

CONSTRUCTION, VALIDATION, AND ADMINISTRATION OF A DIAGNOSTIC TEST
OF CELLO TECHNIQUE FOR UNDERGRADUATE CELLISTS

By

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The most perfect technique is that which is not noticed at all.
—Pablo Casals

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DEFINITION OF TERMS

- Fingerboard geography—the knowledge of pitch location and the understanding of the spatial relationships of pitches to each other
- Horizontal intervals—intervals formed across two or more strings
- Vertical intervals—intervals formed by the distance between two pitches on a single string
- Visualization—the ability to conceptualize the fingerboard and the names and locations of pitches while performing or away from the instrument
- Technique
 - 1) the artistic execution of the skills required for performing a specific aspect of string playing, such as vibrato or staccato bowing
 - 2) the ability to transfer knowledge and performance skills previously learned to new musical material
- Target Note—a note within a playing position used to find the correct place on the fingerboard when shifting

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The purpose of this study was to construct, validate, and administer a diagnostic test of cello technique for use with undergraduate cellists. The test consisted of three parts: (1) A written test, which assessed a student's understanding of fingerboard geography, intervals, pitch location, and note reading, (2) A playing test, which measured a student's technique through the use of excerpts from the standard repertoire for cello, and (3) A self-assessment form, through which students could describe their experience, areas of interest, and goals for study. A criteria-specific rating scale with descriptive statements for each technique was designed to be used with the playing test.

The written test, playing test, and self-assessment were pilot-tested with five undergraduate students at a university in the southeast. A validation study was conducted to determine to what extent teachers felt this test measured a student's technique. Nine cello teachers on the college and preparatory level were asked to evaluate the test.

The test was administered to 30 undergraduate cellists at universities located in the southeastern region of the United States. Strong interitem consistency was found for the written test ($r_{KR20} = .95$). A high internal consistency of items from the playing test was found ($\alpha =$

.92). Interjudge reliability of the playing test was high, as measured by comparing the independent evaluations of two judges with the researcher's evaluations using Pearson's r (Judge A $r = .92$; Judge B $r = .95$). Other conclusions drawn from the study include: (1) Piano experience has a significant positive effect on the results of the playing test ($R^2 = .15$); (2) The playing test is a good predictor of teacher-rankings of their student in terms of technique; (3) Year in school, degree program, or years of playing experience were not significant indicators of students' playing ability as measured by this test.

Participating teachers described this test as a valuable tool for evaluating students and charting their course of study. They found it to be an efficient means to identify a student's strengths and weaknesses in cello technique.

CHAPTER 1 INTRODUCTION

Diagnosing a student's playing is a primary function of every music teacher's daily routine. Boyle and Rodocy (1987) note that "applied music teachers focus instruction on the basis of their diagnostic evaluations of a performer's strengths and weaknesses. In short, diagnostic evaluation is a critical and ever present part of any good music program" (p. 11). Without denying the role and value of traditional means of gathering information subjectively in the teaching studio, educators agree that "evaluative decisions are better when they have a strong information base, that is a base including both subjective and objective information" (Boyle and Rodocy, p. 2). A diagnostic test of cello technique, designed for use at the college-level, could supplement existing methods of evaluation and provide a greater degree of objectivity in assessing a student's needs.

The successful teacher has much ability to rapidly determine strengths and weaknesses of a new student's technique and prescribe exercises, pieces, or new ways of thinking about the instrument to correct errors in playing. However, deficiencies of technique or understanding often show up in a student's playing while working on an assigned piece from the standard repertoire. When this occurs, teachers must then backtrack and correct the deficiencies with etudes or exercises, or jettison the work for a simpler piece--a demoralizing experience for the student. Determining the playing level and technical needs of each new student is an immediate need. Within a few weeks of a college student's entry into a studio, the focus of lessons often becomes preparation for a degree recital or jury exam. The opportunity to study technique on a broader scale than what is merely required to prepare an upcoming program can quickly diminish. A diagnostic test, administered to assess technique, could be a valuable tool in this process.

Purpose of the Study

The purpose of this study was to design, validate, and administer a diagnostic test of cello technique for use with undergraduate college-level students.

Research Questions

1. To what extent can a test of cello playing measure a student's technique?
2. To what extent can a criteria-specific rating scale provide indications of specific strengths and weaknesses in a student's playing?
3. Can a written test demonstrate a student's understanding of fingerboard geography, and the ability to apply music theory to the cello?

To answer these questions, a diagnostic test of cello technique was administered to thirty college-level students currently studying the cello. The test results were analyzed using a rating scale designed for this study (see Chapter 3). Interjudge reliability of the test was measured by comparing independent evaluations of two judges who viewed video-recordings of five students taking the test.

Delimitations

This study was not concerned with the following.

- Instruments other than the cello
- Creating an assessment instrument for ranking students, determining a letter grade, or determining chair placement in ensembles
- Creating a playing test to be used in auditions
- Determining the subject's sight-reading ability
- The measurement of musical aptitude
- The measurement of a student's musicality or expressivity

Significance of the Study

A review of literature indicates that this is the first attempt to systematically measure the diverse elements of cello technique. The five items used by Zdzinski/Barnes (2002) in their *String Performance Rating Scale: Interpretation/Musical Effect, Articulation/Tone, Intonation,*

Rhythm/Tempo, and *Vibrato* do not attempt to examine a broad array of technical skills, but rather provide a general assessment of a student's performance. This present study appears to be the first to evaluate specific aspects of cello technique.

The results of this study can inform the teaching of strings, particularly the cello, at the college-level. For example, teachers may find it useful to have a diagnostic tool to evaluate the technical level of new students. Results from such a test may support or bring into question conclusions commonly made by teachers based primarily on audition results and/or the student's performance in initial lessons. Similarly, the test could expose areas of deficiencies in technique and provide the teacher with indications regarding the etudes exercises or solo materials most appropriate for study. An assessment of the student's overall playing level can assist the teacher in choosing repertoire that is neither too easy nor too difficult.

Often errors in cello playing can be traced to a student's lack of clarity about the location and relationship of pitches on the fingerboard. This understanding of so called 'fingerboard geography' is measured in the Written Test, as well as an awareness of intervals, fingering skill, and the ability to read in the three clefs used in cello music. The written test can quickly reveal if a student is deficient in understanding this ability. Clarification of these areas can bring instant results that no amount of practice can achieve.

The approach and design of this study could be used to create similar diagnostic tests for violin, viola, and bass. Though there are aspects of technique that are unique to each of the instruments in the string family, much of what is explored in this study would be transferable. Future studies could also include a version designed for high school students.

CHAPTER 2 REVIEW OF LITERATURE

Introduction

Literature dealing with assessment of musical performance tends to fall into two categories: *summative assessments* focus on the value of a finished project; *formative assessments* focus on data gathered during the process of reaching a goal or outcome (Colwell, 2006). A studio teacher's ongoing process of diagnosis, correction, and reevaluation is an example of formative assessment in music. A student recital or jury exemplifies summative assessment in music performance. The diagnostic test of cello technique designed for this study is a formative assessment, in that it measures a student's performance ability as a certain point on a continuum that leads to mastery.

This literature review is divided in three parts. Part One examines the philosophical foundation for this study. Part Two explores assessment theory and provides the theoretical bases for this research. Part Three reviews research in assessment with particular emphasis on performance.

Part One: Philosophical Rationales

A philosophic rationale is the bedrock upon which any scholarly inquiry is made. Reimer (2003) succinctly describes its importance:

The "Why" questions—the questions addressed by philosophy—are the starting point for all conceptualizations of education, whether in music, other subjects, or education as a whole. Answers to these questions—questions of value—provide the purposes of education, purposes dependent on what people in a culture regard to be so important that education must focus on them (p. 242).

These questions must be asked not only of a given educational curriculum but also of the means chosen for evaluation of material taught. Simply asking ourselves, "How do we determine what we know?" brings our educational materials and pedagogy into greater focus.

Subjective as well as objective information shape our systems of evaluation. As Boyle and Radocy (1987) observe, subjective information tends to vary from observer to observer and its value in informing decision making is limited. Objective information, by definition, is relatively unaffected by personal feelings, opinions, or biases. Musical evaluation should not be limited to gathering only objective data but should include subjective observations as well. Although certain aspects of musical performance can be measured with scientific precision, such as vibrato width or decibel levels, the complex multi-faceted nature of music makes the reliability of any measure less than perfect. This observation need not discourage music educators, but rather help them recognize the need for stronger objective criteria for evaluation.

A music educator's personal philosophy of assessment is not tangential to their work, but an essential base from which to define and direct teaching. Brophy (2000) explains the need for a philosophy of assessment:

A personal assessment philosophy is an essential element in the development of a general teaching philosophy. Exploring one's reasons for being a music teacher should inevitably reveal personal reasons and motivations for believing that assessment is important, including why it is important. The depth of one's commitment to music education as a profession is also a fairly reliable predictor of one's commitment to assessment as an important aspect of the music program (p. 3).

Deciding *what* is important for students to learn and *why* it is important determines how one will assess what students know. Attitudes toward assessment directly influence the content and quality of teaching. Inevitably, a teacher's philosophy of assessment will be most influenced by how he or she was taught and evaluated as a student. This may help explain the range of attitudes noted by Colwell (2006):

Evidence from learning psychology reveals that assessment properly conducted makes a major difference in student learning and when incorrectly used, a corresponding negative effect. The current hype, however, has not produced much action in the United States, Canada, or Great Britain. To many music educators, assessment is so much a part of instruction—especially in achieving goals in performance—that they do not believe more

is needed. Other music educators believe that any assessment is inappropriate as either too quantitative or too mechanical (p. 210).

That some applied music teachers believe that they have no need for methods to assess technique beyond their own listening skill is understandable. Most have spent their lives refining evaluative skills: first, of their own playing, and then that of their students. These teachers may feel it insulting to suggest that a test is better than they are at diagnosing a student's strengths and weaknesses. However, these same teachers would not think twice about having a diagnostic test of their car's electrical system if it were acting strangely. If a diagnostic test of cello technique could be shown to give a reasonably accurate and rapid assessment of a student's playing level and particular needs, skeptical teachers might come to appreciate the test's pragmatic value.

Aristotle in his *Politics* stated what is implied by every music school faculty roster: "It is difficult, if not impossible, for those who do not perform to be good judges of the performance of others" (p. 331). These philosophic roots may help to explain why teachers of applied music are almost always expected to be expert performers. Skills of critical listening required of a teacher must be refined and molded in the furnace of performance; these listening skills are the essential abilities that a music teacher cannot do without. Because music performance involves competence in the cognitive, affective, and psychomotor domains of learning, authentic assessment must extend beyond single criterion, bi-level tests of the type appropriate for math or spelling. No single test can measure all factors that go into a performance; at best a single test may evaluate only a few aspects of a student's playing.

Two contemporary philosophical views on the role of evaluation in music are those of Bennett Reimer (1989/2003), and David Elliott (1995). Though these scholars share many beliefs about the role and value of universal music education, they represent two poles of thought

regarding the best way to achieve a musically fluent society. Their differences are philosophic and concern a definition of the very nature of music.

Bennett Reimer

Reimer makes an important claim when discussing evaluation in music. After raising the question: “By what criteria can those who partake of the work of musicians evaluate that work,” he asserts, “...the same criteria applied to their work by musicians all over the world are the criteria that can be applied to evaluating the results of their work” (pp. 266-267). For example, if certain technical skills are required for a musically satisfying performance, these same skills can and should be criteria for evaluation. Reimer’s use of the term *craft* comes close to what musicians mean when they speak of technique:

Craft, the internalization within the body of the ways and means to make the sounds the music calls on to be made, is a foundational criterion for successful musicianship. This is the case whether the musician is a first grader “being a musician,” a seasoned virtuoso, or anything in between. It is the case whatever the music, of whatever style or type, from whatever culture or time (p. 266).

What is universal is the craft of music making, in all its varieties. However, the expression of that craft is very distinct: “But crucially what counts as craft is particular to the particular music being evaluated” (p. 266). Reimer’s argument seems to support the validity of designing assessment measures that are instrument, and even genre, specific.

Bennett Reimer notes: “... everything the music educator does in his job is carrying out in practice his beliefs about his subject (Reimer, 1970, p. 7).” It is important that the pedagogical approach a teacher uses reinforces his or her philosophical belief about why we do what we do in music. If we believe, as Reimer does, that we are fundamentally teachers of aesthetics *through* the medium of music, then every aspect of our work should support and defend this view rather than detract from it.

Instrumental technique is a means to an end, not the end itself. Certainly the virtuosic pyrotechniques required for some pieces blurs this distinction, but by and large most teachers would be quick to acknowledge that complete absorption with the mechanics of playing is a recipe for burn-out and loss of the joy of music-making. Cello teacher Fritz Magg observed that ‘Calisthenics’ literally comes from two Greek words: *kalos*, which means beautiful and *stenos*, which means strength (Magg, 1978, p. 62). Accepting the principle that the development of ‘strength’ is a requisite for expression of ‘the beautiful’ serves as a rationale for designing a test to assess technique.

Reimer believes that past and present attempts of assessment have two crucial flaws (2003). First, they are not tailored to a specific musical activity, making the false assumption that what is tested for is applicable to any and all musical involvements. Reimer states, “The task for the evaluation community...is to develop methodologies and mechanisms for identifying and assessing the particular discriminations and connections required for each of the musical roles their culture deems important (p. 232). Just as Gardner (1983) brought to our attention the need to define distinct kinds of intelligence, Reimer cautions that we should be wary of assuming direct transfer of musical intelligences from role to role.

The second weakness of music testing according to Reimer is its almost exclusive concentration on measuring the ability to discriminate, thereby neglecting to examine the necessary connections among isolated aspects of musical intelligence (2003). The question of how meanings are created through connections has been largely ignored, he suggests. This may be partially attributed to heavy dependence on objective measurement in music research. Qualitative studies may be better suited for this purpose. Reimer notes that many recent studies in cognitive science may be applicable to musical evaluation.

David Elliott

Elliott (1995) makes a clear distinction between evaluation and assessment. He notes, “The assessment of student achievement gathers information that can benefit students directly in the form of constructive feedback”. He sees evaluation as “being primarily concerned with grading, ranking, and other summary procedures for purposes of student promotion and curriculum evaluation” (p. 264). For Elliott, however, achieving the goals of music education depends on assessment. He describes the primary function of assessment as providing accurate feedback to students regarding the quality of their growing musicianship. “Standards and traditions” are the criteria by which students are measured in determining how well they are meeting musical challenges. Elliot leaves it to the reader to define what these standards and traditions are and more specifically what means are used to determine their attainment.

Elliott’s concept of assessment is one of supporting and advancing achievement over time, noting “the quality and development of a learner’s musical thinking is something that emerges gradually” (p. 264). Elliott is concerned with the inadequacy of an assessment which focuses on the results on a student’s individual thinking at a single moment in time. Real assessment of a student’s development occurs when he or she is observed making music surrounded by “musical peers, goals, and standards that serve to guide and support the student’s thinking” (p. 264).

Regarding evaluation, Elliott is unequivocal: “...there is no justification for using standardized tests in music” (p. 265). He sees conventional methods of evaluation as inappropriate in music because they rely on linguistic thinking. Like Gardner, Elliott insists that an assessment, if it is to be intelligence-fair, must be aimed directly at the student’s artistic thinking-in-action.

To summarize, Elliott sees assessment as a process-oriented approach to teaching, using constructive feedback embedded into the daily acts of student music making. Music is something that people do; music assessment must then occur in the context of music making.

Comparing and Contrasting the Philosophic Viewpoints of Reimer and Elliott

The crux of the difference in music philosophies of Reimer and Elliott revolves around the role of performance. Elliott sees all aspects of music revolving around the central act of performing. As stated by Elliott, “*Fundamentally, music is something that people do*” (Elliott, p.39, italics in original). Reimer notes that processes (music making) produce products (integral musical works) and that, “performance is not sufficient for doing all that music education is required to do, contrary to what Elliott insists” (Reimer, p. 51). Reimer sees performance as only one of several ways musical knowledge is acquired, as opposed to being the essential mode of musical learning. Elliott defines assessment of student achievement as a means of gathering information that can be used for constructive feedback. He also values it as a means to provide useful data to teachers, parents, and the surrounding educational community (p. 264).

However, Elliott is uncomfortable with any use of testing that simply focuses on a student’s thinking at one moment in time. One can imagine him acknowledging the value of a diagnostic performance test, but only if it were part of a continuum of evaluations. Elliott’s insistence on the central role of performance prevents him from recognizing the value in a critique of a musician’s abilities at a given moment in time. Reimer sees the act of performing composed music and improvisation as one requiring constant evaluation. Because he is willing to acknowledge musical products (form) separately from the act of creating or regenerating, he asks a more incisive question: “By what criteria can those who partake of the work of musicians evaluate that work?” (p. 265). Considering the myriad styles, types and uses of music, Reimer

concludes that criteria for judging music must be distinctive to each form of music and therefore incomparable to one another (p. 266). Reimer softens his stance by providing examples of universal criteria: that is, criteria applicable to diverse musical forms. He does insist, however, that they must be applied distinctively in each case:

Assessment of musical intelligence, then, needs to be role-specific. The task for the evaluation community (those whose intelligence centers on issues of evaluation) is to develop methodologies and mechanisms for identifying and assessing the particular discriminations and connections required for each of the musical roles their culture deems important. As evaluation turns from the general to the specific, as I believe it urgently needs to do, we are likely to both significantly increase our understandings about the diversities of musical intelligences and dramatically improve our contribution to helping individuals identify and develop areas of more and less musical capacity (p. 232).

Reimer accepts the view that there is a general aspect of musical intelligence, but suggests that it takes its reality from its varied roles. This allows him to see evaluation in music as a legitimate aspect of musicianship, part of the *doing* of music that Elliott insists on. His philosophic position supports creating new measures of musical performance, especially as they bring unique musical intelligences to light and aid in making connections across diverse forms of music making.

Part Two: Theoretical Discussion

Assessment in Music: Theories and Definitions

Every era has a movement or event that seems to represent the dynamic exchange between the arts and the society of that time. Creation of the National Standards for Art Education is one such event. The Goals 2000: Educate America Act defined the arts as being part of the core curriculum in the United States in 1994. That same year witnessed the publication of *Dance Music Theatre Visual Arts: What Every Young American Should Know and Be Able to Do in the Arts* (MENC, 1994). It is significant that among the nine content standards, number seven

was: *Evaluating music and music performances*. Bennett Reimer, one of the seven music educators on the task force appointed to write the document, discusses the central role of evaluation in music:

Performing composed music and improvising require constant evaluation, both during the act and retrospectively. Listening to what one is doing as one is doing it, and shaping the sounds according to how one judges their effectiveness (and affectiveness), is the primary doing—responding synthesis occurring within the act of creating performed sounds (Reimer, 2003, p. 265).

Central to success is the ability to assess one's work. This assessment includes all of the content standards, including singing, performing on instruments, improvising, and composing.

Evaluation is the core skill that is required for self-reflection in music. When a student is capable of self evaluation, to some extent teachers have completed their most important task.

Reimer sees the National Standards as the embodiment of an aesthetic ideal, not merely a tool to give the arts more legislative clout:

The aesthetic educational agenda was given tangible and specific formulation in the national content standards, and I suspect that the influence of the standards will continue for a long time, especially since their potential for broadening and deepening the content of instruction in music education has barely begun to be realized (p. 14).

Reimer and the other members of the task force were given an opportunity to integrate a philosophy into the national standards that values music education. With this statement they articulated a philosophy defending the scholastic validity of the arts:

The Standards say that the arts have “academic” standing. They say there is such a thing as achievement, that knowledge and skills matter, and that mere willing participation is not the same thing as education. They affirm that discipline and rigor are the road to achievement—if not always on a numerical scale, then by informed critical judgment (MENC, 1994, p. 15).

Such statements are necessary in a culture that perniciously sees the arts as extracurricular activities and not part of the core educational experience of every child.

Reimer has provided a philosophical foundation for assessment in the arts. Others, like Lehman (2000), observe that, “Our attention to this topic is very uneven. It is probably fair to

say that in most instances evaluation is treated in an incidental manner and is not emphasized in a systematic and rigorous way” (Lehman, pp. 5-6). As the standards movement grows, fueled by greater interest in achievement testing in the arts, it is likely that this attitude will change.

Lehman describes how he sees the emerging role of music assessment:

I believe that the standards movement has set the stage for an assessment movement, and I believe that assessment may become the defining issue in music education for the next decade. Developing standards and defining clear objectives that flow naturally from standards make assessment possible where it was often not possible before. But standards do more than make assessment possible. They make it necessary. Standards have brought assessment to the center of the stage and have made it a high-priority, high-visibility issue. Standards and assessment inescapably go hand in hand. We cannot have standards without assessment (p. 8).

Furthermore, we cannot have assessment without tests that are designed to measure all kinds of music making, whether it be in bands, orchestras, choirs, or jazz ensembles. Included in this list should be assessment of individual performance. New ways of more objectively determining achievement in individual performance are greatly needed.

The need for assessment measures capable of assessing the multiple intelligences present in the arts has been articulated:

Although some aspects of learning in the arts can be measured adequately by paper-and-pencil techniques or demonstrations, many skills and abilities can be properly assessed only by using subtle, complex, and nuanced methods and criteria that require a sophisticated understanding. Assessment measures should incorporate these subtleties, while at the same time making use of a broad range of performance tasks (Reimer, p. 15).

When Reimer observes that assessment in the arts is a complex task with subtle shades of meaning, he is alluding to the *ill-structured* quality of many of the subject content domains in music. Spiro, Vispoel, Schmitz, Smarapungavan, and Boeger (1987) define ill-structured domains as content areas where “there are no rules or principles of sufficient generality to cover most of the cases, nor defining characteristics for determining the actions appropriate for a given case” (p. 184, as quoted Brophy, p. 7). Criteria for judgment in performance, therefore, must be

tailored to the idiosyncrasies of the particular instrument, its role as a solo or ensemble member, the age and/or playing level of student, and the purpose of assessment.

Constructivism and Process/Product Orientation

Brophy defines the constructivist view of knowledge as those situations in which students draw upon previous experience to understand new situations (2000, p. 10). This occurs when teachers assess something specific like cello technique. Students are asked to transfer knowledge and psycho-motor skills from one context: (previous playing experience) to another (performing new or unfamiliar excerpts). Constructivist theory coincides with one of the definitions of *technique* used in this research: the ability to transfer knowledge and performance skills previously learned to new musical material.

