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Computerized Music Theory Placement Exams and Correlations between Placement Levels and Demographics

Sarah Catherine Bailey
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Sarah Catherine Bailey entitled "Computerized Music Theory Placement Exams and Correlations between Placement Levels and Demographics." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Music, with a major in Music.

Barbara Murphy, Major Professor

We have read this thesis and recommend its acceptance:

Philip Ewell, Don Pederson

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Acceptance for the Council:

Anne Mayhew___________
Vice Chancellor and Dean of
Graduate Studies

(Original signatures are on file with official student records.)

Computerized Music Theory Placement Exams and Correlations between Placement Levels and Demographics

A Thesis
Presented for the
Master of Music
Degree
The University of Tennessee, Knoxville

Sarah Catherine Bailey
August 2006

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ABSTRACT

The purpose of this study was to determine if there are relationships between theory placement level and major, major instrument, gender, ethnicity, and the location of the student's high school of entering freshmen music students. The hypothesis was that there would be a relationship between instruments and scores on sections of the test, and that there would be no significant relationship between gender or ethnicity and score. It was also hypothesized there would be a relationship between major and/or location of the student's high school and score.

Sixty students at least 18 years old auditioning for the University of Tennessee's music department participated in the study. The subjects completed a theory placement test consisting of 77 questions; 11 on each of the following topics: seventh chords, rhythm, analysis, triads, intervals, notation, and key signatures. The students also completed a demographic survey containing questions on age, ethnicity, major, major instrument, and location of high school.

Results showed there was no statistical significance between major or major instrument and placement score; however, results did indicate that vocalists scored lower on all parts of the test and received the lowest overall score on the test. The percussionists participating in the study did very well overall on the test but the low number of participants in that instrument group (3) combined with the high scores of the participating students makes those results unreliable. Students who indicated an interest in music education also consistently scored in the lower third on the test as a whole. The results showed no significant relationships between gender and score and ethnicity and

score. Further research needs to be conducted with more control for each demographic group. This could show more significant relationships not able to be confirmed in this study.

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INTRODUCTION

Music theory is one of the courses that should be part of the foundation of a classical music education. However, many students do not take music theory either in high school or privately. Secondary schools may not offer theory classes. Private teachers may not include theory in their lessons. Since music students come to college with a wide range of abilities in music theory, to help these students, placement tests should be offered so that students can be placed into the most appropriate level of theory as freshmen. Such a placement test can ensure that each student will receive the information s/he needs and make students comfortable in their classes. A more homogenous group of students also helps the teacher; when students in the class have a similar background teachers can plan better and address the needs of each student.

Placement tests can be given in many ways: paper-and-pencil tests, a single computerized test, or a combination of both. A computerized test is hypothesized by many to be the best method of placement-testing because it provides an immediate placement result (Smith, 1994; Piagentini and Snodgrass, 2006; Vispoel and Coffman, 1994). Electronic tests also keep records, significantly reducing the amount of paperwork. The records can be analyzed to improve the test's function. Results can also be used to tailor class offerings.

The idea of a music theory placement exam via computer has been explored for the past twenty years and recently the need has arisen for these tests to come to fruition due to increasing time constraints and the larger number of incoming students as well as the ease of programming and the integration of computers into curricula. The need for

computerized tests is currently being answered with the creation of placement tests by Vispoel and Coffman (adaptive-test experiments), Pearlman, Berger, and Tyler (attempt to computerize the music GRE), Timothy Smith (RON program), Murphy (music theory placement test), and Piagentini and Sterling-Snodgrass (MUSE program).

In Chapter I of this study, literature on computerized placement tests in music and studies concerning the relationship of demographic information and music tasks are discussed. Chapter II, Methodology, includes discussion about this study's revision of an already existing placement exam to include demographics to facilitate the hypotheses. Chapter III contains the results of the study. Finally, in Chapter IV conclusions are drawn from those results and implications for current music educators and potential future paths of study are discussed.

CHAPTER I: LITERATURE REVIEW

This project was designed to examine demographic information from incoming music students and compare that information to each student's results on a music theory placement test. The comparisons would be analyzed for relationships regarding the stereotypes and generalizations so prevalent in music theory regarding the background of students. Stereotypes might include the level of aptitude for students who play certain instruments or choose certain majors. For example, it has been assumed in colleges that percussionists are good at rhythm and bad at pitches, while keyboardists are good at key signatures and analysis. These assumptions are made by educators and even fellow students based on the observation of a few students, but may not be the norm.

There have been only a few studies conducted using computerized placement testing in music in the past thirty years. Some studies focused on new tests developed and the positive and negative aspects of those tests as well as implications of the results. Other studies focused on the method of testing and did not study the results and the possible coordinating relationships between results and students' demographic information.

Walter P. Vispoel and Don D. Coffman conducted a study in 1994 at the University of Iowa to determine which of three different kinds of tests—computerized-adaptive, self-adapted, and fixed-item—is the most appropriate method of testing music listening skills. When students take the computerized-adaptive test, the computer adjusts the difficulty of each forthcoming question according to the student's accuracy level on the previous questions. On the self-adapted test, the student chooses the difficulty level

of the forthcoming question. The fixed-item test is a linear test with no difficulty adjustment.[1]

Fifty-three middle school students enrolled in three groups of a required general music class served as subjects. All classes were taught by the same instructor. Students had an average of two years of private lessons on their instruments. The subjects had been taking paper-and-pencil listening tests but were familiar with computers. Each student completed a personal questionnaire that included questions regarding the students' demographic information, took a Test Anxiety Inventory, a 15 and 30 item tonal memory computer-adapted test, a 15 and 30 item tonal memory self-adapted test, and five standardized paper-and-pencil music-listening tests covering pitch discrimination, chord recognition, and musical memory.[2]

The results showed that the students scored highest on the self-adapted test and the authors hypothesized this might have been due to a reduction of stress based on the results of the Test Anxiety Inventory. However, the self-adaptive test took an average of twice as long for the students to finish than the computerized-adaptive test, as the students were required to set the difficulty-level for each question. The computer-adaptive style of testing took the least amount of time compared to both of the other test versions. On a 15-item test, the average score on the self-adapted test was 28 points higher than the computerized-adaptive test and was 66 points higher on a 30-item test.[3]

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[1] Walter P. Vispoel and Don D. Coffman, "Computerized-Adaptive and Self-Adapted Music-Listening Test: Psychometric Features and Motivational Benefits," Applied *Measurement in Education* 7/1 (1994): 25.
[2] Ibid., 29.
[3] Ibid., 38.

The Vispoel and Coffman study neglected to look at how the students' respective backgrounds might have affected the scores. For example, a student used to taking computerized-adaptive tests might perform differently than a student who has only taken paper-and-pencil tests in the past. While test anxiety can be a debilitating factor in some cases, most students, particularly music students, should be expected to perform under pressure, and therefore performance anxiety should not be a problem.

