training Instruction." *Dissertation Abstracts International* 42A (May 1982): 4756-57.
- Gauldin, Robert. "Teaching Music Theory: The Conservatory." *Journal of Music Theory* 18 (Spring 1974): 75-90.
- George, Warren E. "Significant Predictors for College Achievement in Specified Areas of Music Education and Identification of Potential Graduates, (Volumes One and Two)." *Dissertation Abstracts International* 30A (January 1970): 3040.
- Greer, Douglas R. Design for Music Learning. New York: Teachers College Press, 1980.
- Gross, Dorothy, and Wendy Griffin. "Implementation and Evaluation of a Computer-Assisted Course in Musical Aural Skills." *Association for Educational Data Systems Journal* 15 (Spring 1982): 143-50.

Harrison, Carole S. "Predicting Music Theory Grades: The Relative Efficiency of Academic Ability, Music Experience, and Musical Aptitude." *Journal of Research in Music Education* 38 (Summer 1990): 124-37.

\_\_\_\_\_. "Relationships Between Grades in the Components of Freshman Music Theory and Selected Background Variables." *Journal of Research in Music Education* 38 (Fall 1990): 175-86.

Harrison, Carole S., Edward P. Asmus, and Richard T. Serpe. "Effects of Musical Aptitude, Academic Ability, Music Experience, and Motivation on Aural Skills." *Journal of Research in Music Education* 42 (Summer 1994): 131-44.

Higgins, William. "Technology." In Handbook of Research on Music Teaching and Learning, ed. Richard Colwell, 480-97. New York: Schirmer, 1992.

Hilley, Martha, and Lynn Freeman Olson. PDM I: Piano for the Developing Musician. 2d ed. New York: West, 1985.

Hofstetter, Fred T. "Computer-Based Aural Training: The GUIDO System." *Journal of Computer-Based Instruction* 7 (February 1981): 84-92.

Humphreys, Jere T. "An Investigation of an Experimental Harmonic Audiation Skills Testing and Training Program for Instrumental Music Education Majors." Ph.D. dissertation, University of Michigan, 1984.

Jousse-Wilkins, Colette T. "Report on Initial Development of Microcomputer Programs in Reading and Aural Training for Music Students." In Proceedings of the Association for the Development of Computer-Based Instructional Systems, 20-23. Bellingham, WA: Western Washington University, 1980.

Kendall, Michael J. "The Effects of Visual Interventions on the Development of Aural and Instrumental Performance Skills in Beginning Fifth-Grade Instrumental Students: A Comparison of Two Instructional Approaches." Ph.D. dissertation, University of Michigan, 1986.

Killam, Rosemary N., and W. Kenton Bales. "Music CAI: A Model for Epistemological Research Applications." In Proceedings of the Third Canadian Symposium on Instructional Technology, 417-30. Vancouver, British Columbia, CANADA: National Research Council, 1980.

Killam, Rosemary N., W. Kenton Bales, Richard L. Hamilton, and Dan W. Scott. "AMUS: The Computer in Music Instruction." In Proceedings of the Texas Music Educators Association Conference, 1-13. Houston, TX: Texas Music Educators Association College Division, 1979.

Kingsbury, Henry O. "Music as a Cultural System: Structure and Process in an American Conservatory." *Dissertation Abstracts International* 46A (July 1985): 190.

Kuehn, John W. "The Effects of Training on the Melodic and Harmonic Ear-to-Hand Coordination of Undergraduate Music Majors in an Educational Setting." *PMEA News* (March 1989): 20-22.

\_\_\_\_\_. "A Three-Year Study of the Relationship Between Freshman Melodic Ear-to-Hand Scores and Standard Indicators of Musical Achievement at Indiana University of Pennsylvania Department of Music." *PMEA News* (May 1990): 14-15.

Kuhn, Wolfgang E., and Raynold Allvin. "Computer-Assisted Teaching: A New Approach to Research in Music." *Journal of Research in Music Education* 15 (Winter 1967): 305-15.

LeCompte, Margaret D., and Judith Preissle Goetz. "Problems of Reliability and Validity in Ethnographic Research." *Review of Educational Research* 52 (Spring 1982): 31-60.

Leverett, John M. "Relationships Between Freshman Admissions Data and the Completion of a Bachelor of Music Degree." *Dissertation Abstracts International* 45A (September 1984): 679.

Lewis, Ralph, and James O. Froseth. "Utilization of CAI for Self-Directed Aural Skills Training." Unpublished research report, University of Michigan, 1984.