Process-orientation tends to be aligned with a constructivist approach. Inquiry into new areas of knowledge and understanding does not necessarily have a predetermined outcome. Learning occurs during the process of exploration. Methods of evaluation in music and elsewhere have tended to be product-oriented. The need to objectively quantify what has been learned is an ongoing problem in the arts.

The desire to evaluate student achievement in relation to the attainment of pre-specified objectives led to the creation of *criterion-referenced* or *objective-referenced* tests. These tests evaluate achievement in relation to specific criteria rather than through comparing one student to another (Boyle and Radocy, pp. 9-10). These tests, however, have been criticized for measuring verbal intelligence rather than authentic music making (Elliott, pp. 75-76). It is possible, however, for tests to be designed that measure components of both the process (technique) and product (complete musical statement) of making music. Diagnostic tests that evaluate students as they progress through increasing challenges may give the teacher insight regarding the

students' cognitive and psychomotor abilities. Thus, a diagnostic test in music can be designed to evaluate both process and product.

Definitions

To understand theoretical rationale behind the evaluation of music ability terminology must be clear. The term *test* refers to any systematic procedure for observing a person's behavior relevant to a specific task or series of tasks. *Measurement* is a system designed to quantify the extent to which a person achieves the task being tested. In music, testing usually involves some form of a scoring system or rating scale. *Evaluation* means making judgments or decisions regarding the level of quality of a music behavior or of some other endeavor (Boyle, 1992). The ideal evaluation model has a strong objective data component but encompasses subjective but enlightened judgments from experienced music teachers (Boyle, p. 247). Boyle and Radocy claim that evaluative decisions are best made when, "decision makers (a) have a strong relevant information base, including both subjective and objective information, (b) consider affective and, where appropriate, aesthetic reactions of (or to) the individual, group, or endeavor being evaluated, and (c) be made with the primary goal of improving the quality of the learner's educational experiences" (1987, p. 8). True evaluation must provide information that enhances the educational experience and does not simply provide data for the purpose of assigning grades, for determining who is allowed to play, or what the students chair placement will be.

A *diagnostic test* is one which focuses on the present and is used to classify students according to their strengths and weaknesses relative to given skills or knowledge (Boyle and Radocy, p. 10). Such a test can be used to (a) group students for instruction or (b) provide individualized instruction that corrects errors or challenges the learner. The diagnostic test of

cello technique created for this study is designed to serve the latter purpose. It falls into the category of a narrow content focus test, which is defined as *intensive* in nature (Katz, 1973). This type of test is appropriate for judging an individual's strengths and weaknesses. It allows for *intra*-individual comparisons, such as ability levels of differing skills. Intensive tests provide the basis for remedial instruction, as well providing indications of the means of improving areas of weakness.

The purpose of a test largely determines what type of test needs to be chosen or constructed for assessment purposes. If a test's primary purpose is to discriminate among individuals, then the test is norm-referenced (Boyle and Radocy, p. 75). An individual performance is judged in comparison to the performances of his or her peers. This type of test is appropriate for making comparisons among individuals, groups or institutions.

“Criterion-referenced tests describe student achievement in terms of what a student can do and may be evaluated against a criterion or absolute standard of performance” (Boyle, p. 253). Such a test is ideally suited to individual performance; the challenge for this test is how to establish the criteria to be used as a standard. If a performance evaluation uses excerpts accurately revealing a student's ability in demonstrating specific tasks, then that test has good *content validity*; the test materials coincide with the skills being tested.

The focus of performance assessment may be *global*, i.e. a judgment of its totality, or *specific*, i.e. a judgment of only particular aspects of performance. A diagnostic test would be expected to use criteria that reveal specific aspects of performance, although the evaluation could still include global statements about overall playing ability. The use of global and specific approaches are explored in the review of literature at the end of this chapter.

Part Three: Research

The field of testing in string instrument performance is remarkably uncultivated. However, there is a growing body of literature dealing with performance assessment in general, and this writing has many implications for the problem addressed in this study. Examination of this literature will begin with a survey of research in solo instrumental performance, noting the specific aspects of performance measured and the approaches used. An exploration of the use of factor analysis as a means of achieving high reliability and criterion-related validity will follow. This section will close with a review of the research in measurement of string performance.

The Measurement of Solo Instrumental Music Performance

John Goodrich Watkins

The earliest known research in the area of solo instrumental performance was carried out by Watkins (1942) for his doctoral dissertation at Teachers College, Columbia University. Watkins constructed an objectively scored, cornet rating scale. For this he composed 68 melodic exercises based on selected cornet methods. Four equivalent forms of the test were designed, each containing sixteen melodies of increasing difficulty. The measure was established as the scoring unit and was considered to be played incorrectly if any errors of pitch, time, change of tempo, expression, slur, rests, holds and pauses, or repeats occurred. After administering the four preliminary test forms to 105 students, he used item analysis to construct two final forms of the test. Equivalent forms and test-retest reliability coefficients were high (above .90).

Following this research, Watkins developed the *Watkins-Farnum Performance Scale* (WFPS) (1954) for wind instruments and snare drum. This scale, along with the subsequently constructed *Farnum String Scale* (Farnum, 1969), constitutes the only readily available performance measure. As with the Watkins cornet study, this test, administered individually,

requires the performance of a series of passages of increasing difficulty. The student plays with the aid of a metronome, continuing through the exercises until he or she scores zero in two consecutive exercises. Again, the scoring unit is the measure, and the examiner is given a detailed explanation of what constitutes an error. Two equivalent forms were constructed and 153 instrumentalists were tested. Correlations between Form A and Form B of the test have ranged from .84 to .94. Criterion-related validity based on rank-order correlations ranged between .68 for drum to .94 for cornet and trumpet.

Concerns have been raised about how well-suited the examples are for particular instruments (Boyle and Radocy 1987). Some dynamic markings appear artificial and no helpful fingerings are provided for technical passages. There is no attempt to measure tone quality, intonation, or musical interpretation. The latter is an inherently subjective judgment but nevertheless a critical part of an assessment of musical performance. As a result, the test's content validity has been questioned (Zdzinski and Barnes, 2002).

The WFPS contains highly specific directions for scoring aspects of playing, that teachers can all agree upon. As a result, it continues to be used by default, as no other measure provides a similar level of objectivity. A number of investigators have used the WFPS as a primary measurement tool for their research. Boyle (1970), in an experimental study with junior high wind players, demonstrated that students who practiced reading rhythms by clapping and tapping the beat showed significantly greater improvement as measured by the WFPS. More recently Gromko (2004) investigated relationships among music sight reading as measured by the WFPS and tonal and rhythmic audiation (*AMMA*, Gordon, 1989), visual field articulation (*Schematizing Test*, Holzman, 1954), spatial orientation and visualization (*Kit of Factor-Referenced Cognitive Tests*, Ekstrom et al., 1976), and academic achievement in math concepts

and reading comprehension (*Iowa Tests of Educational Development*, Hoover, Dunbar, Frisbie, Oberley, Bray, Naylor, Lewis, Ordman, and Qualls, 2003). Using a regression analysis, Gromko determined the smallest combinations of variables in music sight reading ability, as measured by the WFPS. The results were consistent with earlier research, suggesting that music reading draws on a variety of cognitive skills including visual perception of patterns rather than individual notes.

The WFPS has its greatest validity as a test for sight reading. Sight reading is a composite of a variety of skills, some highly specialized. Using only this test to rank students on musicianship, technique or aptitude would be inappropriate, however. This test design reveals a certain degree of artificiality; the use of the measure as a scoring unit and choice of ignoring pauses between measures are somewhat contrived. Nevertheless, Watkins and Farnum succeeded in developing the most reliable and objective performance testing instrument in their day.

Robert Lee Kidd

Kidd (1975) conducted research for his dissertation concerning the construction and validation of a scale of trombone performance skills at the elementary and junior high school levels. His study exemplifies a trend toward more instrument-specific research. Kidd focused on the following questions:

- What performance skills are necessary to perform selected and graded solo trombone literature of Grades I and II?
- What excerpts of this body of literature provide good examples of these trombone performance skills?
- To what extent is the scale a valid instrument for measuring the performance skills of solo trombonists at the elementary and junior high school level?
- To what extent is the scale a reliable instrument?

Solos from the selective music lists of the National Interscholastic Music Activities Commission of the MENC were content analyzed, and 50 performance skills were identified coinciding with range, slide technique and articulation. Each skill was measured by four excerpts and administered to 30 junior high school trombonists. These performances were taped and evaluated by three judges. Results from this preliminary form of the measurement were analyzed, providing two excerpts per skill area. Equivalent forms of the measure were created, each using one of the two excerpts selected. This final version was administered to 50 high school students. Interjudge reliability coefficients were .92 for form A and .91 for form B. Equivalent forms reliability was found to be .98. Validity coefficients ranged from .77 to 1.0 for both forms. Zdzinski (1991, p.49) notes that the use of a paired-comparison approach rather than the use of teacher rankings may have affected validity coefficients.

Kidd concluded that the Scale of Trombone Performance Skills would be useful to instrumental music educators in their appraisal of the following areas of student progress: guidance, motivation, improvement of instruction and program, student selection maintenance of standards, and research. Kidd recognized that the time requirement (thirty-six minutes for administration, twenty one minutes for judging, and nine minutes for scoring) could make this version of the scale impractical in a public school situation and acknowledged that some modifications in the administration and scoring procedures could facilitate the extent of the scale's use (pp. 93-94).

Janet Mills

Mills (1987) conducted an investigation to determine what extent it was possible to explain current assessment methods for solo music performances. In a pilot study, she chose six instrumental music students, aged 15 years or above, who were capable of performing grade-

eight music from a British graded music list. Videotapes were made of their performances and these were scored by 11 judges. Judges were asked to write a comment about each performance and give it a mark out of 30 based on the scale of the Associated Boards of the Royal Schools of Music. Two adjudicating groups were formed consisting of: 1) Music teachers and music specialist students, and 2) Nonspecialists with experience of musical performance. After the judging occurred, judges were interviewed about the evaluative criteria. From these interviews, the following 12 statements or constructs were generated:

- The performer was Nervous/Confident
- The performer Did not enjoy/Did enjoy playing
- The performer Hardly knew/Was familiar with the piece
- The performer Did not make sense/Made sense of the piece as a whole
- The performer's use of dynamics was Inappropriate/Appropriate
- The performer's use of tempi was Inappropriate/Appropriate
- The performer's use of phrasing was Inappropriate/Appropriate
- The performer's technical problems were Distracting/Hardly noticeable
- The performance was Hesitant/Fluent
- The performance was Insensitive /Sensitive
- The performance was Muddy/Clean
- I found this performance Dull/Interesting

In the main part of her study, phase two, Mills taped ten performances, again dividing her 29 judges into the groupings previously mentioned. Judging was done using both the original 30-point overall rating (with comments), as well as with the newly created criteria. Inter-item correlations and correlations among marks on the 30-point scale were all positive. Correlations between overall marks and individual items were all negative. Because of the small sample size, no data on significance could be provided. Nevertheless, this study demonstrates a well designed method for examining criterion-related validity of newly created evaluative statements with an existing performance measurement.

The Use of Factor Analysis in Performance Measurement

The tests discussed so far, and others like them, have a fundamental problem with reliability; the measures employed were typically subjective judgments based on uneven and unspecified observations. It became increasingly clear to researchers that greater attention needed to be focused on systematically objectifying the methods used in musical evaluation. The use of rating scales to replace or substantiate judges' general impressions is an approach that has been explored by several researchers. Factor analysis of descriptive statements generated for assessment became an important technique for improving content validity and interjudge reliability.

Factor analysis comprises a number of techniques that can be used to study the underlying relationships between large numbers of variables. Common factor analysis reveals the factors that are based on the common or shared variance of the variables (Asmus and Radocy, 2006). All methods of factor analysis seek to define a smaller set of derived variables from a larger collection of data. When applied to performance evaluation, factor analysis can help to determine systematically common evaluative criteria. Potential benefits include increased content validity and greater interjudge reliability. The groundbreaking work of Abeles in the use of factor analysis to develop a highly reliable and valid performance scale for clarinet led other researchers to use factor analysis in designing their scales. The following studies are examples of the application of factor analysis to performance measurement.

Harold F. Abeles

Abeles' (1973) research in the development and validation of a clarinet performance adjudication scale grew from a desire to replace a judge's general impressions with more systematic procedures. He turned to rating scales because they would allow adjudicators to base

their decisions on a common set of evaluative dimensions rather than their own subjective criticisms.

In the first phase of the study, 94 statements were generated through content analyses of essays describing clarinet performance. These statements were also formulated through a list of adjectives gathered from several studies which described music performance. Statements were paired with seven a priori categories: tone, intonation, interpretation, technique, rhythm, tempo, and general effect. The statements were then transformed to items phrased both positively and negatively; items that could be used by instrumental music teachers to rate actual clarinet performances. Examples from this item pool are: 1. The attacks and releases were clean. 2. The clarinetist played with a natural tone. 3. The clarinetist played flat in the low register. The items were randomly ordered and paired with a five point Likert scale, ranging from “highly agree” to “highly disagree.”

Factor analysis was performed on the evaluation of 100 clarinet performances using this scale. Six factors were identified: interpretation, intonation, rhythm, continuity, tempo, articulation, and tone—with five descriptive statements to be judged for each factor. The final form of the Clarinet Performance Rating Scale (CPRS) was comprised of items chosen on the basis of having high factor loadings on the factor they were selected to measure and low factor loadings on other factors. The thirty statements chosen were grouped by factors and paired with a five-point Likert scale. Ten taped performances were randomly selected and rated using the CPRS by graduate instrumental music education students. For the purpose of determining interjudge reliability, judges were divided into groups of 9, 11 and 12 judges. Item ratings from these judges were again factor analyzed to determine structure stability.

Abeles found that the six-factor structure produced from the factor analysis was essentially the same as the a priori theoretical structure. This suggested good construct validity. He concluded that this structure would be appropriate for classifying music performance in general, as none of the factors seemed to reflect idiosyncratic clarinet characteristics. On the other hand, Zdzinsky (2002) found that the factors identified to assess stringed instrument, wind instrument and vocal performance are distinct and related to unique technical challenges posed by each performance area.

The interjudge reliability estimates for the CPRS were consistently high (.90). Individual factor reliabilities ranged from .58 to .98, with all factors but tone and intonation above .70. Criterion-related validity based on correlations between CPRS total scores and judges' ratings were .993 for group one, .985 for group two, and .978 for group three. Predictive validity (<.80) was demonstrated between the CPRS and global performance ratings.

Martin J. Bergee

The development of a rating scale for tuba and euphonium (ETPRS) was the focus of a doctoral dissertation by Bergee (1987). Using methods similar to Abeles, Bergee paired descriptive statements from a literature, adjudication sheets and essays with a Likert scale to evaluate tuba and euphonium performances. Judges initial responses led to identification of five factors. A 30-item scale was then constructed based on high factor loadings. Three sets of ten performances were evaluated by three panels of judges ($N = 10$) using the rating scale. These results were again factor analyzed, resulting in a four-factor structure measuring the items: interpretation/musical effect, tone quality/intonation, technique, and rhythm/tempo. Interestingly, factor analysis produced slightly different results than in the Abeles' *Clarinet Performance Adjudication Scale*. Technique was unique to this measure, while articulation was

unique to the Abeles measure. Abeles' measure also isolated tone quality and intonation as independent items. The idiomatic qualities of specific instruments or families of instruments may result in the use of unique factors in performance measurement.

Interjudge reliability for the ETPRS was found to be between .94 and .98, and individual factor reliabilities ranged from .89 to .99. Criterion-related validity was determined by correlating ETPRS scores with global ratings based on magnitude estimation: (.50 to .99). ETPRS scores were also correlated with a MENC-constructed wind instrument adjudication ballot resulting in validity estimates of .82 to .99.

The Development of a Criteria-Specific Rating Scale

T. Clark Saunders & John M. Holahan

Saunders and Holahan (1997) investigated the suitability of criterion-specific rating scales in the selection of high school students for participation in an honors ensemble. Criteria-specific rating scales differ from traditionally used measurement tools in that they include written descriptors of specific levels of performance capability. Judges are asked to indicate which of several written criteria most closely describes the perceived level of performance ability. They are not required to express their like or dislike of a performance or decide if the performance meets an indeterminate standard.

In this study, criterion-specific rating scales were used by 36 judges in evaluating all 926 students seeking selection to the Connecticut All-State Band. These students were between grades 9-12 and enrolled in public and private high schools throughout the state of Connecticut. Only students who performed with woodwind and brass instruments were examined in this study, because the judges were able to use the same evaluation form. The 36 adult judges recruited in this study were comprised of elementary, secondary, and college-level instrumental

music teachers from Connecticut. All had a minimum of a bachelor's degree in music education and teacher's certification.

Three aspects of student performances were examined: solo evaluation, scales, and sight reading. The following specific dimensions of instrumental performance were assessed:

- Solo Evaluation: Tone, Intonation, Technique/Articulation, Melodic Accuracy, Rhythmic Accuracy, Tempo, and Interpretation
- Scales: Technique, Note Accuracy, and Musicianship
- Sight-Reading: Tone, Note Accuracy, Rhythmic, Technique/Articulation, and Interpretation

For each performance dimension, a five-point criteria-specific rating scale was constructed using either "continuous" (sequentially more demanding performance criteria) or "additive" (nonsequential performance criteria). Each of the criteria were chosen to describe a specific level of music skill, content, and technical achievement. The Woodwind/Brass Solo evaluation was comprised of 11 continuous rating scales and four additive rating scales. The overall level of performance achievement for each student was derived from the sum of the scores for each of the performance dimensions.

The observed means and standard deviations indicated that judges found substantial variation in the performances in each dimension and for each instrument. Despite the relative homogeneity of the student sample, judges demonstrated a high level of variability. Students were provided specific information about levels of performance strengths and weaknesses. The median alpha reliability among the 16 instruments was .915, suggesting that there was a sufficient level of internal consistency among judges. The correlations between each performance dimension and the total score ranged from .54-.75 with a median correlation of .73. These correlations suggest that each scale dimension contributed substantial reliable variance to the total score. Saunders and Holahan concluded that the pattern of correlations provided indirect

evidence of the validity of the criteria-specific rating scales for diagnosing the strengths and weaknesses of individual performances. The researchers noted that because three kinds of performances (prepared piece, scales, and sight-reading) were measured, factor analysis would provide insight into the interdependence of performance dimensions across these types of playing. Factor analysis would indicate the constructs that guide adjudicators in the evaluation process as well.

Saunders and Holahan's findings have implications for the present study. Their data provide indirect evidence that criteria-specific rating scales have useful diagnostic validity. Through such scales, students are given a diagnostic description of detailed aspects of their performance capability, something that Likert-type rating scales and traditional rating forms cannot provide. Such scales help adjudicators listen for specific aspects of a performance rather than having them make a value judgment about the overall merits of a performance.

The Measurement of String Performance

Stephen E. Farnum

Because of the success obtained and reported with the *Watkins-Farnum Performance Scale*, and its practical value as a sight-reading test for use in determining seating placement and periodic measurement, it was suggested that a similar scale be developed for string instruments (Warren, 1980). As a result, the *Farnum String Scale: A Performance Scale for All String Instruments* (1969) was published. Both tests require the student to play a series of musical examples that increase in difficulty. No reliability or validity information is provided in the *Farnum String Scale* (FSS). The test manual describes four preliminary studies used to arrive at sufficient range of item difficulty. Initially Farnum simply attempted to transpose the oboe test from the WFPS, but he found that there was an inadequate spread of difficulty. New exercises

were written, resulting in a final form of 14 exercises that are designed to evenly increase in difficulty level.

Like the WFPS, the *Farnum String Scale* uses scoring based on measure-by-measure performance errors. The performance errors that can be taken into account are as follows:

- Pitch Errors (A tone added or omitted or played on a wrong pitch)
- Time Errors (Any note not given its correct time value)
- Change of Time Errors (A marked increase or decrease in tempo)
- Expression Errors (Failure to observe any expression marks)
- Bowing Errors
- Rests (Ignoring a rest or failure to give a rest its correct value)
- Holds and Pauses (Pauses between notes within the measure are to be counted as errors)
- Repeats (Failure to observe repeat signs)

The *Farnum String Scale* manual does not indicate how to use test results, except for the title page which states: “A Standard Achievement Test for Year to Year Progress Records, Tryouts, Seating Placement, and Sight Reading” (1969). Grading charts are included as part of the individual sheets.

Despite the extensive revision process, criticism has been leveled at this test by some, suggesting that the bowings were not well thought out (Warren, 1980). In examining the exercises written, the following problems are found: 1. bowings that require excessive retakes, 2. bowings that are awkward, i.e. non-idiomatic, and 3. bowings that are ambiguous, or not clearly marked. Clarity in bowing is a concern because bowing errors often lead to other errors, especially in rhythm. In several of the exercises, arbitrary bowing decisions have to be made when sight-reading. Since bowing is one of the tested items, students should not be required to devise bowing solutions that are not clearly marked. Bowing ambiguity represents a flaw in the test validity.

Boyle and Rodocy observe that, “despite the criticisms that may be leveled against the WFPS and the FSS, the tests do attain a certain amount of objectivity by providing highly

specific directions for scoring performance aspects about which most experienced teachers could agree regarding correctness” (p. 176). These tests established a precedent for providing explicit detail as to what constitutes an error in performance.

Stephen F. Zdzinski & Gail V. Barnes

Zdzinski and Barnes demonstrated that it was possible to achieve high reliability and criteria-related validity in assessing string instrument performances. In their 2002 study, they initially generated 90 suitable statements gathered from essays, statements, and previously constructed rating scales. These statements were sorted into a priori categories that were determined by previous research. As with the Abeles study, a Likert scale was paired with these items. Fifty judges were used to assess one hundred recorded string performances at the middle school through high school level. Results from the initial item pool were factor-analyzed using a varimax rotation. Five factors to assess string performance were identified: (interpretation/musical effect, articulation/tone, intonation, rhythm/tempo and vibrato). These were found to be somewhat different than Abeles (1973) and Bergee (1987) in their scales construction studies of woodwind and brass performance. This is not surprising, considering the unique challenges of string instrument and woodwind instrument technique. String instrument vibrato had items that were idiomatic for the instrument. Likewise, articulation and tone quality are largely controlled by the right (bowing) side in string performance and were loaded onto a single factor, as contrasted with wind instrument assessment scales. The authors found that factors identified to assess string instrument, wind instrument, and vocal performance are distinct, and related to unique technical challenges specific to the instrument/voice (Zdzinski, p.253).