Pearlman, Berger, and Tyler's (1993) study explored the applications of technology to standardized testing. They worked with the Educational Testing Service to create a computerized test to replace the Music Subject GRE. The authors, all non-musicians, created their test by combining parts of the paper-and-pencil Music Subject GRE and with some new aural questions. The Music Subject GRE was chosen because, compared to the other subject GRE's such as psychology or biology, it showed the most promise for conversion to multimedia software due to the aurally focused aspects of music.[4]

Two groups of music students at varying levels of education from Westminster Choir College took the new computerized test several times. The test used Multimedia Toolbook™ software and was developed to include questions from the older version of the GRE as well as aural questions not included in the previous version. The test was developed on a PC with a CPU speed of 33 megahertz and was tested on machines with a CPU speed of 25 megahertz. The topics covered included intervals, chords, and harmonic and melodic dictation. The dictation sections of this computerized test were in

[4] Mari Pearlman, Ken Berger, and Linda Tyler. *An Application of Multimedia Software to Standardized Testing in Music.* Educational Testing Service, (1993): 5.

a palette format, meaning the student would see an empty stave, listen to the musical example, and then begin notating the example on the computer screen. The students complained about the interface and the time it took to notate the example and correct mistakes. The difficulty the students experienced is possibly due to the creators' lack of musical experience.[5]

There were many confounding variables affecting this study. Perhaps the most problematic variable was the design of the user interface. Although the interval and chord sections were acceptable to the students, the difficulty of the user interface in the harmonic and melodic dictation sections made them unacceptable. Another major problem was that the test was developed on a computer other than the computers the students used, which resulted in the test running slowly and even crashing when students were using it. The authors conceded that technology in general was not advanced enough for such a test to be developed at a level acceptable for use as the music subject GRE. They were accurate on this point, as the *General* GRE has been successfully computerized and implemented only recently, 10 years after Pearlman, Berger, and Tyler's test was attempted.

Pearlman, Berger, and Tyler were on the right track with their computerized Music Subject GRE, but simply had bad timing. Had the Music Subject GRE continued I have no doubt it would have been computerized eventually, particularly considering that the General GRE and many of the subject GRE's have been computerized and are

[5] Ibid., 8-11.

currently being used. Perhaps if the Music Subject GRE computerization had occurred sooner, interest might have increased and the test would still be offered.[6]

The recently computerized General GRE uses the computerized-adaptive method. The difficulty level of each question is determined by the answer given for the previous question. If the answer to the previous answer was correct, the difficulty level of the next question increases, and if the answer was incorrect, the difficulty level decreases. Once the test is complete, the computer gives the student a score corresponding to the student's aptitude that is then used by universities in the admission process. This is a relatively new idea in computerized testing and has rarely been attempted.

Timothy A. Smith (1994) has been one of the most prominent researchers in computerized placement testing and uses a computerized-adaptive method very similar to the General GRE. His "Ready or Not" (*RON*) program is a nonlinear placement test that "quickly, accurately, and reliably places students into the appropriate level of music theory course."[7]

Smith developed and tested his placement test at Ball State University in the years 1992 through 1995. RON was designed as a computerized-adaptive test to increase the efficiency of the placement process. If a student had a higher mastery level Smith saw no reason to require them to answer the lower difficulty questions. Therefore, RON works through at least five of the most discriminating sections of the test with the student; however, Smith does not list what those sections are. Based on those results the test will

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6 The music GRE was discontinued in 2001. Inq_Agent1, "Music GRE Discontinuation?" 16 March 2006, personal email (16 March 2006).

7 Timothy A. Smith, "An ExSPRT System Approach to the Assessment of Students Needing Remediation in Music Theory," *Journal of Music Theory Pedagogy* (1994):181.

either increase or decrease the difficulty level until the student's aptitude level is determined.[8]

Of the 400 music majors he tested, two fifths (160) were advised into a remedial course by *RON*. Half of those students (80) opted to enter the first year of the theory sequence instead, ignoring *RON*'s placement. Of those students who ignored *RON*'s placement advice, more than 66% (53) failed their first year of theory.[9]

The placement accuracy of Smith's test is encouraging for those developing other placement tests. His results show that a placement is certainly beneficial and should not be taken lightly by students. His results also imply that a computerized-adaptive test is more efficient than a fixed-item test and places students just as accurately.

In 1990, James P. Colman developed a music theory placement test for students at Michigan State University. Colman's goals were to create an exam to measure the ability of the incoming students to "replace the assumptions made by college music theory professors, determine whether the test was a reliable predictor of future student success, and to provide help for advisors when deciding what theory class their advisee should take.[10] The test covered topics including scales, pitch notation, notes and rests, intervals, triads, key signatures, and time notation. The test was created in Hypercard and was taken as a linear test, although students could return to skipped questions.

Fifty-nine incoming freshmen took Colman's placement test. The mean score was 56.75 and the reliability of the test was estimated at .86. After the students

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[8] Ibid., 187.
[9] Ibid.,193.
[10] James Peter Colman, "The Development and Validation of a Computerized Diagnostic Test for the Prediction of Success in the First-Year Music Theory Sequence by Incoming Freshmen at Michigan State University." (unpublished Ph.D. Dissertation, Michigan State University, 1990).

completed their year of theory courses Colman reevaluated their scores. Twenty-seven of the subjects did not complete the sequence. The author found that test scores did correlate with student's grades in their classes, but correlated less in the later school terms. Although some test items were useful others needed to be discarded, however this was never done.

Colman's test was a first step in testing the validity of a placement exam; however, he did not run an item analysis to determine the usefulness of the questions. An item analysis, combined with a revision of the test, questions accordingly, would have made his test more reliable, and perhaps his scores would correlate more accurately in the later terms.

Barbara Murphy (1999) of the University of Tennessee developed the Music Theory Placement Exam 1.0 (*MTPE 1.0*). The *MTPE 1.0* mirrors aspects of Timothy Smith's *RON* program as well as Colman's placement program. Although the *MTPE 1.0* is not an adaptive test, the questions are randomized. The *MTPE 1.0* was written as a Supercard stack and is computerized. The test is multiple choice with four answer boxes the student can click to choose his/her answer; each question must be answered. At the end of the test, the students are given their results and their placement into either a Fundamentals of Theory class or Theory I.[11] Extensive item analyses were completed on the 55 test questions in the subtest categories of notation, rhythm, scales, intervals, and triads, and the analyses recommended that at least 11 questions on each topic be asked to place the student appropriately.

[11] Ibid., 56.