Mark of the Unicorn. Professional Composer™ Version 2.2. Cambridge, MA: Mark of the Unicorn, 1985-1988.

Markovich, Victor A. "An Investigation of the Effects of Matching Timbre and Training on Melodic Ear-to-Hand Coordination of College Music Majors." Ph.D. dissertation, University of Michigan, 1985.

Melton, Ellis E., Jr. "A Study of Differences Among Various Groups of Michigan State University Music Students." *Dissertation Abstracts International* 34A (June 1974): 7809.

New Harvard Dictionary of Music. Cambridge, MA: Belknap Press of Harvard University Press, 1986.

Partch, Harry. "Show Horses in the Concert Ring." In Bitter Music: Collected Journals, Essays, Introductions, and Librettos, ed. Thomas McGeary, 174-80. Music in American Life Series. Urbana, IL: University of Illinois Press, 1991.

Placek, Robert W. "A Model for Integrating Computer-Assisted Instruction Materials into the Music Curriculum." *Journal of Computer-Based Instruction* 6 (February 1980): 99-105.

- Plasket, Donna J. "Training Musicians and Developing People: Can a Music Conservatory Do It All?" *Dissertation Abstracts International* 53A (August 1992): 437.
- Platte, Jay D. "The Effects of a Microcomputer-Assisted Instructional Program on the Ability of College Choral Ensemble Members to Sing Melodic Configurations at Sight." *Dissertation Abstracts International* 42A (October 1981): 1368-69.
- Polot, Barton L. "An Investigation of Aural Reinforcement and Kinesthetic Reinforcement as Variants of the Response Mode in Computer-Assisted Harmonic Aural Skills Training." Ph.D. dissertation, University of Michigan, 1992.
- Rist, Ray C. "Overview of the Relations among Educational Research Paradigms: From Disdain to Detente." *Anthropology & Education Quarterly* 8 (May 1977): 42-49.
- Rohrs, Dennis K. "Predicting Academic Success in a Liberal Arts College Music Education Program." *Dissertation Abstracts International* 23A (February 1962): 2937-38.
- Ross, Jerrold. "Qualitative Evaluation and Its Importance for Research in Arts Education." *Southeastern Journal of Music Education* 1 (1989): 61-67.
- Sang, Richard C. "Modified Path Analysis of a Skills-Based Instructional Effectiveness Model for Beginning Teachers in Instrumental Music Education." Ph.D. dissertation, University of Michigan, 1982.
- \_\_\_\_\_. "A Study of the Relationship Between Instrumental Music Teachers' Modeling Skills and Pupil Performance Behaviors." *Bulletin of the Council for Research in Music Education* 91 (Spring 1987): 155-59.
- Shannon, Don W. "Aural-Visual Interval Recognition in Music Instruction: A Comparison of a Computer-Assisted Approach and a Traditional In-Class Approach." *Dissertation Abstracts International* 43A (September 1982): 718.
- Stone, Michael H. "A Study of the Relationships Between Selected Variables and the Differential Academic Achievement of Freshmen in The University of Michigan School of Music." Ph.D. dissertation, University of Michigan, 1969.
- Thompson, Edgar J. "Sightsinging Constant Rhythm Pitch Phrases: A Computer Assisted Instructional System." *Dissertation Abstracts International* 34A (January 1974): 4319.

Thostenson, Marvin S. "The Study and Evaluation of Certain Problems in Eartraining Related to Achievement in Sightsinging and Music Dictation." *Bulletin of the Council for Research in Music Education* 11 (Fall 1967): 14-35.

University of Michigan School of Music. "Class Piano Course Syllabus and Examination Requirements." Unpublished document, 1992-1993.

Vaughn, Arthur C., Jr. "A Study of the Contrast Between Computer Assisted Instruction and the Traditional Teacher/Learner Method of Instruction in Basic Musicianship." *Dissertation Abstracts International* 38A (December 1977): 3357.

Webster's Third New International Dictionary of the English Language: Unabridged. Springfield, MA: G. & C. Merriam, 1964.

Wheatley, Susan E. "An Application of Chunking to the Memory and Performance of Melodic Patterns." Ph.D. dissertation, University of Michigan, 1991.

Wilder, Michael D. "An Investigation of the Relationship Between Melodic Ear-to-Hand Coordination and Written and Aural Theory Skills within an Undergraduate Music Theory Context." Ph.D. dissertation, University of Michigan, 1988.

Wratcher, Marcia A. "Helping Freshmen to Maximize Their Learning Potential." *Journal of College Student Development* 32 (July 1991): 380-81.