Twenty-eight items were selected for subscales of the String Performance Rating Scale (SPRS) based on factor loadings. The reliability of the overall SPRS was consistently very high. Reliability varied from .873 to .936 for each judging panel using Hoyt's analysis of variance procedure. In two studies conducted to establish criterion related validity, zero order correlations ranged from .605 to .766 between the SPRS and two other rating scales.

The researchers concluded that string performance measurement may be improved through the use of more specific criteria, similar to those used in their study (Zdzinsky, p. 254). Such tools may aid the educator/researcher by providing highly specific factors to listen and watch for when analyzing student performances.

Summary: Implications for the Present Study

Studies carried out in the measurement of instrumental music performance have increased in reliability, validity, and specificity since the first standardized test for band instruments—the *Watkins-Farnum Performance Scale* of 1954. Surprisingly, along with the *Farnum String Scale*, this is still the only readily available published performance measure. One can conjecture that the use of teacher-made tests account for this, but the more plausible explanation is music teachers' distrust of any test that would claim to be capable of measuring a subject as complex and multifaceted as music performance.

The use of descriptive statements that were found through factor analysis to have commonly accepted meanings has been a significant development in increasing content validity in performance measurement. As researchers applied the techniques pioneered by Abeles (1973), they discovered that factors identified for one instrument or group of instruments did not necessarily transfer directly to another instrumental medium. Statements about tonal production

on a clarinet may not have the same high factor loadings on a string instrument where tone production is controlled primarily by bowing technique (Zdzinski, 2002).

Through factor analysis the reliability of the new measures improved. However, with additional research came more questions. In the Abeles (1973) and Zdzinski (2002) studies, only the audio portions of performances were analyzed by judges. The reasons these researchers chose not to include visual input is not addressed in their studies, but the fact that they chose to record results using audio only may have contributed to the higher reliability found in these studies. Gillespie (1997) compared ratings of violin and viola vibrato performance in audio-only and audiovisual presentations. Thirty-three inexperienced players and 28 experienced players were videotaped while performing vibrato. A panel of experts rated the videotaped performances and then six months later rated the audio-only portion of the performances on five vibrato factors: width, speed, evenness, pitch stability, and overall sound. While the experienced players' vibrato was rated higher regardless of what mode of presentation, results revealed significantly higher audiovisual ratings for pitch stability, evenness, and overall sound for inexperienced players and for pitch stability for experienced players. The implications are that visual impressions may cause adjudicators to be less critical of the actual sound produced. Gillespie notes; "The visual stimuli give viewers additional information about a performance that can either be helpful or distracting, causing them to rate the performance differently than if they had simply heard it." He adds, "If the members of the panel see an appropriate motion for producing vibrato, they may rate the vibrato higher, regardless if the pitch drifts slightly" (Gillespie, p. 218). At the very least, the study points out the need for the strictest possible consistency in the content-format given to the judges to assess. If assessment is made from an

audiovisual source or a viewed live performance, the possible effects of visual influence on the ratings needs to be considered.

Concerns about content validity were uppermost in mind when choosing the excerpts for the *Diagnostic Test of Cello Technique*. In the following chapter the development and validation of these materials is discussed, as well as the measurement used to quantify the data from the written and playing portions of the test.

CHAPTER 3 METHODOLOGY

The purpose of this study was to construct, validate and administer a diagnostic test of cello technique for use with college-level students. This test is criterion-referenced and included both quantitative and qualitative measurements. This study was implemented in the following stages: (a) development of an initial testing instrument, (b) administration of a pilot test, (c) administration of a validity study, (d) administration of the final test, and (e) data analyses procedures for the final test, including an interjudge reliability measurement. This chapter describes the following methodological elements of the study: setting and participants, instrumentation, data collection, data analysis, and validity and reliability procedures.

Setting and Participants

Approval for conducting this study was obtained first from the Institutional Review Board (IRB) of the University of Florida. A copy of the informed consent letter is included in Appendix D. The testing occurred at the respective schools of the participants, using studio or classroom space during times reserved for this study.

College-level students ($n = 30$) were recruited for this study from three private and three public universities in the southeastern region of the United States. While this demographic does not include all the regions of the United States, the variability is considered adequate for this test, which was not concerned with regional variations, if such variations exist, in cello students. The participants selected were undergraduate cello students, both majoring and minoring in music. This subject pool consisted of music performance majors ($n = 16$), music minors ($n = 1$), double majors ($n = 3$), music therapy majors ($n = 2$), music education majors ($n = 6$), and music/pre-med. students ($n = 2$). Using subjects from a diversity of academic backgrounds assumes that

this test has value as a diagnostic tool for students studying music through a wide variety of degree programs, not just those majoring in performance.

A letter of introduction that explained the purpose of the study was mailed to the cello faculty of the six schools. Upon receiving approval from the faculty cello teacher, the letter of consent along with the Playing Test (Appendix G) was provided for each participant. One copy of the consent form was signed and returned from each participating student. Following this, times were arranged for each student to take the Written and Playing Test. Each student received a copy of the Playing Test a minimum of two weeks before the test date. Included with the Playing Test was a cover letter instructing the students to prepare all excerpts to the best of their ability. Attention was directed toward the metronome markings provided for each of the excerpts. Students were instructed to perform these excerpts at the tempos indicated, but not at the expense of pitch and rhythmic accuracy.

Data Collection

The Written and Playing Test

Each participant met individually with the primary investigator for forty-five minutes. The first thirty minutes of testing time was used for the Playing Test. Before beginning to perform the Playing Test, students were asked to check their tuning with the pitch A-440 provided for them. Students were also asked to take a moment to visually review each excerpt prior to performing it. Students were asked to attempt to play all the excerpts, even if some seemed too difficult for them.

The primary investigator listened to and judged the individual student's skill level for each performance. For each aspect of technique assessed, a five-point criteria-specific rating scale was constructed. The Playing Test evaluation form (Appendix H) used both "continuous"

(sequentially more demanding performance criteria) and “additive” (nonsequential performance criteria). When a technique was measured using a continuous rating scale, the number next to the written criterion that corresponded to the perceived level of skill was circled. When using the additive rating scale, the primary investigator marked the box beside each of the written criteria that described one aspect of the performance demonstrating mastery of the skill. Both the continuous and the additive rating scale have a score range of 2-10 points, as two points were awarded for each level of achievement or each performance competency. It was theoretically possible for a student to score 0 on an item using an additive scale if their performance matched none of the descriptors. Seven continuous rating scales and ten additive rating scales constituted the Playing Test evaluation form. The overall level of performance achievement for each student was calculated as the sum of the scores for each area of technique.

The Student Self-Assessment Profile

The last fifteen minutes was devoted to the completion of the Written Test (Appendix E) and the Student Self-Assessment Profile (Appendix J). To maintain the highest control in administering the test, the primary investigator remained in the room while the Written Test was taken, verifying that neither a piano nor cello was referred to in completing the test. The Written Test evaluation form is provided in Appendix F.

Rationale for the Assessment Methodology

Saunders and Holahan (1997) have observed that traditional rating instruments used by adjudicators to determine a level of quality and character (e.g., outstanding, good, average, below average, or poor) provide little diagnostic feedback. Such rating systems, including commonly used Likert scales, cause adjudicators to fall back on their own subjective opinions without providing a means to interpret the results of the examination in new ways. Furthermore,

due to their design, these rating scales are incapable of providing much in the way of interpretive response. As Saunders and Holahan observe, “knowing the relative degree to which a judge agrees or disagrees that, ‘rhythms were accurate,’ however, does not provide a specific indication of performance capability. It is an evaluation of a judge’s magnitude of agreement in reference to a nonspecific and indeterminate performance standard and not a precise indication of particular performance attainment” (p. 260).

Criteria-specific rating scales are capable of providing greater levels of diagnostic feedback because they contain written descriptors of specific levels of performance capability. A five-point criteria-specific rating scale was developed for this study to allow for greater diagnostic input from judges. Aspects of left hand and bowing technique were evaluated using both continuous (sequentially more exacting criteria) and additive (nonsequential performance criteria). Both continuous and additive scales require a judge to choose which of the several written criteria most closely describe a student’s performance. The additive scale was chosen when a particular technique (such as playing scalar passages) has a number of nonsequential features to be evaluated, such as evenness, good bow distribution, clean string crossings, and smooth connections of positions.

Along with the five-point criteria specific rating scale, the Playing Test evaluation form (Appendix H) provided judges with an option of writing additional observations or comments about each technique evaluated. While these data are not quantifiable for measurement purposes, recording the judge’s immediate reactions in their own words to a student’s performance may capture an insight into some aspect of performance that the written criteria overlooks. Because the primary purpose of this test is diagnostic, allowing room for commentary is important.

Interjudge Reliability

Two adjudicators were recruited to determine interjudge reliability of the Playing Test. Both judges were professional cellists who teach at the college-level. To decrease selection bias as a threat to external validity, the adjudicators were chosen from two different geographical regions and teaching institutions. An introductory DVD was provided, explaining how to use the Playing Test evaluation form in assessing student performances.

Each judge viewed and listened to DVDs of five separate student performances of the Playing Test, and rated the performances using the Playing Test evaluation form (Appendix H). Judges were asked to return the results by a specified date, using a self-addressed stamped envelope provided. The combined judges' evaluations of ten individual students were correlated to the primary investigators evaluation results of these same students.

Data Analyses

Data analyses included item analysis for both the Written and the Playing Test. The distribution of total scores was described using means and standard deviations. Item difficulty, as expressed as the proportion of students who answered an item correctly, was determined. Item discrimination analysis was conducted using the point biserial correlation to reveal the strength and direction of the relationship between success on a particular item and success on the total test. Qualitative data from the Observations/Comments portion of the Playing Test were examined and compared with individual scores.

The content of the Student Self-Assessment Profile was evaluated and correlated to the data from other sections of the test. Relationships were studied between the student's scores on the Written and Playing Test and: a) year in college, b) major/minor distinction c) years of study, d) piano experience, e) extent and content of repertoire, f) degree of interest in performance

areas, g) personal goals for studying the cello, h) expressed area of technique needing improvement, and i) short term and long term goals in music.

Content Validity

The techniques that were assessed in this study are believed to be essential aspects of left-hand and bowing techniques for a college-level student. The choice of categories for left-hand and bowing technique was based on the frequency these techniques are found in the repertoire for cello, as well as the discussion of them in the following sources: *The Ivan Galamian Scale System for Violoncello*, arranged and edited by H. J. Jensen; *The four Great Families of Bowings*, by H. J. Jensen (Unpublished Paper); *Cello Playing of Today*, by M. Eisenberg; *Cello Exercises: A Comprehensive Survey of Essential Cello Technique*, by F. Magg; and *Dictionary of Bowing and Pizzicato Terms*, by J. Berman, B. Jackson, and K. Sarch.

A validation study was conducted to determine to what extent teachers felt this test measured a student's technique (Mutschlecner, 2005). Cello teachers ($N = 9$) on the college and college preparatory level agreed to participate in this validity study by reading all sections of the diagnostic test and then responding to questions in an evaluation form. The results of this study are provided in Appendix B

CHAPTER 4 RESULTS

This chapter describes the procedures used to analyze the data collected and presents the results of these analyses. Data from the Written Test, the Playing Test, and the Student Self-Assessment were collected from 30 participants in accordance with the procedures outlined in Chapter 3. The dependent variables of this study were the Written and Playing Test scores. Independent variables were (a) year in school, (b) major/minor distinction, (c) years of cello study, and (d) piano experience.

Data Analysis

Descriptive data for the scores were tabulated and disaggregated by independent variable. Data were explored using *t*-tests, regressions, and correlations. Regressions were used to determine the effect of the independent variables on the obtained test scores. The independent variables of major/minor distinction, year in school, and piano experience are categorical, and dummy codes were used to represent these variables in the regression analyses. Item difficulty, item discrimination, and point biserial correlations were calculated for the Written Test. Cronbach's Alpha (α) was used to estimate of reliability of individual items on the Playing Test. The Spearman rank-order correlation was used as a measure of the Playing Test's validity. Interjudge reliability was calculated using Pearson's *r*.

Questions on the Written Test were dichotomous, and tests were scored and yielded continuous data. The Playing Test performances were evaluated using the criteria-specific rating scale that was revised following the pilot test (see Appendix A for the Pilot Study report). Two external reliability researchers viewed and evaluated videotapes of 33% ($N = 10$) of the Playing Tests. These data were then correlated with the primary investigator's scores of these same student performances as a measure of interjudge reliability. The participants' cello teachers rank

ordered their students by level of technical skill based on their assessment of the students' playing technique. These rankings were correlated to those based on the Playing Test results as a measure of validity. The data analysis was designed to explore the following research questions:

1. To what extent can a test of cello playing measure a student's technique?
2. To what extent can a criteria-specific rating scale provide indications of specific strengths and weaknesses in a student's playing?
3. Can a written test demonstrate a student's understanding of fingerboard geography, and the ability to apply music theory to the cello?

Participants

Written and Playing Test scores, and student answers to questions in the Student Self-Assessment Profile were obtained ($N = 30$). Participants were undergraduate music majors and minors studying cello at three private and three public universities ($N = 6$) in the southeastern region of the United States.

Part One: The Written Test

Scoring the Written Test

The Evaluation Form used to tabulate the scores for the Written Test is provided in Appendix F. Items on the Written Test were assigned points using the following system:

- (1) Fingerboard Geography: 11 points. (44 pitch locations to identify were divided by 4)
- (2) Interval Identification: 8 points.
- (3) Pitch Location and Fingering: 32 points. (a single point was assigned for correctly identifying both pitch and fingering)
- (4) Single Position Fingering: 32 points.
- (5) Bass, Treble, and Tenor Clef Note Identification: 12 points.

The total possible score for the combined sections of the Written Test was 95 points.

Results from the Written Test

Table K-1 (Appendix K) presents the raw scores of the Written Test items and the composite means and standard deviations. Reliability of the Written Test was obtained using the Kuder-Richardson formula, revealing the internal consistency of test items: $r_{KR20} = .95$. This result indicates that despite the narrow range of scores, the Written Test has strong interitem consistency.

Table 4-1 presents the data from a regression analysis for year in school (freshmen, sophomore, junior, and senior) and the Written, Playing, and combined Test scores. Freshmen classification emerged as a significant predictor ($p < .05$) for the Playing Test and combined test scores. The R -squared value of .28 indicates that freshmen classification accounted for 28% of the variance in the Playing Test Scores. For the combined Written and Playing Test scores, the R -squared value of .265 indicates that freshmen classification accounted for 27% of the variance. With the exception of these findings, year in school does not seem to bear a relationship to technical level, as measured by the Written and Playing Test.

Exploring the relationship of test scores and student's degree program was complicated, as there was a mixture of music performance majors, double majors, music education majors, music therapy majors, and music minors. One school did not allow freshmen to declare music performance as a major until their sophomore year, insisting they enter the studios initially as music education majors. If one classified double majors in the music performance category, then there were 21 music performance majors and nine students in the "other" category. A regression analysis was conducted with major/minor distinction as a predictor of the written, playing and total scores. No effect of major or minor distinction was found for the Written Test ($R^2 = .001$). Results were nearly significant for the Playing Test ($p = .08$) and not significant for the

combined Written and Playing Tests ($p = .15$). A student's choice to major in cello does not appear to be an indication of his or her technical level according to this test.

The 30 cellists participating in this research had studied the cello between five and sixteen years (Table 4-2). A regression was conducted with years of cello study as a predictor of the scores. For the Written Test, ($B = .037$, $SE B = .069$, $\beta = .53$) and the Playing Test, ($B = .044$, $SE B = .024$, $\beta = 1.82$) years of cello playing was not found to be a significant predictor ($p = .60$; $p = .08$). A lack of relationship between years of cello playing and scores may reflect the wide range of students' innate ability and developmental rate. The relatively small sample size also means that outliers have skewed the results. Efficient use of practice time is an acquired skill; it is possible for students with fewer years of experience to surpass those that, while having played longer, are ineffective in their practice.

Though no data on actual numbers of years of piano experience were collected, exactly one-half of the participants reported having piano experience, and one-half reported having no piano experience ($n_s = 15$). A t -test of the means for Written and Playing Test scores was conducted based on the participants' self-reported piano experience. Both tests were significant. Students reporting piano experience scored significantly higher on the Playing Test ($M = 91.93$, $SD = 3.08$), $t(30) = 115.55$, $p = .000$, than those without piano experience ($M = 78.47$, $SD = 12.71$), $t(30) = 23.92$, $p = .000$. Students reporting piano experience also scored significantly higher on the Written Test ($M = 129.73$, $SD = 20.63$), $t(30) = 24.35$, $p = .000$, than those without piano experience ($M = 116.93$, $SD = 28.28$), $t(30) = 16.01$, $p = .000$.

Because significant differences were found in these groups based on reported piano experience, a regression was conducted with piano experience as a predictor of the scores. For the Written Test, ($B = -2.00$, $SE B = 4.21$, $\beta = -.48$) piano experience was not found to be a

significant predictor. In the Playing Test, ($B = -19.20$, $SE B = 8.63$, $\beta = -2.23$) piano experience emerged as a significant predictor ($p < .05$). The R^2 value of .15 indicates that piano experience accounted for 15 % of the variance in the Playing Test scores. Results are shown in Table 4-3.

Regression Analysis of Written Test Items

In the Interval Identification section of the Written Test, the mean score for those with piano experience was 7.07 out of 8 possible points as compared with a mean of 5.73 for those without experience. Through regression analysis piano experience was shown to be a significant predictor ($p = .002$) of the Interval Identification scores ($B = 1.56$, $SE B = .41$, $\beta = 3.81$). The R^2 value of .528 indicates that piano experience accounted for 53 % of the variance in the Interval Identification scores. This is a highly significant figure. Students with piano experience clearly are better at thinking intervallically on the cello.

For the Pitch Location and Fingering section of the test, the means were 31.13 out of 32 possible points for those with piano experience compared with 22.26 for those without. Regression analysis revealed that this piano experience was nearly significant as a predictor of these scores ($p = .061$). Piano experience again emerged as a significant predictor ($p = .002$) of the Single-Position Fingering scores ($B = 1.80$, $SE B = .47$, $\beta = 3.83$). The R^2 value of .53 indicates that piano experience accounted for 53 % of the variance in the Single-Position Fingering scores. This section required students to look at notes vertically through a series of arpeggios and arrive at a fingering, something that pianists are frequently required to do.

Item difficulty, item discrimination, and point biserial correlations were calculated for the Written Test. Results are presented in Table 4-4. The Interval Identification section had the highest average difficulty level (.80) of any section of the Written Test. Items on the Bass, Treble, and Tenor Clef Note Identification section were found to be the least difficult. Item 23

($r_{pbs} = 0.80$) and item 31 ($r_{pbs} = 0.82$) of the Pitch Location and Fingering Section had the two highest correlations to the total test score. The range of difficulty level (1.0-.80) indicates that the Written Test is not at an appropriate level of difficulty for undergraduate cellists.

Using Pearson's r , a low positive correlation was obtained between student scores on the Written and Playing Test ($r^2 = .16$). This suggests little relationship between scores on these tests. This suggests that the cognitive knowledge required to do well on the Written Test may be distinct from the psychomotor ability needed to demonstrate the techniques found in the Playing Test.

Part Two: The Playing Test

Scoring the Playing Test

A discussion of the criteria-specific rating scale used to score the Playing Test is found in Chapter Three. Ten techniques were evaluated using an additive rating scale which ranged from 0 and 10 points per item. Seven techniques were evaluated using a continuous rating scale with a range of 2 to 10 points possible. A zero score resulted from none of the criteria being demonstrated for an additive item. The total possible score for the combined sections of the Playing Test was 170.

Results from the Playing Test

Reliability was estimated by using Cronbach's Alpha to find the relationship between individual items on the Playing Test. The results ($\alpha = .92$) indicate high internal consistency of test items: this suggests that the means of assessing each technique are well-matched.

Table K-3 (Appendix K) presents the raw scores of the Playing Test items and the composite means and standard deviations. Table 4-5 lists these items from highest to lowest based on their mean scores. These data reveal that students scored highest on the *detaché* bowing

stroke ($M = 8.46$), and lowest on *pizzicato* ($M = 6.06$). Discussion of the significance of these mean scores is found in Chapter Five.

Comparison of Left Hand Technique and Bowing Stroke Scores

The total mean scores were calculated for the two sections of the Playing Test: Left Hand Technique ($M = 7.21$), and Bowing Strokes ($M = 7.31$). Students performed at very similar level for both sections and performed uniformly, i.e. higher-scoring students did well on both sections and lower-scoring students did less well on both sections.

Comparison of Playing Test Scores and Teacher-Ranking

To determine the predictive validity of the Playing Test, teachers from the six music school participating in this research were asked to rank their students from lowest to highest in terms of their level of technique. Five of the six teachers responded to this request. These rankings were compared to the rank-order based on the Playing Test scores. The results are shown in Table 4-6.

Two teachers (School A and B) ranked their students in exactly the same order as the Playing Test ranking ($r^2 = 1.0$). Using the Spearman rank-order correlation, the correlations of the other three schools who responded were positive and strong: ($r^2 = 0.65, 0.84, \text{ and } 0.76$ respectively). Results indicate student's performance on the Playing Test closely corresponds to the level of their technique as perceived by their teachers. The Playing Test is criterion-referenced and not designed to be used as a norm-reference test. However, the strong positive correlations of the teacher's rank-order of their students to that of the rank order of the scores on the Playing Test suggests that this measure is a valid means of determining undergraduate cello students' technical ability.

Interjudge Reliability of the Playing Test

Two judges were recruited to evaluate five different student performances of the playing test as described in Chapter Three. Interjudge reliabilities were calculated using Pearson's r . Correlations were as follows: Judge A and the primary investigator ($r = 0.92$); Judge B and the primary investigator ($r = 0.95$). These results are presented in Table 4-7. The students observed by judges A and B represented 33% of the total number of students participating. These data, with its highly significant correlations, appear to confirm the effectiveness of the criteria-specific rating scale used in this study as a means of recording information about specific strengths and weakness in a student's playing.

Part Three: The Student Self-Assessment Profile

The Student Self-Assessment Profile (SSAP) was created as another means to gather diagnostic information about students. Many teachers have developed questionnaires to better understand the performance background of their students. The self-assessment used in this study served this function, as well as providing additional information about areas of performance interest and personal goals. In addition, the SSAP allows students to comment on what aspects of technique they feel they need to improve. Twenty-nine of the thirty students participating in this study completed the Student-Assessment Profile. The following subheadings represent sections of the Student Self-Assessment Profile.

Repertoire Previously Studied

Students listed many of the standard methods and etudes collections for the cello: Cossman, Dotzauer, Duport, Fuillard, Franchomme, Piatti, Popper, Sevick, Starker, and Suzuki. Pieces from the standard literature for cello were listed. For a teacher, such information shows

the extent and breadth of a new student's experience and may indicate appropriate directions for further study.