The test was initially treated as a study to “determine the reliability and predictive validity of the [placement] exams.”[12] The tests were “evaluated to determine how they [were] performing as indicators of student knowledge and student success in theory classes.”[13] To achieve this evaluation, Murphy correlated each student’s placement with the grade s/he received in his/her theory course. The results indicated that the exam predicted the student’s grades in theory with a significant probability of < .01, making it useful for the student and the teacher. Once the study was completed, the test continued to be used as the University of Tennessee’s placement exam although the subtest categories of seventh chords and analysis were added, also with 11 questions each..[14]

Murphy’s placement test was extensively researched to be an effective measure for incoming freshmen. The five topics were thoroughly researched to provide optimal placement results. Although Murphy studied the questions thoroughly, like Smith and others, she did not study the relationship between demographics and test scores.

The most recent research study on music tests was conducted by Susan Piagentini of Northwestern University and Jennifer Sterling-Snodgrass of Appalachian State University. “The [Music Skills Exam (MUSE)] project is an online, customizable assessment tool for music theory.”[15] *MUSE* operates within course management systems (CMS) such as WebCT™ and Blackboard™. This test is the “first fully developed web-

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[12] Barbara Murphy, “The Evaluation and Design of an Undergraduate Music Theory Placement Exam,” *Jounal of Music Theory Pedagogy* 8 (1999): 42.
[13] Ibid., 42.
[14] Ibid., 57
[15] Susan Piagentini and Jennifer Sterling-Snodgrass, *Prospectus – The MUSE Project; An Online, Customizable Assessment Tool for Music Theory*. Unpublished prospectus, (2005): 1.

based music theory assessment tool."[16] In developing the test, the research team collected data from 75 major universities regarding their use and potential use of placement tests and found that almost all the universities had some need for or utilized a placement test of some sort, mostly pencil-and-paper. The topics tested on the placement exams, however, varied greatly between each school. To accommodate the need for a single test that could accommodate many schools, *MUSE* is customizable by a test administrator via a web interface. The customizations are limited, however, to the large question pool included with the test. The instructor can create a test from any number of the hundreds of available questions. New questions cannot be created.

While the *MUSE* project has great potential, it has one major limitation: to use the test students must sign onto a CMS. Using a CMS is highly recommended for students once enrolled in a university, as shown by the large number of universities using CMS's now; however, at some schools students must be assigned a university ID to use the program. This ID requirement undermines the concept of a placement test as it needs to be taken before a student is admitted to the university. Issuing a university ID to prospective students would need to be cleared by the university and could be a large problem. The authors of *MUSE* are currently redeveloping the test as a stand-alone program to address this issue.[17]

Although the above placement tests are interesting and applicable to this research as models, the tests and studies do not take into consideration demographic information in the analysis of the results. One study that does look for relationships of gender and

[16] Ibid., 2.

[17] Jennifer Snodgrass, "Re: New information on placement testing?" 10 March 2006, personal email (10 March 2006).

major to test scores was conducted by Thomas Vives (1998). His study's main purpose was to explore the affect of timbre on chord identification accuracy of college students. But Vives also looked at how the test results were affected by the demographic information of the students. For his test, chords were played using digital recordings of instruments, the students were asked to identify the chords played, and the test scores were recorded along with gender and major of each student. The test was taken in pencil-and-paper format and the students were 40 sophomore level music theory students at the University of Florida. All subjects had completed at least one year of ear training and were music majors.[18]

The results of Vives's study showed that gender did not affect test scores.[19] Major instrument, however, did affect test scores; timbre familiarity increased test scores and therefore increased certain student's scores. The small number of students representing each instrument group (brass=9, piano=4, strings=5, voice=10, woodwinds=12) is a weakness in the research and therefore the results are not conclusive; however it is probable that timbre familiarity can affect test score.[20]

The few studies that have been conducted regarding computerized placement tests in music have not included the demographic information of the students. The one study to address the effect of demographics did not address testing mediums other than paper-and-pencil. The following study combines a computerized placement test with a study of student demographics. The results should dispel some stereotypes that have become

[18] Thomas Edward Vives, "The Effect of Timbre on the Chord Identification Accuracy of Sophomore Level College Music Theory Students," Ph.D. diss., The University of Florida, (1998): 54.
[19] Ibid., 61.
[20] Ibid., 64.

common in music departments such as the relationships between placement level and major, major instrument, gender, ethnicity, and location of high school. The next chapter will describe the methodology used in this study. The subjects, the user interface of the test, and the computer program running the test will all be discussed.

CHAPTER II: METHODOLOGY

The purpose of this research is to confirm or dispel certain assumptions made regarding relationships between students' performance on theory placement tests and their demographic information. In particular, gender, ethnicity, major, instrument, and location of high school will be compared to overall test score as well as scores on the seventh chord, rhythm, analysis, triads, intervals, notation, and key signature subtests.

Subjects

Subjects were students auditioning for the University of Tennessee's School of Music in February and March of 2006. As part of the audition process, the students took this study's version of the music theory placement exam (*MTPE 2.0*). All students who took the test were potential subjects in this study.

There were 125 subjects. Sixty students were 18 or older, and 65 were 17 years old. The data taken from the students aged 17 were not used in this study because minors cannot participate in ethically controlled basic studies. Thus, data from the 60 participants 18 or older were used in this study. Forty-five students were from Tennessee, four from Virginia, and two from Georgia. The other nine students were from Alabama, Arizona, Florida, Indiana, Mississippi, Ohio, Oklahoma, Pennsylvania, and Russia. Instrument groups were developed because there were not enough students playing each individual instrument to properly analyze the results (table 1). The woodwinds group includes 5 flutes, 4 clarinets, 4 oboes, 1 bassoon, and 3 saxophones. The voice group includes 1 soprano, 2 altos, 6 tenors and 2 basses. The Strings group includes 2 violins, 1 viola, and 2 cellos, as well as 4 guitar/electric bass. The percussion

Table 1: Number of Participants by Instrument

Brass	19
Woodwinds	17
Voice	12
Strings	9
Percussion	3

Table 2: Number of Participants by Major

Music Education	27
Performance	14
Undecided	7
Music Minor	6
Studio Music and Jazz	2
Sacred Music	2
Theory/Comp	1
Bachelor of Arts	1

group includes 3 percussionists. Brass includes 12 trumpets, 4 trombones, 4 baritone horns, 1 tuba, and 1 french horn.

Table 2 shows the distribution of majors. There were 27 students interested in music education, 14 in performance, 7 undecided, 6 in a music minor, 2 in both studio music and jazz and sacred music, and 1 in both theory/composition and a Bachelor of Arts. Of the 60 participants, 19 were female and 41 were male. Fifty-four participants were Caucasian, and the remaining participants were of various ethnicities, including 2 African Americans, 2 Asians, 1 Native American and 1 other.