How interested are you in each of these areas of performance: Solo, Chamber, and Orchestral?

Table 4-8 lists students' responses to this question. Eighty-three percent of the students stated they either agreed or strongly agreed to having interest in solo and orchestral performance, and ninety-three percent expressed the same for chamber music. Noting responses to this section could be a means for teachers to initiate discussion with students about their plan of study. If a student's greatest interest was in playing chamber music, his teacher might help to facilitate this desire. Knowing that a student's primary goal was to win an orchestral audition would dictate in part the choice of repertoire studied.

Other areas of performance interest?

Students listed the following areas of performing interest: jazz ($n = 2$), conducting ($n = 1$), piano accompanying ($n = 1$), choir ($n = 1$), improvisation ($n = 1$), bluegrass ($n = 1$), praise bands ($n = 1$), and contemporary performance ($n = 2$). Teachers provided with this information might choose to direct students to nontraditional sources of study, such as improvisation methods, learning to read chord charts, or playing by ear.

What are your personal goals for studying the cello?

Responses to this question are provided in Table 4-9. Five out of the twenty-nine students (17%) listed "teaching privately" as a goal for study. The second most frequently mentioned goal was "orchestral performance" (10%). If this study was conducted with the highest ranking music conservatories in the United States, the researcher suspects that "solo performance" might be frequently mentioned as well.

What areas of cello technique do you feel you need the most work on?

Answers to this question are presented in Table 4-10. Bow stroke was mentioned by ten students as needing the greatest attention. Nine students discussed the need to work on relaxation as they played, specifically referring to left and right hand, shoulder, and back tension. Many of the techniques assessed in the Playing Test were alluded to such as *spiccato* bowing or thumb position. The specificity of many of the areas of technique mentioned may have been due to the students filling out the SSAP after having taken the Playing Test. The difficulty students had with playing certain passages caused them to list these techniques as ones to work on. This appears to be anecdotal evidence that the playing test can cause students to be more self-aware.

Summarize your goals in music and what you need to accomplish these goals.

In answering this question, students described their broad musical objectives, often discussing career goals. The goals in music were to be written for six month, one, two, four, and ten-year intervals, but not all students completed each sub-category. Table 4-11 presents the responses to this section in the students' own words. Many of the goals implied an understanding between the teacher and the student, such as a two-year goal of memorizing a full concerto. Acquiring advanced degrees were goals for two of the students. One student's six-month goal was to "practice more musically than technically." Without agreement between the teacher and student on such a goal, conflicts could arise: what if the teacher felt the next six months were best spent drilling technique?

One student's four-year goal was, "To get past the pre-eliminations in an orchestra audition." The Student Self-Assessment Profile would help to assure that the teacher was privy to this information. One music major's long-term goal was to, "play recreationally, not as a career." This belies the assumption that every music-major is planning on a career in music.

Access to this kind of information could prevent misunderstandings developing between a teacher and student that result from conflicting goals.

Summary of Results

The following summarizes the results obtained in these analyses:

1. The Written Test was found to be too easy for most undergraduate cellists. Lower scores in the Interval Identification section indicate that some students have difficulty applying their understanding of intervals to the cello.
2. Strong interitem consistency was found for the Playing Test, indicating high reliability for this section of the test.
3. Year in school was a significant predictor of Playing Test scores and combined scores for freshmen students.
4. Music performance majors' scores did not differ significantly from scores earned by students in other degree programs.
5. The number of years a student had played the cello was not found to be a significant predictor of the Written or Playing Test scores.
6. Piano experience was found to be a significant predictor of Playing Test scores, and scores on two sections of the Written Test.
7. Playing Test scores were a significant predictor of how teachers would rank their students in terms of level of technique.
8. The criteria-specific rating scale developed for this study appears to be a highly reliable measurement tool based on interjudge reliability.

Table 4-1. Summary of Regression Analysis for Year in School as a Predictor of Written, Playing, and Total Test Scores ($N = 30$)

Score		<i>B</i>	<i>SE B</i>	β
Written Test				
Freshmen	($n = 11$)	.0069	.0079	.88
Sophomore	($n = 8$)	.0060	.0074	.82
Junior	($n = 5$)	.0085	.0060	-1.40
Senior	($n = 6$)	.0031	.0067	-0.47
Playing Test				
Freshmen		.010	.003	3.30*
Sophomore		.0058	.0032	-1.83
Junior		.0032	.0028	-1.16
Senior		.0014	.0030	-0.46
Total Score				
Freshman		.009	.0027	3.18*
Sophomore		.0038	.0029	-1.32
Junior		.0040	.0024	-1.67
Senior		.0009	.0027	-0.34

Note. Written Test Scores: $R^2 = .027$ Freshmen; $R^2 = .023$ Sophomore; $R^2 = .065$ Junior; $R^2 = .008$; Senior. Playing Test Scores: $R^2 = .280$ Freshmen; $R^2 = .107$ Sophomore; $R^2 = .046$ Junior; $R^2 = .008$; Senior. Total Test Scores: $R^2 = .265$ Freshmen; $R^2 = .058$ Sophomore; $R^2 = .091$ Junior; $R^2 = .004$; Senior.

* $p < .05$

Table 4-2. Years of Study, Frequency, and Test Scores

Years of Study	Frequency	Written Test Mean Score	Playing Test Mean Score
5	1	91	144
6	1	91	114
7	6	83	108
8	4	75.5	101.5
9	2	93	126
9.5	1	95	142
10	2	93.5	140
11	7	87.71	141.1
11.5	1	68	140
12	3	81.31	108.7
13	1	93	156
16	1	87	104

Table 4-3. Summary of Regression Analysis for Piano Experience as a Predictor of Written, Playing, and Total Test Scores ($N = 30$)

Test Section	B	$SE B$	β
Written Test Scores	-2.00	4.21	-.48
Playing Test Scores	-19.20	8.63	-2.23*
Total Combined Score	-21.20	11.74	-1.81

Note. $R^2 = .008$ for Written Test Scores; $R^2 = .15$ for Playing Test Scores; $R^2 = .10$ for Total Test Scores.
 * $p < .05$

Table 4-4. Item Difficulty, Discrimination, and Point Bi-Serial Correlation for the Written Test

Category	Item Number	Item Difficulty	Item Discrimination	Point Bi-Serial Correlation
Fingerboard Geography	1	.97	.13	
Interval Identification	1	.77	.25	0.15
	2	.87	.38	0.26
	3	.80	.50	0.37
	4	.77	.13	0.06
	5	.77	.25	0.08
	6	.70	.38	0.06
	7	.90	.25	0.49
	8	.83	.50	0.40
Pitch Location And Fingering	1	.93	.25	0.63
	2	.93	.25	0.63
	3	.90	.25	0.52
	4	.90	.25	0.49
	5	.87	.38	0.41
	6	.93	.25	0.47
	7	.90	.38	0.57
	8	.80	.50	0.50
	9	.97	.13	0.78
	10	.90	.25	0.63
	11	.77	.38	0.75
	12	.87	.38	0.40
	13	.90	.38	0.63
	14	.83	.50	0.63
	15	.93	.13	0.33
	16	.87	.38	0.63
	17	.83	.50	0.70
	18	.83	.50	0.70
	19	.87	.38	0.71
	20	.87	.38	0.70
	21	.90	.38	0.75
	22	.90	.38	0.70
	23	.90	.38	0.80
	24	.90	.38	0.65
	25	.90	.38	0.71

(Table continued on next page)

Table 4-4. (continued)

Category	Item Number	Item Difficulty	Item Discrimination	Point Bi-Serial Correlation
Pitch Location And Fingering	26	.80	.50	0.71
	27	.83	.50	0.73
	28	.80	.50	0.73
	29	.83	.50	0.74
	30	.83	.50	0.74
	31	.83	.50	0.82
	32	.80	.50	0.76
Single Position Fingering	1	.97	.13	0.07
	2	.97	.13	0.07
	3	.97	.13	0.07
	4	.97	.13	0.07
	5	1.0	0.0	N/A
	6	1.0	0.0	N/A
	7	1.0	0.0	N/A
	8	1.0	0.0	N/A
	9	.97	.13	0.43
	10	.97	.13	0.43
	11	.83	.38	0.16
	12	.80	.38	0.15
	13	.93	.13	0.23
	14	.90	.25	0.16
	15	.97	.13	0.36
	16	.97	.13	0.36
	17	.83	.13	0.06
	18	.83	.25	0.32
	19	.90	.25	0.40
	20	.87	.25	0.35
	21	.93	.13	0.23
	22	.93	.13	0.23
	23	.93	.13	0.23
	24	.93	.13	0.23
	25	.90	.25	0.23
	26	.87	.13	0.12

(Table continued on next page)

Table 4-4. (concluded)

Category	Item Number	Item Difficulty	Item Discrimination	Point Biserial Correlation
Single Position Fingering				
	27	.93	.25	0.31
	28	.87	.25	0.18
	29	.93	.13	0.23
	30	.93	.13	0.23
	31	.97	.13	0.36
	32	.97	.13	0.36
Bass, Treble, and Tenor Clef Note Identification				
	1	1.0	0.0	N/A
	2	.97	.13	0.46
	3	.97	.13	0.43
	4	1.0	0.0	N/A
	5	1.0	0.0	N/A
	6	.97	.13	0.02
	7	.97	.13	0.0
	8	1.0	0.0	-0.04
	9	.93	.13	0.08
	10	.93	.13	0.27
	11	1.0	0.0	-0.05
	12	.90	.13	0.01

Note. Point Biserial Correlations were not found for the Fingerboard Geography items as 97% of the students had perfect scores on this section.

Table 4-5. Mean Scores of Playing Test Items in Rank Order

Item	Rank Order	Mean Score
Detaché	1	8.47
Slurred Legato	2	8.23
Arpeggios	3	8.13
Staccato	4	7.93
Vibrato	5	7.93
Portato	6	7.67
Position Changes	7	7.67
Scales	8	7.60
Arp. Chords	9	7.20
Sautillé	10	7.13
Thumb Position	11	7.00
Broken Thirds	12	6.80
Martelé	13	6.67
Double Stops	14	6.40
Spiccato	15	6.30
Intonation	16	6.20
Pizzicato	17	6.00

Note. Ratings ranged from 2 through 10.

Table 4-6. Comparison of Teacher-Ranking to Playing Test-Ranking

Teacher Ranking		Playing Test Scores	Playing Test Ranking	r^2
School A	1	76	1	1.0
	2	102	2	
	3	136	3	
	4	152	4	
	5	156	5	
School B	1	124	1	1.0
	2	140	2	
	3	140	3	
	4	148	4	
	5	152	5	
School C	1	100	1	0.65
	2	142	4	
	3	134	2	
	4	134	3	
School D	1	92	1	0.84
	2	116	2	
	3	116	3	
	4	128	4	
	5	146	6	
	6	152	7	
	7	132	5	
School E	1	76	1	0.76
	2	86	3	
	3	114	4	
	4	120	5	
	5	82	2	
	6	144	7	
	7	140	6	

Table 4-7. Comparison of Researcher's and Independent Judges' Scoring of Student Performances of the Playing Test

Student No	Primary Investigator	Judge A
1	152	162
2	136	142
3	156	158
4	144	142
5	134	136
	<i>M</i>	148
	<i>SD</i>	11.31
	<i>r</i> ²	0.92
Student No	Primary Investigator	Judge B
6	146	138
7	152	152
8	128	104
9	116	98
10	152	134
	<i>M</i>	125.2
	<i>SD</i>	8.67
	<i>r</i> ²	0.95

Table 4-8. Numbers of Students Expressing Interest in Solo, Chamber, and Orchestral Performance ($N = 29$)

Category	Strongly Agree	Agree	Disagree	Strongly Disagree
Solo	10	14	5	0
Chamber Music	20	7	2	0
Orchestral	16	8	4	1

Note. Students could indicate interest in multiple categories, resulting in totals exceeding the number of students completing the form ($N = 29$).

Table 4-9. Personal Goals for Studying the Cello

Specified Goal	Frequency Mentioned (<i>N</i> = 29)
Teaching privately	5
Orchestral performance	3
Chamber music performance	2
Expand repertoire	2
Lifelong hobby, personal enjoyment	2
College-level teaching	1
Obtain advanced degrees with the goal of college teaching	1
Improve concentration	1
Become a fluid improviser	1
Work as a studio musician	1
Ability to convey interpretation of music to others	1

Table 4-10. Student Perception of Priorities for Technical Study

Technique	Frequency Mentioned
Bow Stroke	10
Relaxation, including right and left hand, shoulders and back	9
Vibrato	4
Vibrato in upper positions	2
Thumb position	3
Musicality	3
Sound production/tone	2
Double stops	2
<i>Sautillé</i>	2
Sight-reading	1
Reading in different clefs	1
Rhythm	1
Coordination between right and left hand	1
Proper employment of left hand position and whole arm movement	1
Extensions	1
Shifting	1
<i>Spiccato</i>	1

Table 4-11. Goals in Music and Means of Accomplishing Them

Six Months:

Catch up to my peers.
To shift easily.
Work strictly on technique, not worrying about pieces or recitals.
Practice more musically than technically.
Have lessons with other teachers.
Improve jazz vocabulary.

One Year:

Keep my scholarships.
To have perfect intonation.
Become an effective music educator (lifelong).
Resolve all tension issues; slow, loose practice-making it a habit.
Increase in difficulty of music.
Work on awareness of bowing choices.
Practice.

Two Years:

To be able to support myself solely through playing and teaching.
I hope to memorize a full concerto and feel comfortable performing.
Much practice; memorization and performance practice will be needed.
Graduate, and find a graduate school with a fabulous teacher.

Four Years:

To get past the prelims in an orchestral audition.
To graduate, get a job as a music therapist, and join the community of a professional orchestra.
Play recreationally, not as a career.

Ten Years:

To be a guest artist at a major music festival.
Be teaching at a university with a Ph.D. in music.
Be employed in a high school as a music teacher, but still make time to perform and possibly give private lessons.
Able to teach other cellists.
Gigging professionally.
Be a financially stable musician.

CHAPTER 5 DISCUSSION AND CONCLUSIONS

This chapter presents a discussion of the results of administering the Diagnostic Test of Cello Technique. Following a review of the purposes and procedures of this study, the findings of this study are addressed in light of (a) the research questions posed, (b) a comparison of results with similar studies, and (c) implications for string education. This chapter closes with conclusions and recommended directions for future research.

Overview of the Study

The purpose of this study was to design, validate, and administer a diagnostic test of cello technique for use with college-level students. Written and playing tests were designed, pilot tested, and a validity study was undertaken. Thirty students from six different universities in the southeastern United States were recruited to participate in this research. Each student completed a written test, playing test, and a self-assessment profile. A criterion-based rating scale was developed to evaluate the Playing Test performances. Two university-level teachers were recruited to judge ten video-taped performances of students taking the Playing Test. Evaluations from those judges were correlated with the primary researcher's to determine interjudge reliability.

Review of Results

The independent variables in this study were (a) year in school, (b) major/minor distinction, (c) years of cello study, and (d) piano experience. Freshmen classification emerged as a significant predictor of Playing Test scores ($p = .003$) and total scores ($p = .004$). No effect of major/minor distinction was found for the Written Test ($R^2 = .001$). Results were nearly significant for the Playing Test ($R^2 = .104$) and not significant for the combined Written and Playing Tests ($R^2 = .072$). Years of cello study were not significant predictors of test results.

Piano experience was shown to have a significant effect on the Playing Test scores: ($p = .034$). Students with piano experience scored 14% higher on the Written Test and 7% higher on the Playing Test than those without piano experience. The reliability of the Playing Test was high as shown by coefficient alpha ($r_{tt} = 0.92$). Correlation coefficients obtained between the primary researcher and the two reliability researchers were positive and strong (Judge A, $r^2 = 0.92$; Judge B, $r^2 = 0.95$), suggesting that the criteria-specific rating scale designed for this study was effective.

Observations from the Results of Administering the Diagnostic Test of Cello Technique

The Written Test

Future versions of the Written Test designed for college-students should eliminate The Fingerboard Geography section, as only one student made errors in filling out this section. This section should be included for a high school version of the test; the likelihood is that not all students at this level would be clear about the location of pitches on the fingerboard.

The Interval Identification section as a whole had the highest average difficulty level of any section of the Written Test based on item analysis. In this section, item six (a major sixth across two strings) had the highest difficulty level of any item on the test (.70). This item, however did not discriminate well between high-scoring and low-scoring students (.38). On this item students most likely erred by not keeping in mind that on the cello, the interval of two notes lying directly across from each other on adjacent strings is always a perfect fifth. Adding a whole step to a perfect fifth, results in the interval of a major sixth. This is an example of something universally known by undergraduate cello students but not necessarily visualized by them on the fingerboard. This suggests that some students were either unclear about interval designations or that they do not think intervallically when playing the cello. It is the researcher's

opinion that an awareness of intervals while playing represents a higher-order of thinking than simply playing note-by-note. Additional research is needed to determine to what extent intervallic thinking while playing the cello is a distinguishing characteristic of advanced performers.

In the Interval Identification section of the Written Test, the mean score for those with piano experience was 7.07 out of 8 possible points as compared with a mean of 5.73 for those without experience. Piano experience was found to be a significant predictor for this item ($p = .002$). Students who play piano are able to identify intervals more easily on a representation of a cello fingerboard than those without piano experience. In the Single-Position Fingering section piano experience again was found to be a significant predictor of a student's score ($p = .002$). This suggests that students with piano experience may think more clearly about vertical pitch relationships. String instrument teachers would likely concur, observing that their students who play piano tend to: 1) be better sight readers, 2) have a clearer sense of pitch and intervals, and 3) have better rhythmic accuracy. Additional evidence of the positive effect of piano experience on cello performance would be gained through studies that compared students' length of time studying both instruments to their performance on the Playing Test.

The Single Position Fingering section may be unclear in its directions. Several students thought they were being asked for fingering that would allow the notes to be played as a simultaneous chord, which wasn't possible for some items. The final section (Note Identification in Three Clefs) had several very low point biserial correlations (0.07). Errors in this section were almost certainly caused by carelessness and did not reflect a student's ability in note reading. One single exception was a student who missed all the tenor clef items but got all the other note identification items right. Complete fluency in note reading is an essential

prerequisite for sight-reading ability. As a result, this section should be included in future versions of this test.

The Written Test needs to be revised for undergraduate students in terms of difficulty level. A greater range of scores would likely result if the present version of the test was administered to high school students. In future versions, using actual passages from the cello repertoire to evaluate a student's understanding of intervals, fingering, and fingerboard geography would be in keeping with the testing philosophy of using situated cognition.

The Playing Test

Left Hand Technique (nine items) and Basic Bowing Strokes (eight items) were evenly dispersed within the range of lowest to highest mean scores (Table 4-5). The choice in this study to divide technique into left hand techniques and bowing techniques does not reflect in reality how integrated these two areas are. This study's design did not isolate bow techniques from the musical context in which they are found. If such a study was conducted, it might reveal that some students excel in bowing techniques and others in left hand technique. These two areas of technique are so intermeshed that it would be difficult to isolate them. Bowing serves literally to amplify what the left hand does. Development of bowing skill, through practice on open strings without using the left hand, is limited, and is usually, though not always, confined to initial lessons.

The Playing Test's mean scores revealed that students scored highest on the *detaché* bowing stroke ($M = 8.46$), followed by *legato* bowing ($M = 8.33$), and *arpeggios* ($M = 8.13$). *Detaché* bowing is the most commonly used bow stroke; *legato* playing is also very ubiquitous. One might have expected to find Scales, Broken Thirds and Arpeggios grouped together the same difficulty category. These three areas of technique are considered the core left hand

techniques: indeed most music is comprised of fragments of scales, arpeggios, broken thirds, and sequential passages. The excerpts used in the Playing Test to evaluate scales may have been more challenging to perform than the arpeggios; this may partially explain why scales were not among the easier items. Another explanation may be that scales are the first item on the test. Initial nervousness or stage fright may have affected this item more than subsequent ones. The researcher noted that most students seemed to become free of nervousness shortly after commencing the test, but these initial jitters may have had a deleterious effect on their performance of the first item.

In the Pilot Study (Appendix A) broken thirds were the fourth most difficult item. It was conjectured that broken thirds are under-assigned by teachers, and as a result, not practiced much. In this present study broken thirds again were found to be difficult for students to demonstrate. The ability to play (and especially to sight read) broken thirds requires two skills: 1) The capacity to quickly discern if a written third is major or minor, and 2) having an accurate sense of interval distances on a given string. The correlation of students' scores on broken thirds to their total Playing Test scores was strong ($r = .81$), suggesting that students' ability to perform well in this area may be a good indicator of their overall level of technique.

The difficulty of demonstrating a given technique through excerpts varies. *Spiccato* bowing, the third lowest score ($M = 6.3$), requires a succession of separately bowed notes played rapidly enough that the bow bounces off the string almost of its own accord. This is not a technique that is easily demonstrated unless the player is very familiar with the notes. *Sautillé* bowing, another bounced-bow stroke ($M = 7.13$) appears to be slightly easier than *spiccato*. Though *sautillé* bowing requires a faster bow speed than *spiccato*, the repetition of pitches meant the speed of fingering changes is actually slower for these passages, thus easier to play.

The relatively low score for *martelé* bowing is likely due to a lack of understanding as to what constitutes this bow stroke. The two excerpts used for this item were moderately easy to play. A large number of students, however did not demonstrate the heavily, accented articulation, and stopping of the bow on the string, which characterizes this stroke. While many method books include a description of *martelé* bowing, students are unlikely to have a clear grasp of how to execute this bowing unless it is demonstrated by a teacher.

The item with the lowest score was *pizzicato* ($M = 6.06$). The excerpts chosen featured three separate techniques: (a) arpeggiated chords using the thumb (Elgar), (b) notes with a strong vibrant tone (Brahms), (c) clear ringing sound in the upper register (Kabalevsky). These excerpts were not easy to sight read for students who were ill-prepared. This was the final section in a series of excerpts requiring great concentration; mental and/or physical fatigue may have been a factor. It is also possible that the study of *pizzicato* is neglected in lessons.

Intonation was the second lowest score ($M = 6.20$). Judge B assigned the only perfect score given to a student. It is axiomatic that string players must be constantly vigilant about playing in tune. Not allowing students to become tolerant of playing out-of-tune is one of the essential roles of the teacher. Pablo Casals' words on this subject are timeless:

‘Intonation’, Casals told a student, ‘is a question of conscience. You hear when a note is false the same way you feel when you do something wrong in life. We must not continue to do the wrong thing’ (Blume, 1977, p.102).