The Test

Before the students began the test, they were given the following instructions:

> You are about to take the Music Theory Placement Exam. This test will not affect your entrance into the university; it simply tells us what theory class you should take in the event that you come here to study. There are 77 questions on the exam. It should take you about 45 minutes to complete. The demographic questions you will have the opportunity to answer at the end of the exam are part of an anonymous research project and will not effect your placement. If you do not wish to participate, please leave the demographic questions blank.

The students were then placed at any available computer randomly. When the student began the test, s/he viewed simple instructions on the use of the program (figure 1). The instructions gave information on how to use the test, the purpose of the test and the fact that demographic information would be recorded if the student participated in the study. After reading the directions, the student began the test by clicking the "next" arrow button. The first question appeared immediately. A sample question is shown in figure 2. All questions were multiple choice in format with four possible answers. The student read the question and chose his/her answer by clicking on the radio button next to his/her choice. The student could change an answer as many times as s/he wished; when the student was finished s/he clicked the "next" button.

The test was not timed, and progressed in a linear fashion; they were presented in a prescribed order: seventh chords, rhythm, analysis, intervals, triads, notation, and key signatures. There were 77 total questions and each subtest contained 11 questions. The seventh chord subtest contained questions on chord quality and inversions of seventh chords.

Figure 1: Student Instruction Screen

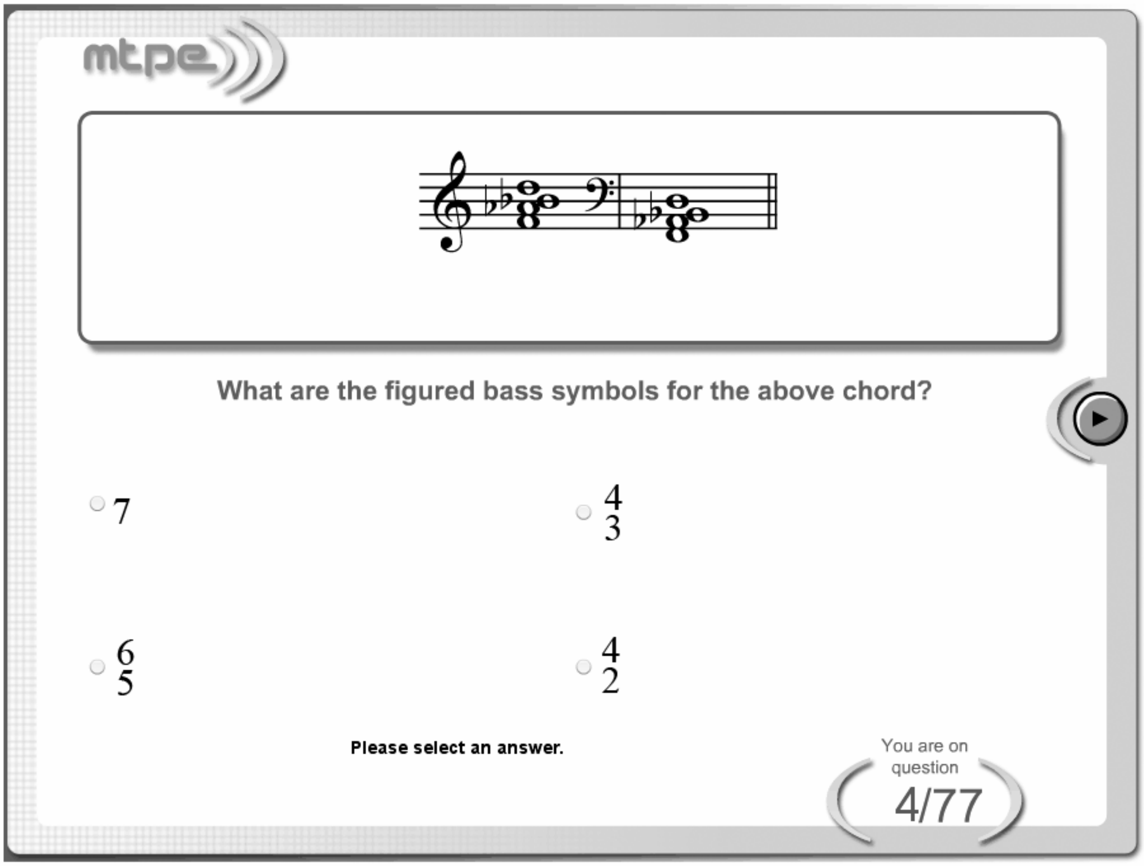

Figure 2: A Sample Question from the Placement Exam

The rhythm subtest contained questions requiring the student to complete a measure and identify subdivision of beats and time signatures. The analysis subtest included questions on identification of chord function and analysis of short musical examples (8-10 chords). The interval subtest contained questions on simple interval identification (i.e., size and quality). The triads subtest contained questions on simple triad chord identification (i.e., quality and inversion). The notation subtest contained questions on correct notation and the meaning of notes in various clefs. The key signature subtest contained questions on key signatures, scales, and modes.

At the end of the test, the student was shown the number of questions answered correctly and incorrectly, their percentage score, and their placement. Placement was "Fundamentals of Music" if the student's score was 0-69%, and "Theory I" if the score was 70% or above.

The demographic questions asked on the results screen included questions about the student's age, major, instrument, high school location, ethnicity, and gender (figure 3). All required questions (for departmental record-keeping purposes only) were marked "(required)." Entry methods for the demographic questions were a combination of pull-down menus (age, major, instrument, state of high school, ethnicity, and gender) and type-entry boxes (first and last name, name of high school, and city of high school). Once the student answered the demographic questions, s/he clicked on the "finished" button and a window appeared that told the student they had completed the test and instructed them to tell the test proctor s/he had finished. The screen then reset to the

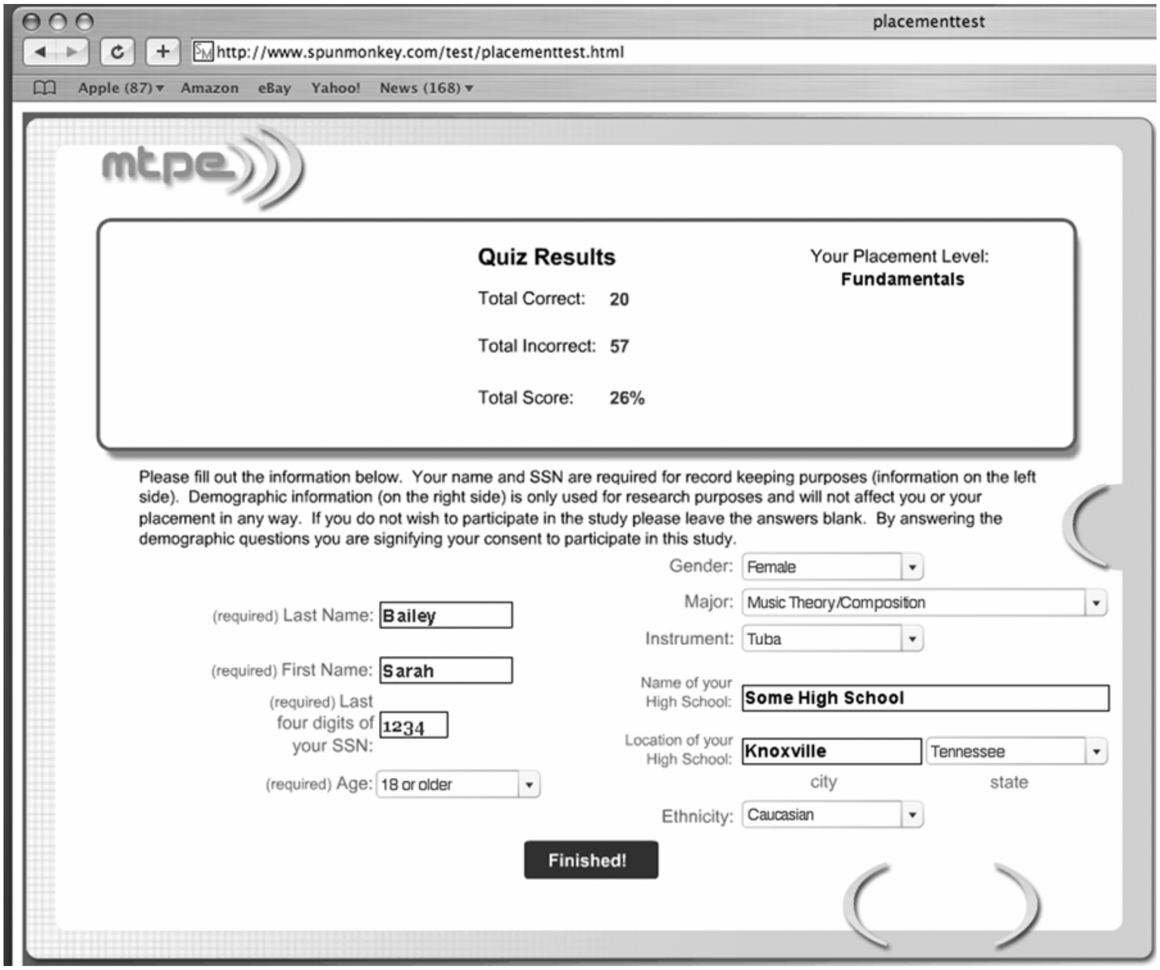

Figure 3: The Student Demographic Questionnaire From the Placement Exam

beginning of the test to assure the student's privacy. When the student finished the test, the proctor closed the final instruction window and prepared the test for the next student.

Computer Program

The Music Theory Placement Exam was written to run on any computer capable of running the free Macromedia Flash™ plug-in. Flash was chosen as the programming language since it could be used on all computers in the lab and be portable to future computers. The computers used in the study were those in the ear-training lab at the University of Tennessee School of Music. There were eight G3 Mac computers running Mac OS 9 and eight iMac computers running Mac OS X version 10.4.2. Both types of machines used similar versions of the Flash™ plug-in.

The *MTPE 2.0* questions were the same as those on the current placement test in use at the University of Tennessee but was rewritten to function on Mac OS X. Demographic questions were added for this study.

A combination of three scripting languages—PHP 4, Actionscript 2.0, and HTML 4.0—were use to create the exam. The visual elements of the test were created in Flash. Actionscript (Flash's programming language) was used to write the record-keeping portion of the program. PHP was used to store the Actionscript record in a comma-delimited file on a server.[21] HTML was used to display the student's information for the administrator. Each of these elements performed its part when the test was taken. When the test begins, Flash loads the interface and creates an empty array to record the

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[21] While Actionscript can write to a previously created text file, it cannot create one. Therefore, the PHP file had to first create the student's text file, and then insert the student's record which was POSTed from Flash.

student's answers and information. As the student progressed through the test, each answer was saved to the array created by Actionscript. When the student completed the test and the demographic questionnaire, all the data was sent to an external PHP file. The student's personal data, scores, and answers were written to an individual comma delimited file on a storage server. Once the data was written the PHP file sent a pop-up screen to the browser instructing the student that they had completed the exam and telling the proctor the student was finished. The students' files could be printed or simply accessed for viewing by using any internet file browser. The students' files could also be downloaded for local storage on a disk or another computer.

Chapter III: Statistical Analysis

The data collected from this study were analyzed to determine whether a student's major, instrument, gender, ethnicity, or location of high school affected their music theory placement level using the Music Theory Placement Exam 2.0, an exam created for this study. Hypotheses include:

1. There will be no difference in placement test scores due to gender.
2. There will be no difference in placement test scores due to ethnicity.
3. Students playing certain instruments will score better on particular elements of the exam. Keyboard students will score the highest total scores followed by string players. String players will score highest on the interval questions and percussion students will score highest on the rhythm questions.
4. Choice of major will affect students' total percent scores. Majors that require more theoretical work such as theory/composition and studio music and jazz will score higher than the other majors.
5. There will be significant differences in total score due to the location of the students' high schools.

First, all students' individual files were combined into one comma delimited file and imported into the Statistical Product and Service Solutions (SPSS) program, version 12.02 (SPSS, 2004). Each individual student file included the following information:

1. Student's individual file name
2. Last name
3. First name
4. Last 4 digits of social security number
5. Age (17 or younger or 18 or older)
6. Instrument
7. Major
8. Name of high school
9. City and state of high school
10. Gender

11. Ethnicity
12. Total number of questions correct
13. Total number of questions incorrect
14. Total percent correct
15. Placement level
16. Percent correct for each of the following subjects:
    - Seventh chords
    - Rhythm
    - Analysis
    - Intervals
    - Triads
    - Notation
    - Keys
17. Question Number
18. Answer given
19. Whether that answer was right or wrong