Five students (15%) mentioned intonation when asked, ‘What areas of cello technique do you feel you need the most work on’ (see Chapter 4, p. 63). From this study it appears the Playing Test may help make students more aware of the importance of work on intonation.

The Student Self -Assessment Profile

The premise for designing the Student Self-Assessment Profile is that better information about a student's background, interests, and goals for study can result in more effective teaching. Its value as a diagnostic tool is in revealing a student's years of study, previous repertoire studied, and playing experience. The emphasis on identifying personal goals for studying the cello as well as overall goals in music opens a window into a student's self awareness. Communication of these goals to a teacher can affect the course of study. Allowing students' goals to influence their education may result in their feeling more invested in the learning process. The outcome may be more effective, goal-directed practice. Students are more likely to be motivated by goals that they perceive as being self-initiated. Awareness of these goals is not necessarily derived by conventional teaching methods; it comes from a dialogue between the teacher and student. The Student Self-Assessment Profile can act as a catalyst for such a dialogue.

The personal goal for studying the cello most often mentioned was "teaching privately" (Table 4-9). When a teacher knows that a student wants to teach the cello as a vocation, his role becomes more of a mentor, exemplifying for the student the art of teaching. A greater role for discussion during the lesson may ensue as the need for various approaches to problems becomes apparent. Perhaps the most important thing a teacher can provide a student aspiring to teach is to help them become reflective about their own playing; asking themselves why they do something a certain way. Questions that ask *why* rather than *how* take precedence. Two students mentioned college-level teaching as one of their personal goals. Providing student-teaching opportunities for these students as well as opportunities to observe experienced teachers at work would be invaluable.

Goals such as orchestral or chamber music performance could have a direct effect on the program of study if the teacher agreed that these objectives were appropriate and attainable. A student who has expressed a sincere goal of playing professionally in a major orchestra deserves to know both the playing standards required and the fierce competition involved. A serious attempt to address some of the personal goals mentioned here would challenge even the most veteran of teachers. How do you help a student improve concentration? Become a fluid improviser? Convey their interpretation of music to others? Addressing these goals as a teacher means taking risks, varying one's approach, and being flexible.

Over one third of the students who filled out the Student Self-Assessment Profile listed "bow stroke" as a priority for technical study (Table 4-10). They are in good company; string musicians agree that true artistry lies in a player's mastery of the bow. Musical issues such as phrasing, dynamics, and timing are the bow's domain. A cellist's approach to bowing largely determines their tone, and articulation. These qualities, along with vibrato, are the distinguishing unique characteristics of an individual cellist's sound.

After "bow stroke" the most commonly noted area of technique addressed was relaxation or lowering body tension. This is an aspect of technique that musicians have in common with athletes. Gordon Epperson summarized the observations of many teachers:

What is the chief impediment to beauty of sound, secure intonation, and technical dexterity? I should answer, without hesitation, *excess tension*. Sometimes tension alone is blamed; but surely, we can't make a move without some degree of tension. It's the *excess* we must watch out for. (Epperson, 2004, p. 8).

Excessive tension may not always be readily apparent; teachers may not realize students are struggling with this area unless the issue is raised. Students who mention excessive tension while playing as a major concern should be directed to a specialist in Alexander Technique.

Work on Vibrato, either in general or in upper positions was mentioned by six students. Despite sounding like an oxymoron, it is true that an effortless sounding vibrato is very difficult to make. Dorothy Delay, of the Juilliard School of Music, assigned the first hour of practice to be spent on articulation, shifting, and vibrato exercises for the left hand, and various bow strokes for the right (Sand, 2000). Students who express a desire to develop their vibrato should be guided with appropriate exercises, etudes, and solos.

Other areas of technique are far more easily addressed. A student who mentions sight-reading or reading in different clefs can be easily directed to materials for study. Applying oneself to the exercises in *Rhythmic Training*, by Robert Starer will benefit any student who felt deficient in rhythm (Starer, 1969). There are materials to address virtually every technical need, as long as the need is made apparent to the teacher.

The final question of the SSAP asks, “Summarize your goals in music and what you need to do to accomplish these goals.” The words with underlined emphasis were added based on input from the Validity Study (Appendix B). This phrase is meant to suggest a student’s personal responsibility to follow-through with their stated goals. Table 4-11 is a transcription of student responses to this question in their own words.

Six-month goals are short term, and reflect a student’s semester-long objectives. “Work strictly on technique, not worrying about pieces or recitals,” is one example. Some one-year goals seem naïve: “To have perfect intonation.” Goals are the driving forces behind ones outward acts; playing with perfect intonation may not be attainable but that doesn’t mean it isn’t a valid aspiration. One student has shown they understand the need to make some aspects of playing virtually automatic through repetition: “Resolve all tension issues: slow loose practice-making it a habit.” Music and athletics have in common the need for drilling desired actions.

As Aristotle noted, “We are what we repeatedly do. Excellence then, is not an act, but a habit” (Aristotle, trans. 1967).

Goal setting is most effective when it is measurable, as with a student’s two-year goal of memorizing a full concerto. Academic ambitions, such as pursuing graduate studies, are important to share with ones teacher, and can dictate a student’s course of study. Teachers may occasionally be surprised in reviewing their students’ long-term goals: One performance major stated her goal as a cellist was to play recreationally, not as a career. However, most four-year and ten-year goals were career-oriented. There is value in having students express these goals concretely; through this activity, students visualize doing something they are presently not able to do. Goal setting requires a leap of faith.

Discussion of Research Questions

In this section the original research questions are reexamined in light of the results. These questions are restated below with discussion following.

To what extent can a test of cello playing measure a student’s technique?

The extent to which the Playing Test is able to measure an individual cello student’s technique depends on the way a teacher uses it. If students are strongly encouraged by their teacher to practice the excerpts and are expected to play from them in the lesson, testing error resulting from unfamiliarity with the music and sight-reading mistakes can be minimized. The results can come much closer to a true diagnosis of a student’s technical level. The comparison of teacher-ratings to Playing Test ratings (Table 4-7) revealed a high correlation and tended to confirm the test’s validity. It is possible that, in some cases, ranking differences occurred due to a teacher’s bias based on his or her estimation of a student’s potential. As one teacher noted in discussing a student’s rating: “It pains me to make this assessment, as I confirm that (student)

has far underperformed both her stated aspirations and potential the last several years” (personal correspondence, May 2007). One of the primary purposes of this test was to provide a tool that allows greater diagnostic objectivity, thereby providing a counterbalance to the subjective impressions that a teacher receives about each student.

Each technique is represented by several excerpts of increasing difficulty. On those items using an additive scale, the listener can find a descriptive statement that corresponds to the performance level a given student has demonstrated. In thirty minutes of concentrated listening the teacher/evaluator is able to come to definite conclusions about a student’s ability to demonstrate seventeen essential areas of technique. As the Playing Test is made up of excerpts from the standard repertoire for cellists, the teacher is given insight into what pieces are appropriate for study.

To what extent can a criteria-specific rating scale provide indications of specific strengths and weaknesses in a student’s playing?

Interjudge reliability was positive and strong (Judge A $r^2 = 0.92$, Judge B $r^2 = 0.95$), suggesting that the criteria-specific rating scale designed for this study was an effective means of directing the evaluator to listen and watch for specific aspects of technique. A factor analysis of the descriptive statements generated for the Playing Test evaluation form is recommended. Statements that were found to have low factor loadings could be replaced, and reliability of this measure could be increased. One example where improvement might be made is in the criteria choices provided for *Vibrato*. There were students who did not really match any of the descriptors provided for this item; their vibrato was not tense nor too fast, but to the contrary, was unfocused and too slow.

Can a written test demonstrate a student’s understanding of fingerboard geography, and the ability to apply music theory to the cello?

The answer to this research question is a provisional “yes,” noting that the results of such a test do not necessarily predict how well a student plays. Additional research is needed to determine to what degree intervallic understanding or fingerboard visualization is part of the practical core knowledge of an advanced cellist.

While scores on the Written Test ranged from 62% to 100% correctly answered, the difficulty level for all items was found to be low. However, it is good that the Fingerboard Geography section was filled out flawlessly by 29 out of the 30 students. Any real confusion here would be a signal that something was seriously lacking in a student’s understanding of half steps, the chromatic scale, or the relationship of strings tuned a fifth apart from each other. The Written Test may be seen as a kind of barrier examination; if students score below 90%, review of these content domains is indicated. Item difficulty could be increased by more challenging interval identification and pitch location items.

Perhaps a means to achieve more authentic assessment of fingering skills would be to have students provide fingerings for passages from actual orchestral, chamber, or solo music written for the cello. The challenge in this would be the number of “acceptable” choices. Nevertheless, a teacher might gain more insight about a student’s situated cognition, that is, the thinking process ‘at’ the cello, by using this approach. Ensuing results could become the basis for discussion about why one fingering might be better than another.

The point biserial correlations from the Interval Identification section indicate that some students, who otherwise had high scores, were less successful on this section. However, seven of the nine students who made perfect scores in this section also were the top scorers of the whole test. Of the nine students who correctly identified all the intervals, eight had piano experience.

Piano experience emerged as a significant effect on student's scores on the Interval Identification section through regression analysis ($p = .002$). It is suspected that discussions of intervals rarely occur in the teaching of string instruments. A student's understanding of intervals derived from music theory classes may not automatically transfer to the cello fingerboard and cello music.

The use of fingerboard representations to test interval understanding may have favored visual learners. This test does not extend beyond mere interval identification to the more important skill of seeing a written interval and being able to imagine how it will sound. This skill, traditionally tested in sight-singing classes, is very valuable to instrumentalists but is often underdeveloped. Future versions of the test might include having students play passages based on a series of intervals rather than given pitches.

Student's Written Test scores do not have a strong correlation to their Playing Test scores ($r^2 = 0.16$). The Written Test may measure a theoretical understanding that, while valuable, does not directly influence a student's demonstration of the techniques found in the Playing Test. A comparison of students' scores on the Written Test and a sight reading test such as the *Farnum String Scale* (Farnum, 1969), might be found to have a higher correlation. Pitch Location and Fingering, as well as the Single Position Fingering section, require the students to demonstrate a skill that is required for effective sight reading, namely, coming up with efficient fingerings.

Additional research is needed to explore to what extent an understanding of fingerboard geography and music theory, as applied to the cello, affects a student's playing. It can be hypothesized that there is a cognitive skill set that accompanies the psychomotor skills of string playing. Better understanding of the kind of situated cognition required to think well on a string instrument would be valuable to teachers and students.

Observations on the Playing Test from Participating Teachers

After the research for this study was complete, participating teachers were asked to comment on the value of the test as a diagnostic tool. In one particular case, a teacher had his students play from the Playing Test during lessons at the beginning of the semester. He comments on the beneficial aspects of using the excerpts within his studio:

In terms of using the playing test as a studio project, it was helpful in several ways. First, it was great to have a community project that I could get everyone involved in working on. Secondly, it was useful to have excerpts that were shorter than any etude I might assign (I do sometimes assign etude excerpts, however) but focused on a small sub-set of technical problems. For some students, certain excerpts were a lot harder than others (though they all struggled on the double-stop section of the Dvorak concerto!) which meant it was also a process of self-discovery. Finally, in some cases I later assigned repertoire included in the excerpts, and students were able to build upon the work they'd already done, learning some of the trickier parts (Personal communication, May 2nd, 2007).

The reference to self-discovery corroborates evidence gathered through the Student Self-Assessment Profile (SSAP) that the Playing Test can result in greater student self-awareness of their playing. The number of comments found in the SSAP referring back to techniques encountered in the Playing Test suggests that the test can indeed make students more self-aware of their strengths and weaknesses. That the test could influence the choice of repertoire assigned to students was also demonstrated. The positive value the test had uniting the studio in a “community project” was unexpected. If students worked on this common repertoire and played it for each other in cello class, the test could function as a means to connect members of a studio and to learn from each other.

The completeness of the Playing Test’s content and its capacity to quickly assess a student’s skill level was noted by another teacher:

I found the test to be a very thorough and comprehensive survey of all of the basic issues in cello technique, using excerpts drawn mostly from the standard repertoire, so that at least some of them should already be familiar to any cello student. By asking an

intermediate-to advanced level student to play through these excerpts (or even just one or two excerpts under each technical element), with or without prior preparation, the teacher should be able to quickly (in about thirty minutes or less) identify the student's strengths and weaknesses in any of the essential aspects of cello technique. (Personal communication, May 23rd, 2007)

Another participating teacher confirmed the diagnostic worth of the test and its usefulness in setting goals:

I feel the diagnostic test designed by Tim Mutschlecner is a valuable tool for evaluating students and charting their course of study. Students come to a teacher's studio with such a wide diversity of skill and backgrounds that any aid in assessing their abilities is welcome. Thank you for your original and worthwhile test. (Personal communication, May 10th, 2007).

This teacher addresses what the test results have shown; students enter college with a wide range of experience and preexisting abilities. One of the student participants, a freshman, scored higher on the Playing Test than five out of six seniors. This exemplifies why the test has questionable value as a norm-referenced measure. When ranking students, one teacher observed that comparing students was like comparing "apples and oranges." The playing test provides a set of criteria that can supplement a teacher's performance standards and expectations.

Comparative Findings

The Farnum String Scale

When discussing the Farnum String Scale (FSS) in Chapter Two, it was observed that the test requires the student to play a series of musical examples that increase in difficulty. This approach was adopted in the Diagnostic Test of Cello Technique (DTCT). Unlike the FSS, musical examples were taken directly from actual music written for the cello. The rationale for this was that using real music increased the test's capacity for authentic assessment; students would be playing the actual passages where the techniques in question would be found. The downside to this was the potential of distracters, aspects of the excerpts that would mask a

student's real ability with a given technique. In some cases, for example the double-stop excerpt from the Dvorák concerto, other challenges in playing the passage may have adversely affected a student's ability to demonstrate the technique. However, after administering the test and receiving positive feedback from students as well as teachers, it is felt that the benefits of using real music far outweigh the disadvantages. Students liked the fact that they were playing from standard works for cello and ones that they would quite possibly study someday, if they hadn't already. This illustrates a weakness of the DTCT if it is used normatively. Unlike the FSS passages, which would be unfamiliar to all test takers, students approach the DTCT with varying degrees of familiarity with the excerpts. It would be unfair and ill-advised to use this test as a means to compare students among themselves or to assign grades. Each student's performance of the test must be judged solely on the criteria defined in the evaluation form.

One university professor declined to have his students participate in this study because the bowings and fingering were not always the ones that he taught. Although he was alone in this objection, it does demonstrate a dilemma that this kind of test design faces: If the test-maker provides ample fingerings and bowings, there will be students who have learned these passages differently and will be thrown off. If few or none are provided, it will create much more work for the average student to play these excerpts. The best compromise may be to seek bowings and fingerings that are most commonly used, even while instructing students that they are free to develop their own choices.

Zdzinski and Barnes

The design of this study owes much to the string performance rating scale of Zdzinski and Barnes (2002). The success they found in using a criteria-specific rating scale was validated in this research. High interjudge reliability correlations (Judge A $r^2 = 0.92$, Judge B $r^2 = 0.95$)

indicate that drawing a judge's attention to specific aspects of the playing is an effective way to increase consistency in evaluating music performances. Additive rating scales, as used by Saunders and Holahan, (1997) eliminate the use of unspecific numerical ratings such as those commonly used in Likert scales. By requiring a judge to listen for specific evaluative criteria, rather than trusting in their general impressions of a music performance, reliability is increased.

Conclusions

The following conclusions can be drawn from the results of this study.

1. Results from the Interval Identification section of the Written Test indicate that not all students recognize intervals confidently on the cello.
2. The excerpts used in the Playing Test are a valid and reliable way to measure a undergraduate cellist's technique.
3. Piano experience improves how well student's perform on the Playing Test.
4. The Playing Test is a good predictor of teacher-rankings of their students in terms of technique.
5. The criteria-specific rating scale used in this study is a reliable instrument for measuring a student's technique.
6. A student's year in school, degree program, or years of cello study are not strong indicators of their playing ability.

Recommendations for future research in the area of string instrument teaching and assessment are:

1. A high school version of this test should be developed for use in diagnostic evaluation and teaching.

2. This test can be used as a model for violin, viola, and bass diagnostic tests of technique.
3. Future studies should explore the relationship of theoretical knowledge and performance ability on the cello.

As testing increasingly becomes a major focal point in discussions on improving education, questions regarding the value and purpose of assessment will increasingly be raised. Diagnostic evaluation, because of its capacity to inform teaching, is an important component of music education, including applied music. Tools like the Diagnostic Test of Cello Technique help clarify for both teachers and students what needs to be learned. Along with existing approaches to evaluation, music educators will continue to seek better objective means to assess musical behavior.

Normative assessment has limited value in the arts; students come from such diverse backgrounds and experiences that their work must be judged by established criteria, not from comparison. The effectiveness of instrumental teaching depends on how clearly performance objectives are communicated to the student. Well-defined performance criteria results in clear objective goals. In music, as in life, when the target is clear, it is easier to hit the mark.

APPENDIX A PILOT STUDY

A pilot study was carried out (Mutschlechner, 2004) which provided indications of ways to improve an initial form of the *Diagnostic Test of Cello Technique*. Five undergraduate music majors studying at a school of music located in the southeastern region of the United States volunteered to participate in the pilot study. Four out of the five students were cello performance majors. One was a music education major. These students were met with individually at the school of music in a studio space reserved for this use.

The students were first given the Self-Assessment Profile to fill-out. Following this, students were given the Written Examination, which took between ten and fifteen minutes for them to complete. The Written Examination used in the pilot study was shorter than the one developed for the present study. It included: a fingerboard chart, horizontal and linear (on one string) interval identification, note identification in three clefs, and single-position fingering exercises.

In the pilot study students were not given the Playing Examination ahead of time but were required, essentially, to sight-read the excerpts. However, students were advised that this was not a sight-reading test per se, but rather a test to assess their ability to demonstrate specific technical skills and bowings. The students were encouraged to take some time to visually familiarize themselves with the excerpts, and were told they could repeat an excerpt if they felt that they could play it better a second time, an option only chosen twice. The students took between thirty and forty-five minutes to complete the playing portion of the test. The pilot study's version of the Playing Examination was shorter than the present study, measuring fewer categories of left hand and bowing technique and not using as many excerpts for each technique.

Results of the Written Examination showed that the students had no difficulty with the questions asked. What errors there were amounted to careless mistakes. This suggests that the Written Examination did not discriminate well for cello students at this level. These results led the researcher to increase the difficulty level of the present study

The rating instrument used for the Playing Examination was a five-point Likert scale which included brief descriptions as to what each performance level represented. Student performances of the Playing Examination ranged between 74.7% and 93.3% of a perfect score. The student who had the weakest score was a music education major. Students in general did slightly better in the Basic Bowing Strokes section of the exam than in the Left Hand Technique section (91% compared to 86%). This was not surprising: The musical excerpts used to demonstrate left hand technique were of necessity more difficult, and less easy to sight-read. The lowest combined score was for the *portato* bowing. This was defined in the Playing Examination as:

A series of broad strokes played in one bow with a smooth slightly separated sound between each note. The bow does not stop as in the slurred staccato. Each note is to be clearly enunciated with a slight pressure or ‘nudge’ from the index finger and upper arm.

Despite this extended definition students were unable to consistently demonstrate this bowing. The evidence suggested that this stroke is not being taught or discussed to the same extent as other bowings.

The next three lowest combined scores after *portato* bowing were for position changes, string crossings, and broken thirds. Well-performed position changes and string crossings may be part of the identifying characteristics of an advanced player. The researcher suspects that broken thirds are not practiced much and not emphasized by teachers, thus explaining the lower

scores in this area. Results from the Playing Examination indicate the need to increase the difficulty level.

The results of the Student Self-Assessment Profile included the following responses:

How interested are you in each of these areas of performance?

I am interested in solo performance.

1 Strongly agree 1 Agree 3 Disagree 0 Strongly disagree

I am interested in chamber music performance.

4 Strongly agree 1 Agree 0 Disagree 0 Strongly disagree

I am interested in orchestral performance.

3 Strongly agree 2 Agree 0 Disagree 0 Strongly disagree

What was most unexpected was the number of students who chose “disagree” for the statement: I am interested in solo performance. One would have expected performance majors to at least agree with this statement, if not strongly agree. They may have been influenced by the choice of the word, “performance,” and were thinking about whether they enjoyed the experience of solo playing which, by connotation, meant auditions, juries and degree recitals. These students may have been reading “solo” as meaning “solo career,” and responded likewise.

In the Student Self-Assessment Profile students responded to the question, “What are your personal goals for studying the cello,” in a variety of ways such as:

- (a) Would like to have a chamber group and coach chamber groups.
- (b) To play anything that is set before me—I don’t want to have limits in terms of technique. To be able to convey to the audience what I feel when I play.
- (c) Perfect intonation before I graduate, attempt to win the concerto competition.
- (d) To get an orchestra gig, have a quartet/quintet, and teach students on the side.
- (e) I want to be able to use the cello in all sorts of ways including orchestral, chamber, rock & roll, and studio recording.

These answers are very specific and focused. A teacher, informed about these goals, could modify teaching to address some of these goals. For example, students that have expressed an interest in teaching would find discussions on how one might teach a particular skill very

valuable. If a student expresses the desire to be able to play, “anything set before me,” they would be likely to respond enthusiastically to a rapid, intense survey of a wide variety of cello literature. For the student who specifically mentions perfecting intonation as a goal, there are studies and approaches that would be recommended.

The question, “What areas of technique do you feel you need the most work on?” elicited even more specific responses such as shifting, general knowledge of higher positions, fluid bow arm, relaxing while playing, exploring musical phrasing, etc. These responses help give the teacher a window into the student’s self-awareness. They could become excellent starting points for examining technique and would go far in helping technical study be goal-directed rather than a mechanical process.

The final section of the Student Self-Assessment Profile had the students summarize their goals for six months, one, two, four, and ten year periods. Responses showed students had clear ideas about what they wanted to do after school, such as orchestral auditions or graduate school. One revision made for the present study was to ask students what they needed to do to accomplish their goals. A personal commitment in the plan of study is essential for insuring the student’s motivation to accomplish the goals formulated by both the teacher and himself. For example, if a student seriously wants to compete for an orchestral job, preparation must begin long before the position opening is announced, through study of orchestral excerpts, a concerto, and the *Suites for Unaccompanied Cello* by J.S. Bach. It is incumbent upon the teacher to discuss these kinds of issues with students who express ambitions to play professionally in an orchestra.