A sample student file is shown in figure 4.

```
records/Bailey1234.csv, Bailey, Sarah, 1234, 18 or older, Tuba, Music
Performance, Some High School, Knoxville, Tennessee, Female, Caucasian, 43
right, 34 wrong, 56%, Fundamentals, 18% sevenths right, 82% rhythm right,
45% analysis right, 55% interval right, 73% triad right, 91% notation right, 27%
keys, right, 1, 1, right, 2, 2, wrong, 3, 3, wrong, 4, 4, wrong, 5, 4, right, 6, 2,
wrong, 7, 2, wrong, 8, 1, wrong, 9, 2, wrong, 10, 4, wrong, 11, 3, wrong, 12, 1,
right, 13, 4, right, 14, 3, wrong, 15, 3, wrong, 16, 3, right, 17, 4, right, 18, 1,
right, 19, 2, right, 20, 3, right, 21, 3, right, 22, 3, right, 23, 1, right, 24, 4, right,
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37, 3, wrong, 38, 4, right, 39, 1, wrong, 40, 2, wrong, 41, 2, right, 42, 1, right,
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4, right, 50, 3, right, 51, 1, right, 52, 2, wrong, 53, 2, right, 54, 4, wrong, 55, 1,
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62, 4, right, 63, 3, right, 64, 1, right, 65, 1, right, 66, 2, right, 67, 4, wrong, 68, 3,
wrong, 69, 2, right, 70, 3, wrong, 71, 2, right, 72, 3, wrong, 73, 3, wrong, 74, 2,
right, 75, 1, wrong, 76, 2, wrong, 77, 2, wrong
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Figure 4: A Sample Student File Recorded by the *MTPE 2.0*

The results of an analysis of variance (ANOVA) using the total percent correct as the dependent variable (table 3) indicate no significant effect of gender ($F(1,42) = .054$, $p > .50$), thus Hypothesis 1 is true. The mean total percent correct by gender are only .013 different.[22] Further analysis of the scores by gender shows no significant difference in the mean scores of each subtest. Females scored higher on 5 of the 7 subtests, including seventh chords (.029 difference), analysis (.016), intervals (.036), notation (.059), and key signatures (.001), while males scored higher on rhythm (.034) and triads (.006) (tables 4-11).

The results of the same ANOVA (table 3) indicate no effect of ethnicity ($F(4, 42) = .892$, $p < .50$), agreeing with Hypothesis 2. However, these results are not reliable due to the small number of ethnicities other than Caucasian.

Table 3: Results of the ANOVA Using Total Percent Correct as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.836(a)	17	.049	1.704	.081
Intercept	2.200	1	2.200	76.269	.000
Instrument	.296	4	.074	2.565	*.052*
Major	.296	8	.037	1.281	*.279*
Gender	.002	1	.002	.054	*.817*
Ethnicity	.103	4	.026	.892	*.477*
Error	1.212	42	.029		
Total	27.645	60			
Corrected Total	2.047	59			

[22] Scores are all given as decimals. Therefore, .013=1.3%.

Table 4: Total Scores Listed by Gender

Gender	Mean	Std. Error
Female	.668	.083
Male	.655	.079

Table 5: Seventh Chord Scores Listed by Gender

Gender	Mean	Std. Error
Female	.663	.113
Male	.634	.107

Table 6: Rhythm Scores Listed by Gender

Gender	Mean	Std. Error
Female	.838	.087
Male	.872	.083

Table 7: Analysis Scores Listed by Gender

Gender	Mean	Std. Error
Female	.541	.117
Male	.525	.111

Table 8: Intervals Scores Listed by Gender

Gender	Mean	Std. Error
Female	.684	.109
Male	.648	.104

Table 9: Triads Scores Listed by Gender

Gender	Mean	Std. Error
Female	.555	.135
Male	.561	.128

Table 10: Notation Scores Listed by Gender

Gender	Mean	Std. Error
Female	.824	.080
Male	.765	.076

Table 11: Keys Scores Listed by Gender

Gender	Mean	Std. Error
Female	.593	.121
Male	.592	.115

The results of an ANOVA indicate a significant effect of instrument ($F (4, 42) = 2.565$, $p = .052$); however these results are confounded due to the high scores of the three participating percussionists. When statistically compared to the low-scoring vocal group, a significant difference appears; however, the high scores of the three participating percussionists might not be representative of that group as a larger whole. A closer look at the mean total percent correct arranged by instrument group in table 12 shows a significant standard of error (.128) for the percussion students. Therefore, the first part of Hypothesis 3 regarding the effect of instrument cannot be proven or contradicted. Further, there were no participants that play keyboard instruments, so the claim that keyboard players will score higher on subtests also cannot be proven or contradicted.

The ANOVAs for each subtest reveal some trends that can provide some predictability of student placement level according to their major instrument. Instrument and major had no significant effect on the following subtests: seventh chords (instrument: $p > .10$, major: $p > .10$), rhythm ($p >.10$, $p > .50$), analysis ($p >.10$, $p > .10$), intervals ($p >.05$, $p > .10$), triads ($p >.10$, $p > .50$), and notation ($p >.50$, $p > .50$) (tables 13-18).

Table 12: Total Mean Scores Listed by Instrument

Instrument	Mean	Std. Error	Lower Bound	Upper Bound
Voice	.492	.090	.310	.675
Strings	.646	.082	.480	.812
Woodwinds	.648	.090	.466	.830
Brass	.678	.092	.492	.865
Percussion	.842	.128	.583	1.101

Table 13: Results of the ANOVA Using Scores on Sevenths as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.114(a)	17	.066	1.221	.291
Intercept	2.117	1	2.117	39.431	.000
Instrument	.226	4	.056	1.051	*.393*
Major	.578	8	.072	1.346	*.248*
Gender	.008	1	.008	.150	*.701*
Ethnicity	.147	4	.037	.685	*.606*
Error	2.255	42	.054		
Total	21.224	60			
Corrected Total	3.369	59			

Table 14: Results of the ANOVA Using Scores on Rhythm as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.671(a)	17	.039	1.235	.281
Intercept	3.678	1	3.678	115.169	.000
Instrument	.236	4	.059	1.847	.138
Major	.215	8	.027	.842	.571
Gender	.011	1	.011	.332	.568
Ethnicity	.087	4	.022	.681	.609
Error	1.341	42	.032		
Total	38.236	60			
Corrected Total	2.012	59			

Table 15: Results of the ANOVA Using Scores on Analysis as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.439(a)	17	.085	1.476	.151
Intercept	1.428	1	1.428	24.908	.000
Instrument	.469	4	.117	2.047	*.105*
Major	.554	8	.069	1.207	*.318*
Gender	.002	1	.002	.040	*.843*
Ethnicity	.197	4	.049	.857	*.497*
Error	2.408	42	.057		
Total	24.673	60			
Corrected Total	3.846	59			

Table 16: Results of the ANOVA Using Scores on Intervals as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.346(a)	17	.079	1.583	.113
Intercept	2.229	1	2.229	44.587	.000
Instrument	.503	4	.126	2.515	*.056*
Major	.577	8	.072	1.442	*.208*
Gender	.012	1	.012	.236	*.630*
Ethnicity	.284	4	.071	1.421	*.244*
Error	2.100	42	.050		
Total	29.070	60			
Corrected Total	3.446	59			

Table 17: Results of the ANOVA Using Scores on Triads as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.644(a)	17	.097	1.267	.260
Intercept	1.567	1	1.567	20.525	.000
Instrument	.465	4	.116	1.524	*.213*
Major	.560	8	.070	.917	*.512*
Gender	.000	1	.000	.005	*.945*
Ethnicity	.363	4	.091	1.189	*.330*
Error	3.207	42	.076		
Total	28.152	60			
Corrected Total	4.851	59			

Table 18: Results of the ANOVA Using Scores on Notation as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.495(a)	17	.029	1.084	.399
Intercept	3.178	1	3.178	118.409	.000
Instrument	.051	4	.013	.472	*.756*
Major	.199	8	.025	.927	*.505*
Gender	.032	1	.032	1.192	*.281*
Ethnicity	.176	4	.044	1.639	*.182*
Error	1.127	42	.027		
Total	39.305	60			
Corrected Total	1.622	59			

For the key signatures subtest, instrument did have a significant effect (F (4, 42) = 2.986, p = .029), but major had no significant effect on scores (F (8, 42) = .799, p > .50) (table 19). Upon closer inspection, the significant effect of instrument may be due to exceptionally high scores in the percussion subject group and exceptionally low scores in the voice subject group (table 20).

To find trends between the instrument groups and subtests, the mean scores for each instrument group on each subtest were analyzed (tables 21-27). Vocal students scored lower than all other instrument groups on 6 of the 7 subtests (30% lower than the highest score on seventh chords, 28% lower on rhythm, 31% lower on analysis, 47% lower on intervals, 46% lower on triads, 49% lower on key signatures). Only on notation did they not score lowest, but they were only 1% higher than woodwinds (table 26). From these results it can be surmised that in addition to proving that instrument does

Table 19: Results of the ANOVA Using Scores on Keys as the Dependant Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.569(a)	17	.092	1.488	.147
Intercept	1.767	1	1.767	28.488	.000
Instrument	.741	4	.185	2.986	*.029*
Major	.396	8	.050	.799	*.607*
Gender	1.15E-005	1	1.15E-005	.000	*.989*
Ethnicity	.089	4	.022	.360	*.835*
Error	2.605	42	.062		
Total	25.250	60			
Corrected Total	4.174	59			

Table 20: Mean Scores on the Keys Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.326	.133
Strings	.574	.121
Woodwinds	.589	.132
Brass	.658	.135
Percussion	.816	.188

Table 21: Mean Scores for the Seventh Chords Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.519	.123
Woodwinds	.580	.123
Brass	.640	.126
Strings	.683	.112
Percussion	.822	.175

Table 22: Mean Scores for the Rhythm Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.735	.095
Strings	.805	.087
Brass	.821	.097
Woodwinds	.902	.095
Percussion	1.00	.135

Table 23: Mean Scores for the Analysis Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.319	.127
Woodwinds	.565	.127
Strings	.565	.116
Brass	.586	.130
Percussion	.629	.181

Table 24: Mean Scores for the Intervals Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.463	.119
Strings	.605	.108
Woodwinds	.632	.119
Brass	.700	.122
Percussion	.929	.169

Table 25: Mean Scores for the Triad Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.359	.147
Strings	.499	.134
Woodwinds	.539	.147
Brass	.576	.150
Percussion	.818	.209

Table 26: Mean Scores for the Notation Subtest Listed by Instrument

Instrument	Mean	Std. Error
Woodwinds	.746	.087
Voice	.755	.087
Strings	.790	.079
Brass	.791	.089
Percussion	.892	.124

Table 27: Mean Scores for the Key Signatures Subtest Listed by Instrument

Instrument	Mean	Std. Error
Voice	.326	.133
Strings	.574	.121
Woodwinds	.589	.132
Brass	.658	.135
Percussion	.816	.188

make a difference on subtests, it can also be confirmed that vocalists will typically score lower than instrumentalists on all theory tests.

Choice of major also had no significant affect on total scores ($F (8, 42) = 1.281$, $p > .10$) (table 28), although a trend does appear (tables 29-35). Majors requiring more theory such as Theory/Composition and Studio Music and Jazz achieved higher total mean scores. However, the standard of error was very high due to small numbers of participants in those majors. Music education majors' mean score was .553, placing them in the third position out of eight (3/8). This result continues through the subtests as well (on seventh chords Music Education ranked 7/8, on rhythm – 3/8, on analysis – 3/8, on intervals – 7/8, on triads – 4/8, on notation – 4/8, on key signatures – 4/8). The music education group scored in the lower half of the subjects on every subtest, and scored lower than majors that require teaching that is more theoretical; specifically Studio Music and Jazz and Theory/Composition, confirming Hypothesis 4. Nevertheless, these results must be regarded as trends due to the small number of subjects in majors other than education and performance.

Finally, the states contributing the highest amount of subjects to the study were Tennessee (45), Virginia (4), and Georgia (2) (table 36). While the number of participants for both Georgia and Virginia were much smaller, the percent of students placed into Theory I was 40% of students from Tennessee, 100% of students from Virginia, and 100% of students from Georgia. The students from other states are single representatives of their state. That group only had a 30% placement into Theory I. It seems as though location of high school has a significant effect on total score, but these

Table 28: Total Scores Listed by Major

Major	Mean	Std. Error
Sacred Music	.478	.144
Music Minor	.547	.097
Music Education	.553	.064
Music Performance	.640	.073
Undecided	.641	.144
Studio Music and Jazz	.801	.142
Bachelor of Arts	.850	.184
Music Theory/Composition	.882	.197

Table 29: Mean Scores on the Seventh Chords Subtest Listed by Major

Major	Mean	Std. Error
Sacred Music	.344	.197
Music Education	.505	.088
Music Minor	.520	.132
Music Performance	.644	.100
Undecided	.648	.196
Studio Music and Jazz	.848	.193
Music Theory/Composition	.871	.269
Bachelor of Arts	.914	.251

Table 30: Mean Scores on the Rhythm Subtest Listed by Major

Major	Mean	Std. Error
Undecided	.689	.109
Music Performance	.753	.077
Music Education	.780	.068
Sacred Music	.860	.152
Music Minor	.870	.102
Studio Music and Jazz	.890	.149
Bachelor of Arts	.927	.194
Music Theory/Composition	1.00	.207

Table 31: Mean Scores on the Analysis Subtest Listed by Major

Major	Mean	Std. Error
Sacred Music	.262	.203
Undecided	.396	.146
Music Education	.424	.091
Music Minor	.459	.137
Music Performance	.551	.103
Studio Music and Jazz	.686	.200
Bachelor of Arts	.810	.260
Music Theory/Composition	.831	.277

Table 32: Mean Scores on Intervals Questions Listed by Major

Major	Mean	Std. Error
Music Minor	.453	.128
Music Education	.484	.085
Sacred Music	.532	.190
Undecided	.584	.136
Music Performance	.674	.096
Bachelor of Arts	.749	.243
Studio Music and Jazz	.841	.186
Music Theory/Composition	.934	.259

Table 33: Mean Scores on the Triads Subtest Listed by Major

Major	Mean	Std. Error
Sacred Music	.288	.234
Undecided	.385	.169
Music Minor	.421	.158
Music Education	.422	.105
Music Performance	.555	.119
Studio Music and Jazz	.722	.230
Bachelor of Arts	.774	.300
Music Theory/Composition	.850	.320

Table 34: Mean Scores on The Notation Subtest Listed by Major

Major	Mean	Std. Error
Sacred Music	.624	.139
Music Minor	.707	.093
Music Performance	.711	.071
Music Education	.741	.062
Undecided	.815	.100
Music Theory/Composition	.861	.190
Studio Music and Jazz	.950	.137
Bachelor of Arts	.950	.178

Table 35: Mean Scores on the Keys Subtest Listed by Major

Major	Mean	Std. Error
Music Minor	.399	.142
Sacred Music	.460	.211
Undecided	.511	.152
Music Education	.513	.094
Music Performance	.606	.107
Studio Music and Jazz	.704	.208
Music Theory/Composition	.836	.289
Bachelor of Arts	.842	.270

Table 36: Percent of Students Placed into Theory I Listed by State of High School

State	Percent placed into Theory I	Participants
Tennessee	40%	45
Other	30%	10
Virginia	100%	4
Georgia	100%	2

results cannot confirm or disprove Hypothesis 5 due to the small number of students from other states.

Implications of these results will be discussed in the last chapter, Conclusions, along with recommendations for further research.

CONCLUSIONS