APPENDIX B VALIDITY STUDY

A validity study was conducted following the pilot study to determine what extent teachers felt this test measured a student's technique (Mutschlecner, 2005). Cello teachers ($N = 9$) on the college and college preparatory level agreed to participate in this validity study by reading all sections of the diagnostic test and then responding to questions in an evaluation form (Appendix C).

In answer to the question, "To what extent does this test measure a student's technique," responses ranged from "Very extensively," and, "Rather completely," to, "The written part tests knowledge, not technique." Fifty six percent of the teachers felt the test measured a student's technique in a significant way. Sixty seven percent of the respondents suggested that sight-reading difficulties might mask or obscure an accurate demonstration of a student's technical ability. As one teacher said, playing the excerpts "...shows if they have worked on this repertoire. If they are reading it, it shows their reading ability." Two teachers came up with the same solution: Provide the playing test to students early enough for them to develop familiarity with the passages which they are asked to play. This would not eliminate the inherent advantage students would have who had studied the piece from which the excerpt was derived, but it could mitigate some effects, such as anxiety or poor sight-reading skill, which adversely affects performance. These suggestions were implemented in the present study.

Criticism of the Written Examination included the concern that, "some fine high school students ready for college might not know intervals yet." In response to this, a new section of the Written Examination was developed (Pitch Location and Fingering) that measures a student's capacity to locate pitches on a fingerboard representation without the use of intervallic

terminology. The Interval Identification and Single Position Fingering sections of the pilot test were extended to provide greater accuracy in measurement of these skills.

Forty four percent of respondents agreed that the excerpts chosen for the Playing Examination were a valid way of determining a student's competence in left hand and bowing technique. Several teachers suggested the addition of specific excerpts to reveal other aspects of a student's technique such as *pizzicato*, and passages with greater variety of double stops (simultaneously playing on two strings). These suggestions were implemented in the present study. Part two of the Playing Examination (Basic Bowing Strokes) was expanded to include Accented *Détaché*, Flying *Spiccato*, and *Pizzicato*.

Reaction to the choice of excerpts used in the Playing Examination included the suggestion that a better assessment of a student's abilities would be to arrange the material in progressive order from easiest to hardest and then see at what point the student began to have difficulty. Ordering and expanding the range of difficulty of the excerpts would provide useful information about the student's playing level so that repertoire of an appropriate difficulty-level could be assigned. The present study applied these recommendations by finding additional excerpts and making them sequentially more demanding. An effort was made to find excerpts in each category that could be played by undergraduate cellists.

Seventy eight percent of the teachers responded positively to the Student Self-Assessment Profile. Comments included, "I really like the Student Self-Assessment page. I think that it is not just valuable to the teacher but important that the students examine their own situations as well." One teacher remarked, "It seems the profile would be a useful tool to gauge the goals and general level of a new student." A teacher proposed having some more open ended questions as well, noting that, "There is music beyond solo, chamber and orchestral." As a

result, a line asking for other areas of performance interest was added. The study indicated that teachers are either using a similar tool in their studios or would consider doing so.

The responses from teachers who participated in the validity study support the premise that the diagnostic test of cello technique is a legitimate way to gather information about a student's technical playing ability. The recommendations of these teachers were taken into account in developing this present test.

APPENDIX C
VALIDATION STUDY EVALUATION FORM

The Diagnostic Test of Cello Technique: Validation Study

Evaluation Form

Instructions: Please read all parts of the test before responding to these questions.

1. To what extent does this test measure a student's technique?

2. What changes to the test construction do you feel would make the test more valid?

3. What changes in content do you feel would make the test more valid?

4. To what extent does the content of the Written Examination: i.e. Fingerboard Geography, Horizontal Intervals, Linear Intervals, Clef Identification and Single Position Fingering demonstrate a basic essential knowledge of music theory as applied to the cello?

5. Would you consider using the Written Examination as a means of assessing a new student's knowledge of music theory as applied to the cello?
Why or why not?

6. Are the excerpts chosen for the Playing Examination a valid way of determining a student's competence in-

a) Left hand technique?

b) Bowing technique?

7. If you feel a particular excerpt is not a good predictor of a student's ability, what alternative passage do you recommend using?

8. Would you consider using the Playing Examination as a means of assessing a new student's technique?

Why or Why not?

9. How would you use information gathered from the Student Self-Assessment and Goal Setting Profile in working with your students?

10. To what extent would you be willing to participate in future Field Testing of this test through administering it to a portion of the students in your studio?

Please include any additional comments here:

APPENDIX D
INFORMED CONSENT

Tim Mutschlecner
2035 NW 18th Lane
Gainesville, FL 32605
E-mail: stmutschlecner@excite.com
December 1st, 2006

Dear Participant,

I am Timothy Mutschlecner, a doctoral student in Music Education at the University of Florida, where I am doing a study of a diagnostic test of cello technique. The test contains three parts. If you choose to participate, I will mail you a *Student Self-Assessment Profile* which you will fill out prior to our meeting. Then, during a pre-arranged time you will take a 10 minute written test. The written test contains sections on Fingerboard Geography, Interval Identification, Pitch Location and Fingering, Single-Position Fingering, and Bass, Treble, and Tenor Note Identification. Next, you will take a 45 minute playing test consisting of short passages demonstrating your ability to play scales, arpeggios, broken thirds, double stops, position changes, arpeggiated chords, thumb position, vibrato, intonation, slurred legato, *détaché*/accentuated *détaché*, *martelé*, *portato*, *staccato*, slurred *staccato*, *spiccato*, flying *spiccato*, *sautillé*, and *pizzicato*. Your performance may be videotaped and view by other judges.

The combined test will take no longer than one hour to complete. Your choosing to participate or not to participate in this study will not affect your grade in cello studies. Test results will be kept confidential and scoring will be reported anonymously. Your identity will not be revealed in the final manuscript.

There are no anticipated risks, compensation or other direct benefits to you as a participant in this survey. You are free to withdraw your consent to participate, and may discontinue your participation in this study at any time without consequence.

If you have any questions about this research protocol, please contact me at (352) 377-1076; Email: stmutschlecner@excite.com, or my faculty supervisor, Dr. Timothy S. Brophy, at (352) 392-0223 ext 222; Email: tbrophy@arts.ufl.edu. Questions or concerns about your rights as a research participant may be directed to the UFIRB office, University of Florida, box 112250, Gainesville, FL 32611; ph. (352) 392-0433.

Your test results will be anonymously reported in my dissertation for partial fulfillment of the requirements for the degree for Doctor of Philosophy. Participating in the test implies your consent and that you have read the statement below:

I have read the procedure described above for the *Diagnostic Test of Cello Technique*. I voluntarily agree to participate in the test and I have received a copy of this description.

Printed Name _____

Signature _____

Date _____

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2006-U-0965
For Use Through 10/25/2007

APPENDIX E
THE WRITTEN TEST

The Diagnostic Test of Cello Technique

Written Test

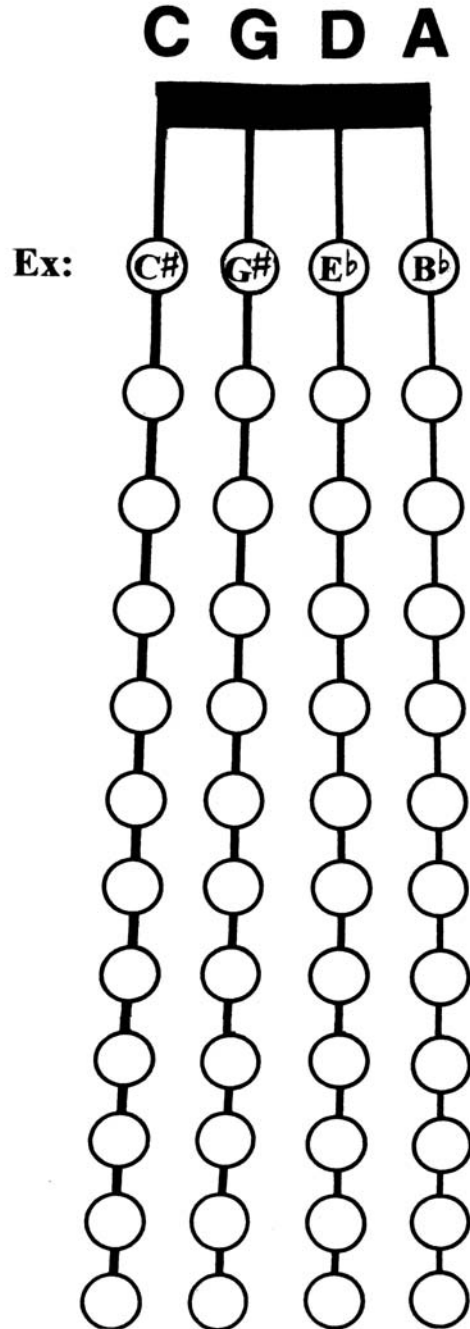
Timothy M. Mutschlecner

- **Fingerboard Geography**
- **Interval Identification**
- **Pitch Location and Fingering**
- **Single-Position Fingering**
- **Bass, Treble, and Tenor Clef Note Identification**

STUDENT'S NAME _____

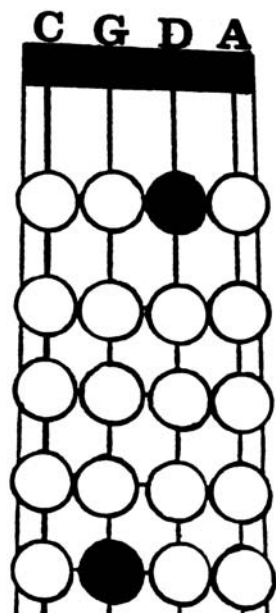
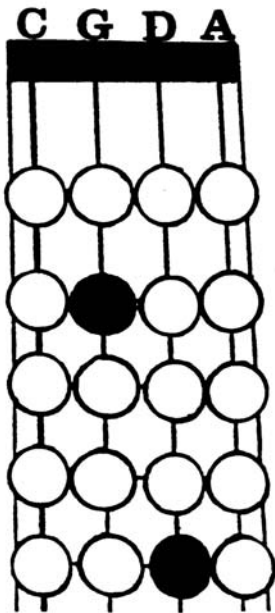
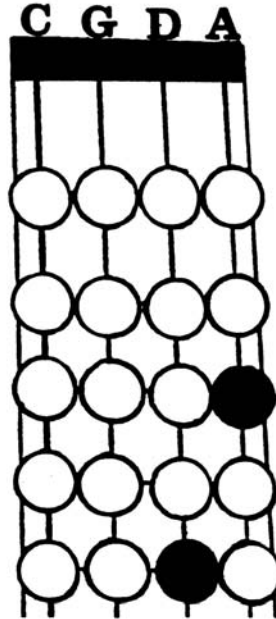
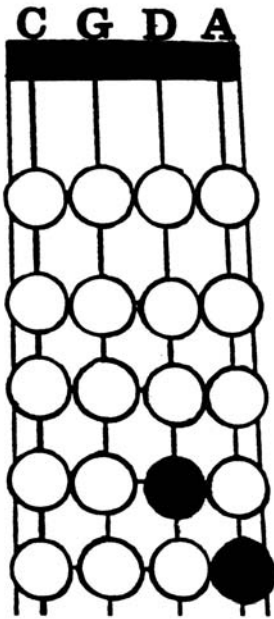
Fingerboard Geography

Fill out this representation of the cello fingerboard with the appropriate pitch name in each circle. Note: The interval between any adjacent circles on a string is a half step.

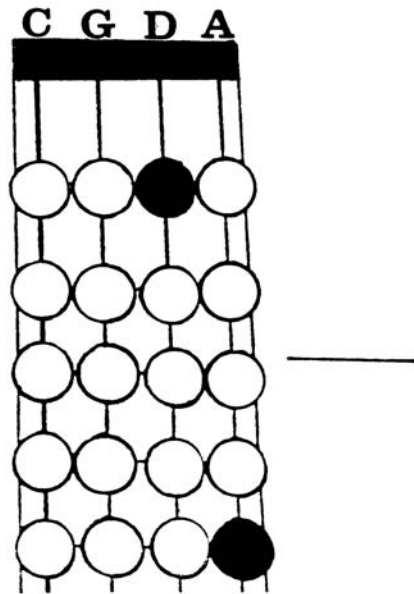
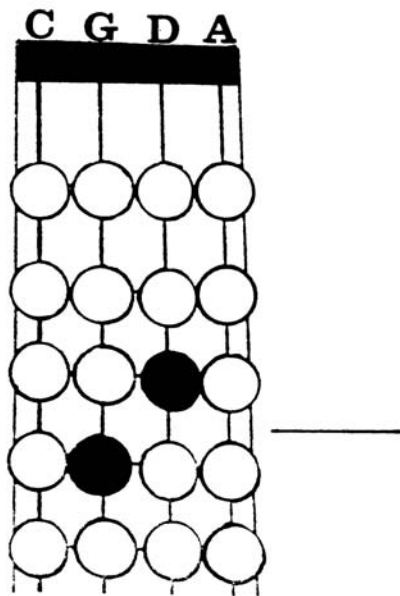
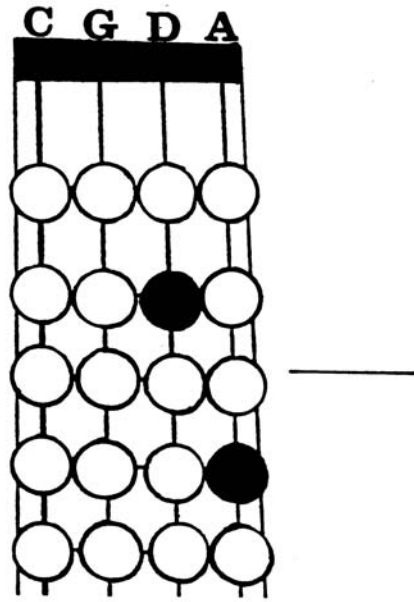
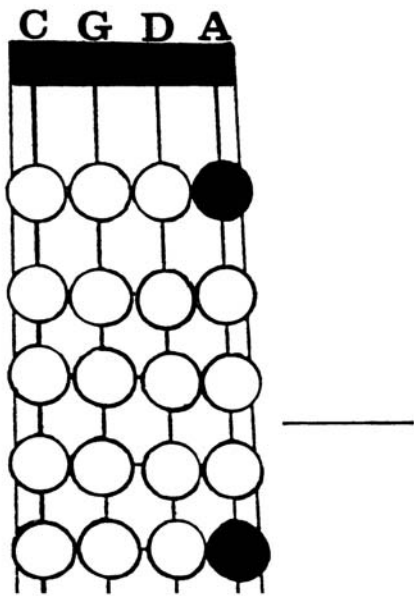


Interval Identification

Identify each interval using the following abbreviations: m 2nd, M 2nd, m 3rd, M 3rd, P 4th, Aug. 4th/Dim. 5th, P 5th, m 6th, M 6th, m 7th, M 7th, P 8.
(m=minor, M=Major, Aug.=Augmented, Dim.=Diminished, P=Perfect)

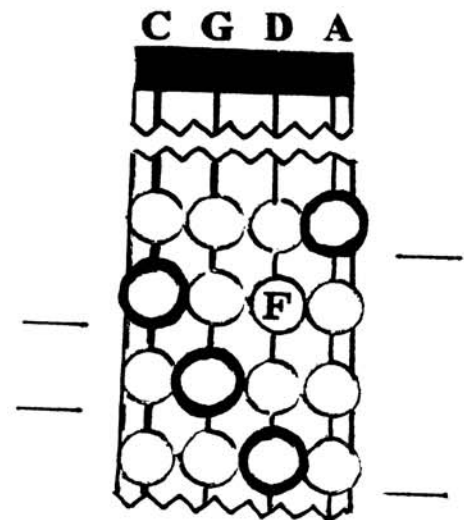
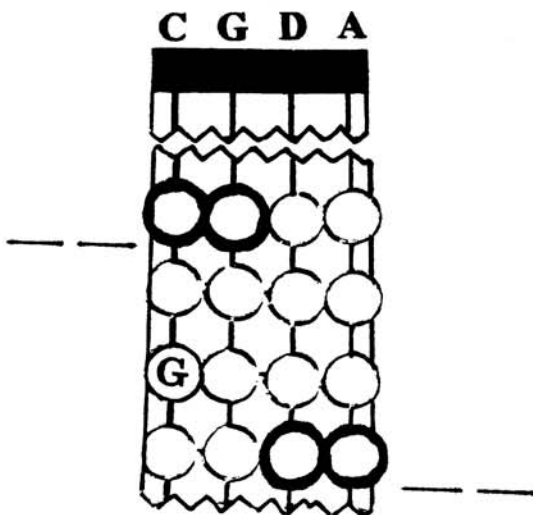
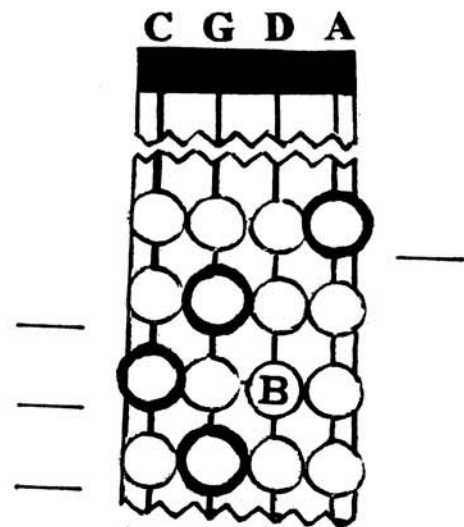
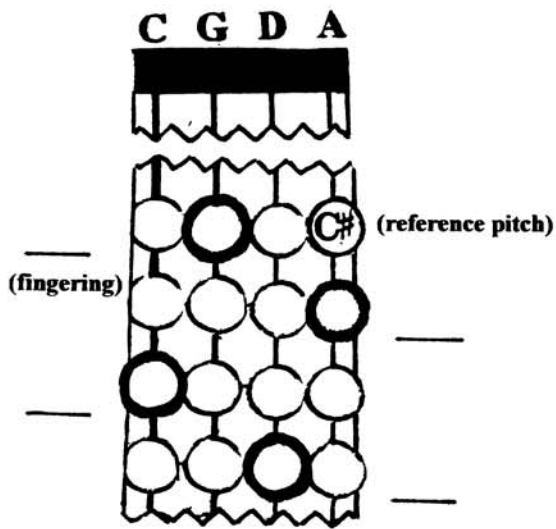


Interval Identification (continued)

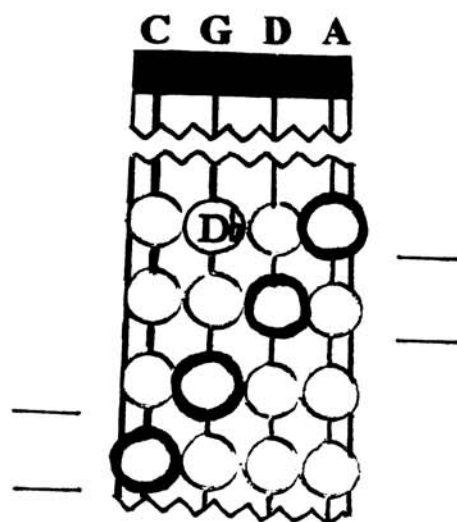
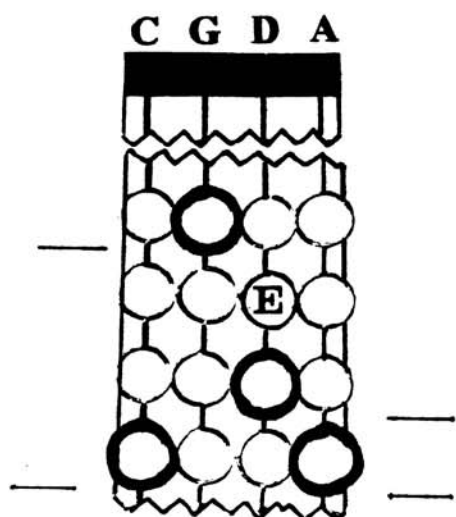
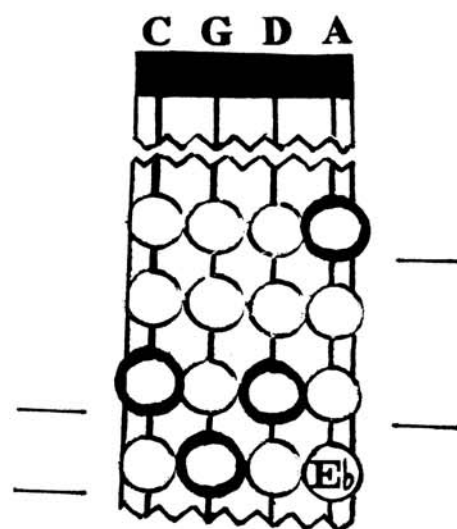
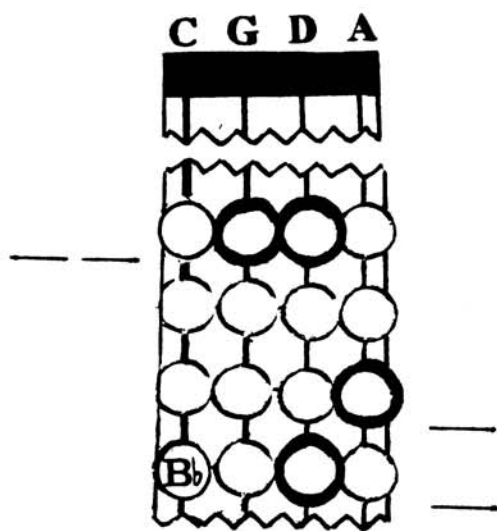


Pitch Location and Fingering

Write the note name in the outlined circles and provide a fingering that would allow the notes to be played in a single position. Use the reference pitch to determine location on the fingerboard. The interval between any adjacent circles on a string is a half step.



Pitch Location and Fingering (continued)



Single –Position Fingering

Indicate the fingering that would allow the four notes in each example to be played in a single position. Use no open strings and no extensions (stretches between 1 and 2).

#1

Handwritten fingering: b above the first note, e above the fourth note.

#2

Handwritten fingering: e above the first note, b above the second note.

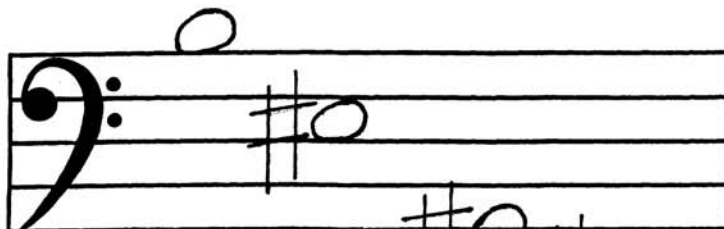
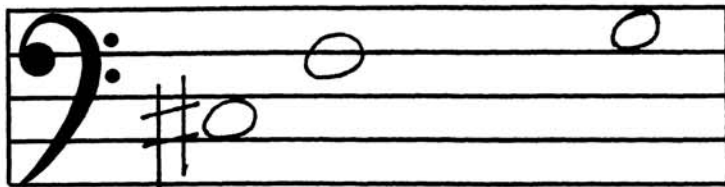
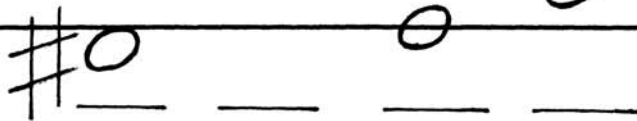
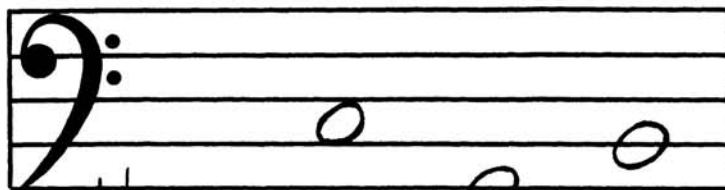
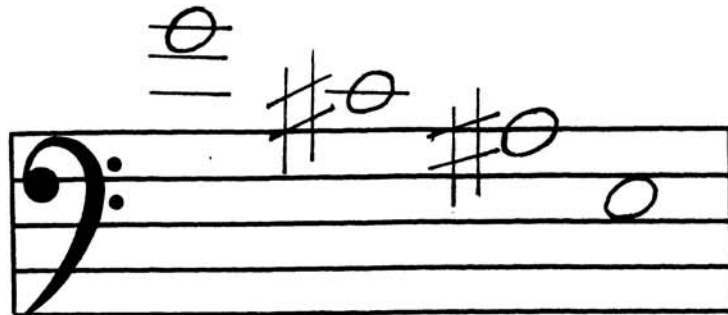
#3

Handwritten fingering: b above the second note, e above the third note.

#4

Handwritten fingering: b above the first note, e above the fourth note.

Single-Position Fingering (continued)



Bass, Treble and Tenor Clef Note Identification

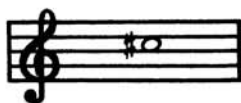
Write the correct pitch name under each note.

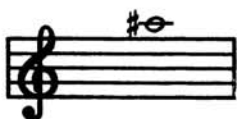




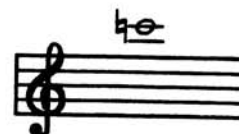


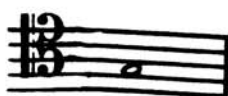


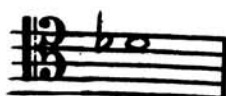
















APPENDIX F
THE WRITTEN TEST EVALUATION FORM

Student's Name _____ Adjudicator's Code _____

Grade Level _____

Degree Program _____

Audition Day _____ Audition Time _____

Test Section	Total Points	Student's Score
Fingerboard Geography	11 points (divide total by 4)	_____
Interval Identification	8 points	_____
Pitch Location and Fingering	32 points	_____
Single Position Fingering	32 points	_____
Bass, Treble, and Tenor Clef Note Identification	12 points	_____
Total Possible Score		Total Student's Score and %
95		_____

THE DIAGNOSTIC TEST OF CELLO TECHNIQUE

PLAYING TEST

Contents:

1. Left Hand Technique

- **Scales**
- **Arpeggios**
- **Broken Thirds**
- **Double Stops**
- **Position Changes**
- **Arpeggiated Chords Across Three or Four Strings**
- **Thumb Position**
- **Vibrato**
- **Intonation**

2. Basic Bowing Strokes

- **Slurred Legato**
- **Détaché/Accentuated Détaché**
- **Martelé**
- **Portato**
- **Staccato/Slurred Staccato**
- **Spiccato/Flying Spiccato**
- **Sautillé**
- **Pizzicato**

The Diagnostic Test of Cello Technique

For the Student:

The following is a series of excerpts primarily taken from the standard solo repertoire for cello. The selections are chosen as representative of certain technical skills or bowing styles. **Part one (Left Hand Technique) contains passages which demonstrate: Scales, Arpeggios, Broken Thirds, Double Stops, Position Changes, Arpeggiated Chords Across Three or Four Strings, Thumb Position, *Vibrato*, and Intonation.** **Part two (Basic Bowing Strokes) features passages which demonstrate essential bowing styles: Slurred *Legato*, *Détaché*/Accentuated *Détaché*, *Martelé*, *Portato*, *Staccato*/Slurred *Staccato*, *Spiccato*/Flying *Spiccato*, *Sautillé*, and *Pizzicato*.** Short definitions of terms and explanations of how to execute bowings are provided. **Metronome markings are given as examples of typical performance speeds. Make your goal to perform these excerpts at the tempos indicated, but not at the expense of pitch or rhythmic accuracy.**

This test is designed to help determine a player's level of competency in specific areas of technique. **It is not a measure of sight-reading ability; what the examiner wishes to see and hear is a demonstration of a particular skill, such as playing in thumb positions or legato bowing. Focus on demonstrating this aspect of the excerpt to the best of your ability. If what is being asked for is unclear to you, please ask the examiner for additional clarification.**

The Diagnostic Test of Cello Technique

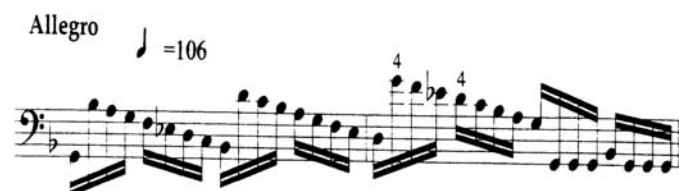
Section Two: Playing Examination

Part One: Left Hand Technique

Scales

[Excerpt from Concerto in G Minor for Two Cellos, RV 531, by A. Vivaldi, 1st movement]

Allegro ♩ = 106



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[Excerpt from *Danse Rustique*, Op. 20, No. 5 by W.H. Squire]

Allegro ♩ = 98



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Scales (continued)

[Excerpt from Sonata Op. 69, in A Major by L. van Beethoven, 1st movement]

Allegro, ma non tanto $\text{♩} = 65$



©G. Schirmer Inc.

[Excerpt from Concerto in Bb Major by L. Boccherini/Grutzmacher, 1st movement]

Allegro moderato $\text{♩} = 58$



©Alfred Publishing

[Excerpt from *Élégie*, Op. 24 by G. Fauré]

Molto Adagio $\text{♩} = 84$



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Arpeggios

[Excerpt from Etude, Op.120, No. 13, by F. Dotzauer]

Dotzauer, Op. 120, N^o 13

Allegro $\text{♩} = 112$

f

f

f

©Carl Fisher, LLC

[Excerpt from Sonata in G Major, by G.B. Sammartini, 1st movement]

Allegro non troppo $\text{♩} = 80$

f

p

f

©Alfred Publishing

[Excerpt from *Fantasy Pieces*, Op. 73 by R. Schumann, 1st movement]

Zart und mit Ausdruck $\text{♩} = 80$
©International Music Company

fp

p

cresc.

f

Broken Thirds

[Excerpt from The Ivan Galamian Scale System for Violoncello, arr. by Hans Jorgen Jensen]

B-Flat Major $\text{♩} = 60$

©ECS Publishing

[Excerpt from Concerto in D Major Op. 101, by J. Haydn, 1st movement]

Allegro moderato $\text{♩} = 106$

p *mf espress.*

Haydn/Gendron CONCERTO FOR VIOLONCELLO IN D MAJOR, OP. 101
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Used by permission of European American Music Distributors LLC
Sole U.S. and Canadian agent for Schott Music

Double Stops

[Excerpt from Sonata in G Major by G.B. Sammartini, 1st movement]

$\text{♩} = 76$

a tempo V

f

dim.

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[Excerpt from Suite No. 3: Allemande, by J.S. Bach] $\text{♩} = 106$

V

simile

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Double Stops (continued)

[Excerpt from Concerto in C Major, Hob. VIII. 1 by J. Haydn, 3rd movement]

Allegro molto ♩ = 152-162

The first excerpt consists of two staves of music in bass clef. The first staff begins with a piano (*p*) dynamic and features a sequence of double stops. The second staff continues the piece with a forte (*f*) dynamic. Fingerings are indicated above the notes, and a *V* (vibrato) marking is present above the final note of the second staff.

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[Excerpt from Concerto in B Minor, Op. 104 by A. Dvorak, 2nd movement]

freely: 90-102

Quasi Cadenza.

The second excerpt is a more complex piece in bass clef, marked *freely* and *Quasi Cadenza.* It features a variety of dynamics including piano (*p*), forte (*f*), *dim.* (diminuendo), *pp* (pianissimo), and *pizz.* (pizzicato). The score includes intricate double stop passages with many fingerings indicated above the notes. A *V* marking is also present. The piece concludes with a *pp* dynamic and a final double stop.

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Position Changes

[Excerpt from Concerto in G Major, Op. 65, No. 4 by G. Golterman, 3rd movement]

$\text{♩} = 152$

96

f

103

110

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[Excerpt from *The Swan*, by C. Saint-Saëns]

Adagio $\text{♩} = 64$

p

11^a

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Position Changes (continued)

[Excerpt from Sonata No. 1 in E Minor, Op. 38 by J. Brahms, 1st movement]

$\text{♩} = 56$ Allegro non troppo

p dolce *cresc.* *f*

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[Excerpt from *An Organized Method of String Playing*, by Janos Starker, p. 33]

Played all on the D string except the last 3 measures.

$\text{♩} = 120$

D string

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Arpeggiated Chords Across Three or Four Strings

[Excerpt from Concerto in G Major, Op. 65, No. 4 by G. Goltermann, 3rd movement]

$\text{♩} = 160$ Piu animato



The main musical score consists of three staves of music in bass clef with a key signature of one sharp (F#). The first staff contains five measures of arpeggiated chords with fingerings 1 3 2, 1 2 2, 1 4 3, 1 1 3, and 1 4 3. The second staff contains six measures with fingerings 0 3 4, 1, 1, and a *cresc.* marking. The third staff contains two measures with a *f* marking.

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[Excerpt from *Sheherazade*, Op. 35 by N. Rimsky-Korsakov, 1st movement]

$\text{♩} = 52$

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The main musical score consists of three staves of music in bass clef with a key signature of three sharps (F#, C#, G#) and a 6/4 time signature. The first staff is marked *Tutti* and *f*, with a *arco* marking. It contains six measures of arpeggiated chords with fingerings 1, 2, and 2. The second and third staves continue the arpeggiated chord pattern across six measures each.

Arpeggiated Chords (continued)

[Excerpt from Concerto in Bb Major by L Boccherini/Grutzmacher, 1st movement]

Allegro moderato ♩ =90

The first excerpt consists of three staves of music in bass clef, 3/4 time. The first staff begins with a *poco* dynamic and a *mp* dynamic, featuring arpeggiated chords with fingerings 4, 1, 4, 0, 1, 2, 1, 4, 0, 4, 3, 3. The second staff starts with a *p* dynamic, followed by a *cresc.* section, and ends with an *accel.* section. The third staff begins with a *rit.* section. A fourth staff shows a chord with fingerings 4, 3, 2, 1 and a *f* dynamic.

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[Excerpt from Concerto in E Minor, Op. 85 by E. Elgar, 4th movement] ♩ =112-120

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Allegro *animato*

The second excerpt consists of three staves of music in bass clef, 2/4 time. The first staff begins with a *f* dynamic and a *sf* dynamic, featuring arpeggiated chords with fingerings 1, 3, 2, 2, 1, 3, 1, 4, 3, 1, 4, 3. The second staff starts with a *sf* dynamic and a *f* dynamic, featuring arpeggiated chords with fingerings 1, 2, 1, 1, 2, 1, 3, 2, 1, 3, 2. The third staff begins with a *sf* dynamic and a *f* dynamic, featuring arpeggiated chords with fingerings 1, 4, 3, 1, 1, 3, 2, 1, 3, 2. The piece concludes with a chord marked *Orch.*

Thumb Position

[Excerpt from Concerto No. 2 in D Major by J. B. Breval, Rondo]

Allegretto ♩ = 116

p *leggiero*

f

p

ff

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[Excerpt from Concerto in Bb Major, by L. Boccherini/Grutzmacher, 1st movement]

Allegro moderato ♩ = 62

p *molto cresc.*

f *pp*

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Thumb Position (continued)

[Excerpt from Sonata in A Major, Op. 69 by L. van Beethoven, 3rd movement]

Allegro vivace $\text{♩} = 80$

The first excerpt consists of three staves of music in A major. The top staff begins with a treble clef, a key signature of one sharp (F#), and a 3/4 time signature. It features a tempo marking of 'Allegro vivace' and a quarter note equal to 80 beats. The music starts with a piano (*p*) dynamic and includes a slur over a series of eighth notes. The middle staff continues the melody with a piano (*pp*) dynamic and a crescendo (*cresc.*) marking. The bottom staff features a bass clef and includes a fortissimo (*ff*) dynamic marking and fingerings (II, I, III) for the thumb position.

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[Excerpt from Scherzo, Op. 12 by D. van Goens]

Vivace molto e con spirito $\text{♩} = 140-160$

The second excerpt consists of three staves of music in A major. The top staff is in treble clef with a 3/4 time signature and a tempo marking of 'Vivace molto e con spirito' and a quarter note equal to 140-160 beats. The music is characterized by rapid sixteenth-note passages and includes articulation marks (accents) and fingerings (1, 2). The middle staff continues the texture with a crescendo (*cresc.*) marking. The bottom staff is in bass clef and features a bass line with fingerings (0, 2).

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Vibrato

[Excerpt from *Chanson Triste*, Op. 40, No. 2, by P. I. Tchaikovsky]

Allegro non troppo ♩ = 86

p con molto espressivo

p *mf*

p

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[Excerpt from Sonata in G Minor by H. Eccles, 1st movement]

Largo ♩ = 66

mf *cresc.* *f*

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Vibrato (continued)

[Excerpt from *Élégie*, Op. 24 by G. Fauré]

Molto Adagio ♩ = 70-74

f *sempre f*

pp

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[Excerpt from *Concerto in B Minor*, Op. 104 by A. Dvorak, 1st movement]

a tempo ♩ = 100

p dolce e molto sostenuto

f animato

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Intonation

[Excerpt from *Arioso* (from Cantata 156), by J.S. Bach]

$\text{♩} = 58$

Adagio

mf *cresc.* *f*

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[Excerpt from *Élégie*, Op. 24 by G. Fauré]

a tempo $\text{♩} = 70-74$

espressivo *poco a poco cresc.* *f*

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Intonation (continued)

[Excerpt from Suite No. 5 in C Minor, BWV 1011 by J.S. Bach, Sarabande]

SARABANDE $\text{♩} = 48$

6

11

16

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[Excerpt from Sonata in D Minor, Op. 40 by D. Shostakovich, 1st movement]

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Allegro ma non troppo $\text{♩} = 138$

68

78

88

97

Piano

mf molto espr.

cresc.

dim.

p

cresc.

accel.

rit.

a tempo

f cresc.

molto rit.

ff

Part 2: Basic Bowing Strokes

Slurred Legato

Execution: Smoothly connected; Groups of notes phrased as smoothly as possible.

[Excerpt from Suite No. 1: Allemande, by J. S. Bach]

ALLEMANDE $\text{♩} = 54$

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The image shows a musical score for the Allemande from Suite No. 1 by J.S. Bach. It consists of three staves of music in bass clef with a key signature of one sharp (F#). The tempo is marked as quarter note = 54. The first staff contains the first two measures, the second staff contains the next two measures, and the third staff contains the final two measures. The music features continuous slurred eighth-note patterns, demonstrating the slurred legato bowing stroke. Fingering numbers (1, 2, 3, 4) are indicated below the notes. A copyright notice for Bärenreiter Music Corporation is located below the second staff.

[Excerpt from Sonata in A Major, by C. Franck, 1st movement]

Allegretto ben moderato $\text{♩} = 60$

PIANO *molto dolce*

CÉSAR FRANCK
(1822-1890)

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The image shows a musical score for the first movement of the Sonata in A Major by C. Franck. It consists of three staves of music in bass clef with a key signature of three sharps (F#, C#, G#). The tempo is marked as quarter note = 60. The first staff contains the first two measures, the second staff contains the next two measures, and the third staff contains the final two measures. The music features continuous slurred eighth-note patterns, demonstrating the slurred legato bowing stroke. Fingering numbers (1, 2, 3, 4) are indicated below the notes. The dynamic marking is piano, and the performance instruction is molto dolce. A copyright notice for International Music Company is located below the third staff.

Slurred Legato (continued)

[Excerpt from Concerto in D Minor, by E. Lalo, 2nd movement]

Andante con moto $\text{♩} = 40-44$
(même mouvement pour la ♩ .)


f *lunga* *p* *pp* *p*

Allegro presto

Détaché

Execution: An active, yet smooth bow stroke with no visible or audible accent.

[Excerpt from Sonata in E Minor, Op. 1, No. 2, by B. Marcello, 2nd movement]

♩ = 90
Allegro \checkmark
2

f



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Accentuated Détaché

Execution: Bow changes are not concealed, but emphasized with accents. One hears the articulation of the bow changes.

[Excerpt from Sonata in C Major, Op. 102, No. 1 by L. van Beethoven, 4th movement]

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Allegro vivace

♩ = 110



Martele' (Marcato)

Execution: A fast well-articulated, heavy, separate stroke resembling a sforzando, or pressed accent. The weight is pressed into the string like in the staccato, but is heavier and more accented. The notes are separated with a momentary stop after each note.

[Excerpt from Sonata in E Minor, No. 5, by A. Vivaldi, 2nd movement]

$\text{♩} = 102$
Allegro **détache'** **martele'**

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[Excerpt from *Tocatta* by G. Frescobaldi, arr. by Cassado]

$\text{♩} = 102-108$
70 **Allegro giusto.**
energico
f sempre
75
f sempre
molto rit.

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Portato (Loure')

Execution: The Portato is a series of broad strokes played in one bow with a smooth slightly separated sound between each note. The bow does not stop as in the slurred staccato. Each note is to be clearly enunciated with a slight pressure or "nudge" from the index finger and upper forearm.

[Excerpt from Sonata in D Minor, by C. Debussy, *Prologue*]

The image shows two staves of musical notation. The top staff is in treble clef, 2/4 time, with a tempo marking of quarter note = 52. It features a series of eighth notes with slurs and accents. Fingerings are indicated by numbers 1-4. Dynamics range from *p* to *mf* to *dim.*. A box labeled '1' is around the first measure, and 'au Mouyt' is written above it. The bottom staff is in treble clef, 2/4 time, with a tempo marking of quarter note = 52. It features a series of eighth notes with slurs and accents. Fingerings are indicated by numbers 1-4. Dynamics range from *p* to *mf*.

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[Excerpt from Sonata in E Minor, Op. 38, No. 1, by J. Brahms, 1st movement]

The image shows two staves of musical notation. The top staff is in bass clef, 2/4 time, with a tempo marking of quarter note = 56. It features a series of eighth notes with slurs and accents. Dynamics range from *p* to *mf*. The bottom staff is in bass clef, 2/4 time, with a tempo marking of quarter note = 56. It features a series of eighth notes with slurs and accents. Dynamics range from *p* to *mf*. The tempo marking is **Allegro non troppo** and *espress. legato*.

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Staccato

Execution: The staccato is a short, stiff on-the string stroke. Press the bow into the string and keep the weight in the string while drawing the bow. Stop after each note, releasing the pressure; repeat for each note.

[Excerpt from Sonata in G Minor, No. 3 by J.S. Bach, 3rd movement]

Allegro $\text{♩} = 66$

The first excerpt consists of two staves of music in G minor (one sharp, F#). The top staff is in 4/8 time and features a series of staccato eighth notes, with a dynamic marking of *f* (forte) and a bowing instruction of *v* (downbow). The bottom staff continues the melodic line with similar staccato eighth notes and some slurs.

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[Excerpt from Sonata in G Minor, by H. Eccles, 2nd movement]

Corrente $\text{♩} = 110$
Allegro con spirito

The second excerpt consists of two staves of music in G minor (one sharp, F#). The top staff is in 3/4 time and features a series of staccato eighth notes, with a dynamic marking of *f* (forte) and a bowing instruction of *v* (downbow). The bottom staff continues the melodic line with similar staccato eighth notes and some slurs. The notation includes various articulation marks such as accents and slurs.

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Slurred Staccato

Execution: Two or more staccato notes to a bow. Press into the string, release the pressure after drawing the bow and quickly draw the next note. The bow stops after each stroke.

[Excerpt from Sonata in E Minor by B. Marcello, 4th movement]

Allegretto ♩ = 126

p

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[Excerpt from Sonata in E Minor, Op. 38, No. 1 by J. Brahms, 2nd movement]

Allegretto quasi Minuetto ♩ = 134

Piano



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Flying Spiccato (sometimes called Flying Staccato)

Execution: A rapid series of notes played up-bow with a bounced bow stroke. Start from on the string and allow the bow to spring slightly from the string.

[Excerpt from *Gavotte* in D Major by D. Popper]

Lively (♩ = 84)

p

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[Excerpt from *Allegro Appassionato*, Op. 43 by C. Saint-Saëns]

Allegro ♩ = 120

f dim.

82 *p* *sempre p*

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[Excerpt from Sonata in D Major by P. Locatelli, 1st movement]

Allegro ♩ = 116

mf

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Sautillé (Sometimes called bounced bow or uncontrolled spiccato)

Execution: The Sautillé is a stroke that uses a rapid natural rebounding of the bow centered around the balance point. It is played much like a rapid détaché but with primary movement from the wrist and hand, with pressure being applied with the first finger only, using a light bow hold. Allow the bow to bounce off the string of its own momentum.

[Excerpt from *Etude*, Op. 44, No. 5 by C. Schröder]

$\text{♩} = 120$ Allegro vivace.

p *mf* *p*

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[Excerpt from *Hungarian Rhapsody*, Op. 68 by D. Popper]

Presto $\text{♩} = 132$

p

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Sautillé (continued)

[Excerpt from *Scherzo*, Op. 12 by D. van Goens]

Vivace molto e con spirito ♩ = 140-160

f *p*

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[Excerpt from Concerto in E Minor, Op. 85, by E. Elgar, 2nd movement]

Allegro molto. ♩ = 160

32 *cont.*

33 *pizz.* *f*

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Pizzicato

Execution: Use of thumb for "strummed" chordal passages in the Elgar excerpt.