This study was designed to determine if there are relationships between theory placement scores and major, major instrument, gender, ethnicity, and location of high school. The results indicated no significant effect of any demographics. However, the results did show a significant trend of lower test scores in students interested in majors in vocal performance and music education and higher test scores in students interested in theory/composition, studio music and jazz, and percussion performance majors. Students from Tennessee scored lower than students from Georgia or Virginia but the numbers were such that results cannot be confirmed. Although the data presented are not statistically significant, the trends are interesting.

Although there was no significant effect of gender, females did score higher than males on five of seven subtests, and their scores on the two remaining subtests were only marginally lower than the male scores. It is also interesting that the range of female and male total percentage scores were very close: females scored between 35% and 95%, while males scored from 35% to 96%. Perhaps the higher female scores on the subtests are a result of the recent encouragement for females to study math and science in secondary schools, which are indirectly related to music theory. These results could also have been a simple coincidence, or they could have been influenced by other factors such as instrument or high school, or factors not examined in this study, such as years of private study. There are many opportunities for further study regarding the sexes. This area alone could be the basis of a new study. Research involving the sexes could delve

much deeper into the background of the student to find trends that might affect an entire gender.

Even though the effect of major instrument is not statistically significant, vocal students scored lowest on seven of eight subtests and had the lowest results on total scores. This could possibly be a result of the theory that some secondary school choral programs teach by rote, but this was not in the scope of this study. Another reason could be that vocal students might not take private lessons until they enter a university. To further explore these results more information about background of the student and the high school would need to be gathered . A questionnaire asking for information about the history of lessons, the type of high school, and how they were taught music would certainly give a clearer explanation for the low vocal scores.

The comparison in table 36 between scores of students from Tennessee, Virginia, and Georgia provokes a question of trends according to state policy. Forty percent of the students from Tennessee placed into Theory I, while 100% of the students from Virginia and Georgia placed into Theory I. These results could possibly have been affected by the fact that students with a lesser education in music theory or less available finances apply to their own state's schools, and those with more education in music theory and available finances apply to out-of-state programs. Another explanation might be the different education requirements according to the location of the secondary school. Since education standards vary from state to state, it is natural that the requirements for music education topics might vary as well. Further research regarding the effect of high school

location could test many students from states with similar music education requirements to eliminate that variable.

Another interesting result is the low test scores of incoming music education majors. The mean score of the music education majors participating in this study was .553 (55%) while the top scoring group, theory/composition, had a mean score of .882 (88%). Out of the 8 available choices for major in the demographic questionnaire, the group of students interested in music education had the third-lowest mean score. The two lowest scoring interest groups, sacred music and music minor each had a low number of participants and therefore have a high standard of error, resulting in ambiguous results. While it is expected for theory and composition majors to score high as they use theory in their day-to-day work, it is surprising that those who want to educate others about music are ranked near the bottom. A possible explanation for these results might be that those who do not want to perform at the university level but still wish to major in music have few choices. Many students opt for a Music Education degree since they are more likely to obtain a job after graduation. Therefore, it is likely that students interested in that major would have a variety of music theory backgrounds, and that group therefore would have a lower mean score than students interested in a more theoretically oriented major. Here again, further details regarding the students' backgrounds in theory at the secondary school level would be needed to substantiate a theory; Also needed would be information regarding their reason for choosing the music education major. The results of such a study might clarify the reason for the low scores of students interested in music education.

Rather than trying to resolve the lack of music theory in secondary school systems, it might be more productive for educators to use these results to inspect their own college level curricula. In order to cover the deficiencies of incoming students, higher education programs with similar theory placement test results should plan to cover introductory material with more students, or provide resources for students coming into a program with a lower placement level. For example, the University of Tennessee offers a remedial music theory course to bring students with lower placement scores up to the level acceptable to enter into Theory I. Placement exam results could also provide enough data for an educator to possibly cover the material in certain sections of a theory course more quickly, provided the students did well on the placement exam. The results could also alert an educator to areas that might need extra coverage in the classroom.

Further research should be conducted that asks more detailed demographic questions regarding the participant's background in theory (i.e., years of private lessons, type of high school, and theory in the classroom). Further studies should also involve more participants to increase the likelihood of significant results. Asking more detailed questions to a larger number of participants might result in clarified results between test scores and demographics.

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VITA

Sarah Bailey was born in Alcoa, Tennessee, on January 11, 1981. She graduated from Alcoa High School in May of 1999 and received her Bachelor of Music in music composition from the University of Tennessee in December of 2003. Sarah entered into the graduate music theory and technology program at the University of Tennessee in August of 2004 and was a graduate assistant at the Innovative Technology Center from August 2004 to August of 2005. In January of 2005, she and Dr. Barbara Murphy received a Faculty First grant from ITC to facilitate completion of this study. Sarah was a graduate teaching assistant for the music theory department from August of 2005 to July of 2006, teaching ear-training classes each semester. She is currently pursuing her doctorate in music theory at the University at Buffalo (SUNY) in Buffalo, New York.