[Excerpt from Concerto in E Minor, Op. 85 by E. Elgar, 2nd movement]

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RECIT. *freely*: ♩ = 102-140

18 *Lento.* *pizz.* *p* *f* *ff* *sf* *Allegro molto.* *arco* *pp*

rit. *pizz.* *a tempo* *arco* *rit. len.* *pizz.* *p* *pp*

a tempo *arco* *rit. molto* *pizz.* *19* *a tempo* *accel.* *mf* *dim.* *ff*



Brahms SONATA FOR PIANO AND VIOLONCELLO. OP. 99, NO. 2
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[Excerpt from Sonata in F Major, Op. 99 by J. Brahms, 2nd movement]

Adagio affettuoso ♩ = 90-110

40 *pizz.* *f* *dim.*

44 *p*

Pizzicato (continued)

[Excerpt from Concerto in G Minor, Op. 49 by D. Kabalevsky, 1st movement]

Allegro (♩. = 100-104)

pizz.
p

3 4 2 1 3 1 2 2 2

II

264 1 1 2 3 2 2 3 1 1 3 1 4 1 2

II

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APPENDIX H
THE PLAYING TEST EVALUATION FORM

Student's Name _____ Adjudicator's Code _____
Grade Level _____
Degree Program _____
Audition Day _____ Audition Time _____

Part One: Left Hand Technique

Scales The student's playing of scales exhibits:

(Check All that Apply, worth 2 points each)

- 95 % accurate whole and half steps.
- evenly divided bow distribution.
- steady tempo.
- effortless position changes.
- smooth string crossings.

Observations/Comments: _____

Arpeggios The student's playing of arpeggios demonstrates:

(Check All that Apply, worth 2 points each)

- mostly accurate intonation.
- smooth connections of positions.
- little audible sliding between notes.
- clean string crossings.
- a steady and consistent tempo.

Observations/Comments: _____

Broken Thirds The student's playing of broken thirds:

(check One only)

- 10 demonstrates the highest level of competency.
- 8 shows a high degree of experience, with only minor performance flaws.
- 6 indicates a moderate degree of competence or experience.
- 4 is tentative and faltering with some pitch and/or intonation errors.
- 2 is undeveloped and results in many inaccurate pitches and out of tune notes.

Observations/Comments: _____

Double Stops The student's playing of double stops features:

(Check All that Apply, worth 2 points each)

- consistently good intonation with all intervals.
- a clear, unscratchy tone.
- the clean setting and releasing of fingers when playing double stops.
- even bow-weight distribution on two strings.
- the ability to vibrate on two strings simultaneously.

Observations/Comments: _____

Position Changes The student's technique of changing positions:

(check One only)

- 10 demonstrates well-prepared, smooth shifting between notes, without interruption of the melodic line, or creating a break between notes.
- 8 shows smooth shifting and uninterrupted melodic line, but includes excessive audible slides.
- 6 indicates experience with position changes, but includes some sudden jerky motions when shifting and several audible slides.
- 4 indicates some experience with shifting but position changes are often either, jerky, unprepared, or filled with audible slides.
- 2 exhibits un-prepared and inaccurate shifting. Sliding between notes is often heard and hand/arm motions are jerky.

Observations/Comments: _____

Arpeggiated Chords The student's playing of arpeggiated chords exhibits:

(Check All that Apply, worth 2 points each)

- coordinated action between the left hand and bow arm.
- even string crossings, with steady rhythm.
- an ease in preparing chordal fingering patterns.
- clear tone on all strings.
- graceful, fluid motion.

Observations/Comments: _____

Thumb Position The student's playing of thumb position reveals that

(Check All that Apply, worth 2 points each)

- the thumb rests on two strings and remains perpendicular to the strings.
- the fingers stay curved and don't collapse while playing.
- correct finger spacing is consistently used.
- there is an ease of changing from string to string.
- the arm and wrist support the thumb and fingers versus resting on the side of the cello.

Observations/Comments: _____

Vibrato The student's vibrato:

(check One only)

- 10 is full, rich, even, and continuous. It is used consistently throughout the fingerboard.
- 8 is full and rich, but occasionally interrupted due to fingering/position changes.
- 6 is mostly utilized, but is irregular in its width or speed and lacks continuity throughout the fingerboard. Excessive tension is apparent in the vibrato.
- 4 is demonstrated, but in a tense, irregular way. It is not used consistently by all fingers in all positions. Vibrato width/speed may be inappropriate.
- 2 is demonstrated marginally with a tense, uneven application. Vibrato is inconsistently used and lacks appropriate width/speed.

Observations/Comments: _____

Intonation The student's intonation:

(check One only)

- 10 is accurate throughout on all strings and in all positions.
- 8 is accurate, demonstrating minimal intonation difficulties, with occasional lack of pitch correction.
- 6 is mostly accurate, but includes out of tune notes resulting from half-step inaccuracies, inaccurate shifting or incorrect spacing of fingers.
- 4 exhibits a basic sense of intonation, yet has frequent errors of pitch accuracy and often doesn't find the pitch center.
- 2 is not accurate. Student plays out of tune the majority of the time.

Observations/Comments: _____

Part Two: Basic Bowing Strokes

Slurred Legato The student's legato bow stroke:

(check One only)

- 10 is smoothly connected with no perceptible interruption between notes.
- 8 is smooth, but has some breaks within phrases.
- 6 includes some disconnected notes and detached bowing.
- 4 shows breaks within phrases and is often not smoothly connected.
- 2 exhibits little skill of smooth bowing. Bowing has many interruptions between notes.

Observations/Comments: _____

Détaché/Accentuuated Détaché The student's détaché bow stroke is:

(check One only)

- 10 vigorous and active-played on the string. Accentuated Détaché features greater accented attacks.
- 8 vigorous and active, but occasionally lacking articulation or bow control.
- 6 moderately active, but lacking articulation or suffering from too much accentuation.
- 4 not making sufficient contact with the string, or else producing a scratchy sound.
- 2 undeveloped, and lacking the control to produce a consistent vigorous sound.

Observations/Comments: _____

Martelé The student's playing of martelé bowing features:

(Check All that Apply, worth 2 points each)

- a fast, sharply accentuated bow stroke.
- a heavy separate stroke resembling a sforzando.
- bow pressure being applied before the bow is set in motion.
- the bow being stopped after each note.
- great initial speed and pressure with a quick reduction of both.

Observations/Comments: _____

Portato The student's use of portato bowing demonstrates:

(Check All that Apply, worth 2 points each)

- a slightly separated legato bow stroke.
- the pressure of the index finger being applied to pulse each note within a slur.
- an enunciation of each note through a slight change of bow pressure/speed.
- the bow does not stop between notes.
- notes being articulated without lifting the bow from the string.

Observations/Comments: _____

Staccato/Slurred Staccato The student's playing of staccato:

(check One only)

- 10 is crisp and well-articulated, with the bow stopping after each note.
- 8 demonstrates a high level of mastery, with minor flaws in execution.
- 6 shows a moderate level of attainment.
- 4 reveals only a limited amount of bow control.
- 2 does not demonstrate the ability to execute these strokes.

Observations/Comments: _____

Spiccato/Flying Spiccato The student's playing of spiccato indicates:

(Check All that Apply, worth 2 points each)

- a bounced-bow stroke with good control of the bow's rebound off the string.
- good tone production through control of bow pressure and speed.
- the bow springs lightly from the string.
- notes are individually activated.
- even use of bow distribution (Flying Spiccato excerpts).

Observations/Comments: _____

Sautillé The student's use of sautillé bowing demonstrates:

(Check All that Apply, worth 2 points each)

- a rapid, natural rebounding of the bow.
- a primary movement initiated from the wrist and hand, using a light bow hold.
- the bow's contact with the string is centered around the balance point of the bow.
- the tempo is fast enough for the bow to continue to bounce of its own momentum.
- the resilience of the bow stick is used to allow the bow to spring off the string.

Observations/Comments: _____

Pizzicato The student's playing of pizzicato illustrates:

(Check All that Apply, worth 2 points each)

- confidently played arpeggiated chords, using the thumb.
- strong, vibrant tone (as demonstrated in the Brahms excerpt).
- clear ringing sound in the upper register (as in the Kabalevsky excerpt).
- an absence of snapping sounds caused by pulling the string at too steep an angle.
- an absence of buzzing or dull, thudding tones due to inadequate setting of the left-hand fingers.

Observations/Comments: _____

APPENDIX I
REPERTOIRE USED IN THE PLAYING TEST

Composer	Piece	Technique/Bow Stroke
Bach, J.S.	<i>Arioso</i> (from Cantata 156)	Intonation
	Sonata in G Minor, No. 3, 3 rd mvt.	Staccato
	Suite No. 1 in G Major, <i>Allemande</i>	Slurred Legato
	Suite No. 3 in C Major, <i>Allemande</i>	Double Stops
	Suite No. 5 in C Minor, <i>Sarabande</i>	Intonation
Boccherini, L./Grutzmacher	Concerto in Bb Major, 1 st mvt.	Scales
	Concerto in Bb Major, 1 st mvt.	Arpeggiated Chords
	Concerto in Bb Major, 1 st mvt.	Thumb Position
	Concerto in Bb Major, 3 rd mvt.	Spiccato
Beethoven, L. van	Sonata in G Minor, Op. 5, No. 2 3 rd mvt.	Spiccato
	Sonata Op. 69 in A Major, 1 st mvt.	Scales
	Sonata Op. 69 in A Major, 3 rd mvt.	Thumb Position
	Sonata in C Major, Op. 102, No. 1 3 rd mvt.	Accentuated Détaché
Brahms, J.	Sonata No. 1 in E Minor, Op. 38, 1 st mvt.	Position Changes
	Sonata No. 1 in E Minor, Op. 38, 1 st mvt.	Portato
	Sonata No. 1 in E Minor, Op. 38, 2 nd mvt.	Slurred Staccato
	Sonata No. 2 in F Major, Op. 99, 2 nd mvt.	Pizzicato
Breval, J. B.	Concerto No. 2 in D Major, <i>Rondo</i>	Thumb Position

Debussy, C.	Sonata in D Minor, <i>Prologue</i>	Portato
Dotzauer,	Etude Op. 20, No. 13	Arpeggios
Dvorak, A.	Concerto in B Minor, Op. 104, 1 st mvt.	Vibrato
	Concerto in B Minor, Op. 104, 2 nd mvt.	Double Stops
Eccles, H.	Sonata in G Minor, 1 st mvt.	Vibrato
	Sonata in G Minor, 2 nd mvt.	Staccato
Elgar, E.	Concerto in E Minor, Op. 85, 2 nd mvt.	Pizzicato
	Concerto in E Minor, Op. 85, 2 nd mvt.	Sautillé
	Concerto in E Minor, Op. 85, 4 th mvt.	Arpeggiated Chords
Fauré, G.	<i>Élégie</i> , Op. 24	Scales
	<i>Élégie</i> , Op. 24	Vibrato
	<i>Élégie</i> , Op. 24	Intonation
Franck, C.	Sonata in A Major, 1 st mvt.	Slurred Legato
Frescobaldi, G.	<i>Tocatta</i>	Martelé
Goens, D. van	<i>Scherzo</i> , Op. 12	Sautillé
	<i>Scherzo</i> , Op. 12	Thumb Position
Golterman, G.	Concerto in G Major, Op. 65, No. 4 3 rd mvt.	Position Changes
	Concerto in G Major, Op. 65, No. 4 3 rd mvt.	Arpeggiated Chords
Haydn, J.	Concerto in C Major, Hob. VIIb. 1 3 rd mvt.	Double Stops
	Concerto in D Major, Op. 101, 1 st mvt.	Broken Thirds
Jensen, H. J.	The Ivan Galamian Scale System for Violoncello	Broken Thirds

Kabalevsky, D. B.	Concerto in G Minor, Op. 49, 1 st mvt.	Pizzicato
Lalo, E.	Concerto in D Minor, 2 nd mvt.	Slurred Legato
Locatelli, P.	Sonata in D Major, 1 st mvt.	Flying Spiccato
Marcello, B.	Sonata in E Minor. Op. 1 No. 2, 2 nd mvt.	Détaché
	Sonata in E Minor. Op. 1 No. 2, 4th mvt.	Slurred Staccato
Popper, D.	<i>Gavotte</i> in D Major	Flying Spiccato
	<i>Hungarian Rhapsody</i> , Op. 68	Sautillé
Rimsky-Korsakov, N.	<i>Sheherazade</i> , Op. 35, 1 st mvt.	Arpeggiated Chords
Saint-Saëns, C.	<i>Allegro Appassionato</i> , Op. 43	Flying Spiccato
	<i>The Swan</i>	Position Changes
Sammartini, G. B.	Sonata in G Major, 1 st mvt.	Arpeggios
	Sonata in G Major, 1 st mvt.	Double Stops
Schröder, C.	<i>Etude</i> , Op. 44, No. 5	Sautillé
Shostakovich, D.	Sonata in D Minor, Op. 40, 1 st mvt.	Intonation
Squire, W.H.	<i>Danse Rustique</i> , Op, 20, No. 5	Scales
Starker, J.	<i>An Organized Method of String Playing</i> (p. 33)	Position Changes
Schumann, R.	<i>Fantasy Pieces</i> , Op. 73, 1 st mvt.	Arpeggios
Tchaikovsky, P. I.	<i>Chanson Triste</i> , Op. 40, No. 2.	Vibrato
Vivaldi, A.	Concerto in G Minor for 2 Cellos, RV 531, 1 st mvt.	Scales
	Sonata in E Minor, No. 5, 2 nd mvt.	Martelé

APPENDIX J
THE STUDENT SELF-ASSESSMENT PROFILE

Name _____

Status (year/college) _____ Major _____ Minor _____

Years of study on the Cello _____ Other instrument(s) played _____

Repertoire previously studied:

Methods/Etudes _____

Solo Literature _____

Orchestral Experience:

How interested are you in each of these areas of performance?

I am interested in solo performance.

Strongly agree Agree Disagree Strongly disagree

I am interested in chamber music performance.

Strongly agree Agree Disagree Strongly disagree

I am interested in orchestral performance.

Strongly agree Agree Disagree Strongly disagree

Other areas of performance interest? _____

What are your personal goals for studying the cello? _____

What areas of cello technique do you feel you need the most work on?

Summarize your goals in music and what you need to do to accomplish these goals.

6 months: _____

1 year: _____

2 years: _____

4 years: _____

10 years: _____

APPENDIX K
DESCRIPTIVE STATISTICS FOR RAW DATA

Table K-1. Raw Scores of the Written Test Items, and Composite Means and Standard Deviations

Student	Fingerboard Geography	Interval Id.	Pitch Location	Single-Pos. Fingering	Note Id.	Total Score
1	11	7	30	32	12	92
2	11	7	30	28	11	87
3	11	7	32	31	12	93
4	11	7	31	30	12	91
5	11	8	32	32	12	95
6	11	7	0	32	12	59
7	5	3	16	25	10	59
8	11	6	32	32	12	93
9	11	6	29	32	12	90
10	11	8	29	32	12	92
11	11	5	31	32	12	91
12	11	4	12	30	11	68
13	11	8	22	12	12	65
14	11	5	31	32	11	90
15	11	7	29	27	12	86
16	11	3	2	32	11	59
17	11	7	32	30	8	88
18	11	8	32	31	12	94
19	11	8	32	32	12	95
20	11	8	31	30	12	92
21	11	3	30	30	11	85
22	11	6	14	32	10	73
23	11	5	28	32	12	86
24	11	6	32	26	12	87
25	11	5	27	31	12	86
26	11	8	32	30	12	93
27	11	8	31	32	12	94
28	11	8	32	32	12	95
29	11	6	29	23	12	81
30	11	8	31	32	12	94
<i>M</i>	10.80	6.40	26.70	29.80	11.57	85.20
<i>SD</i>	1.10	1.63	8.82	4.11	0.90	11.38

Table K-2. Raw Score, Percent Score, Frequency Distribution, Z Score, and Percentile Rank of Written Test Scores

Raw Score	Percent Score	Frequency	Z Score	Percentile Rank
59	62.00	2	-2.30	1.67
62	66.00	1	-2.04	8.33
65	68.00	1	-1.78	11.67
68	72.00	1	-1.51	15.00
73	77.00	1	-1.07	18.33
81	86.00	1	-0.37	21.67
85	89.00	1	-0.02	25.00
86	91.00	3	.07	28.33
87	92.00	2	.16	38.33
88	92.00	1	.25	45.00
90	95.00	2	.42	48.33
91	96.00	2	.51	55.00
92	97.00	3	.60	61.67
93	98.00	3	.69	71.67
94	99.00	3	.77	81.67
95	100.00	3	.86	91.67

Table K-3. Raw Scores of the Playing Test Items, Composite Means, and Standard Deviations

Student	Scales	Arpeggios	Broken Thirds	Double Stops	Position Changes	Arpeggiated Chords
1	10	10	8	10	10	10
2	10	10	8	8	6	6
3	10	10	8	8	10	10
4	10	8	10	8	8	10
5	8	8	6	6	8	10
6	8	10	10	8	8	8
7	10	10	8	8	10	8
8	8	10	8	6	8	8
9	8	10	8	4	8	6
10	8	10	8	8	10	8
11	6	8	8	8	10	4
12	8	10	8	6	10	10
13	8	8	6	8	6	8
14	6	6	6	4	6	6
15	6	6	6	4	6	8
16	6	4	4	4	6	6
17	6	6	6	8	6	2
18	8	8	4	6	4	4
19	8	8	8	8	8	10
20	6	10	6	4	8	8
21	4	6	6	6	10	8
22	6	6	4	4	6	4
23	0	2	2	2	6	2
24	6	6	4	4	4	4
25	8	10	6	4	6	2
26	8	8	6	8	8	8
27	8	8	8	8	10	10
28	10	10	8	6	8	10
29	10	8	8	8	8	10
30	10	10	8	8	8	8
<i>M</i>	7.6	8.13	6.8	6.4	7.67	7.2
<i>SD</i>	2.19	2.10	1.86	1.99	1.83	2.66

(Table K-3 continues on next page)

Table K-3. (continued)

Student	Thumb Position	Vibrato	Intonation	Slurred Legato	Détaché	Martelé
1	8	10	8	8	8	8
2	6	8	8	8	8	10
3	10	10	6	10	10	10
4	10	8	8	10	8	4
5	10	10	8	10	8	10
6	8	8	6	10	8	8
7	6	10	6	10	10	10
8	4	8	6	10	8	6
9	8	4	6	4	10	6
10	6	10	8	10	10	10
11	6	8	6	8	10	8
12	6	10	8	8	8	8
13	8	10	6	8	10	2
14	6	4	4	8	8	4
15	6	8	4	6	6	8
16	4	6	2	8	8	2
17	6	4	4	8	8	2
18	4	6	8	8	8	4
19	6	8	8	8	10	8
20	10	8	6	9	10	10
21	2	8	6	6	2	2
22	8	6	6	4	8	6
23	6	8	4	8	8	4
24	8	10	4	8	10	4
25	6	4	4	4	8	4
26	8	8	6	10	6	6
27	8	10	8	8	10	10
28	10	8	8	10	10	8
29	10	8	6	10	10	8
30	6	10	8	10	8	10
<i>M</i>	7.0	7.93	6.2	8.23	8.47	6.67
<i>SD</i>	2.08	2.00	1.69	1.85	1.72	2.84

(Table K-3 continues on next page)

Table K-3. (concluded)

Student	Portato	Staccato	Spiccato	Sautillé	Pizzicato	Total Score
1	10	8	8	10	8	152
2	8	10	8	4	10	136
3	8	8	10	10	8	156
4	8	8	6	10	10	144
5	8	8	8	4	4	134
6	10	10	8	8	10	146
7	10	10	10	8	8	152
8	10	10	8	6	4	128
9	4	6	8	10	6	116
10	10	10	8	10	8	152
11	6	4	4	4	6	114
12	10	8	8	8	6	140
13	10	6	2	8	6	120
14	10	8	2	4	4	96
15	10	8	8	10	6	116
16	4	6	2	2	2	76
17	10	8	6	8	4	102
18	4	10	6	6	2	100
19	8	10	8	10	10	142
20	10	10	3	8	8	134
21	6	6	2	4	2	86
22	0	6	2	2	4	82
23	8	8	4	0	4	76
24	4	8	8	8	4	104
25	0	6	6	10	4	92
26	10	6	4	10	4	124
27	10	8	10	10	8	152
28	8	8	8	4	6	140
29	10	8	6	10	10	148
30	6	8	8	8	6	140
<i>M</i>	7.67	7.93	6.3	7.13	6.07	123.33
<i>SD</i>	2.97	1.62	2.61	3.00	2.55	25.18

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BIOGRAPHICAL SKETCH

Timothy Miles Mutschlecner was born on November 17, 1960 in Ann Arbor, Michigan. A middle child with an older brother and younger sister, he grew up mostly in Bloomington, Indiana, but finished high school in Los Alamos, New Mexico, graduating in 1979. He earned his Bachelors in Music from Indiana University in 1983 where he studied cello with Fritz Magg. In 1992 Tim graduated from the Cleveland Institute of Music with a Masters degree in Performance and Suzuki Pedagogy. He taught in the Preparatory Department at The Cleveland Institute of Music from 1992 to 1995 before accepting the position of director of the cello program at the Suzuki School of Music in Johnson City, Tennessee.

In Tennessee, Tim taught a large cello studio and played in two regional orchestras. He taught students as well through Milligan College and East Tennessee State University. Along with giving recitals and playing in the Meadowlark Trio, Tim was a featured soloist with the Johnson City Symphony.

In 2003, Tim began work on his Ph.D. in Music Education at the University of Florida in Gainesville. During the next four years he taught university cello students as a graduate assistant while completing his degree. Tim remained an active performer while studying at the University of Florida, serving as principal cellist in the Gainesville Chamber Orchestra from 2003 to 2007, and performing with the Music School's New Music Ensemble. He maintained a private studio with students of all ages and levels.

Upon the completion of his Ph.D. program, Tim will begin teaching at the University of Wisconsin-Stevens Point in the Aber Suzuki Center. This position will provide opportunities to work with beginning and intermediate level cello students, as well to offer cello pedagogy for university-level students. He anticipates continuing to do research in the field of string music

education, particularly in the areas of string pedagogy and assessment. Tim has been married to Sarah Caton Mutschlecner, a nurse practitioner, for 18 years. They have three daughters: Audrey, age 16; Megan, age 14; and Eleanor, age 10.