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A quantitative study of the relationship between academic achievement and the developmental study of vocal and instrumental music

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A QUANTITATIVE STUDY OF THE RELATIONSHIP BETWEEN ACADEMIC ACHIEVEMENT AND THE DEVELOPMENTAL STUDY OF VOCAL AND INSTRUMENTAL MUSIC

by
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Abstract

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A Quantitative Study of the Relationship Between Academic Achievement and the Developmental Study of Vocal Instrumental Music
1999
Dr. Theodore Johnson
School Administration

The purpose of this study was to determine whether a quantitative relationship existed between academic achievement as measured by California Achievement Test scores and the involvement of high school students in the developmental study of vocal and instrumental music.

The California Achievement Test Level 20 (CAT-5) scores of a cohort of 170 students were evaluated from grades nine and ten. Students were grouped according to whether they were involved in developmental vocal music, instrumental music, vocal and instrumental music programs, or no music study.

Reading, Language, and Mathematics scores for students in music programs were compared to non-music students using the *t* - Test analysis to assess statistically significant differences. The $p < 0.05$ level was chosen as the standard for statistical significance.

Results indicated that students involved in developmental music study had marginally higher scores in grade nine and substantially higher scores in grade ten and that instrumental music study had the most profound positive influence upon these scores.

Mini Abstract

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Dr. Theodore Johnson
School Administration

This study explored the relationship between academic achievement and the developmental study of vocal and instrumental music. Results indicated that students involved in developmental music study had marginally higher scores in grade nine and substantially higher scores in grade ten. Instrumental music study had the most influence upon test scores.

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A Quantitative Study of the Relationship Between Academic Achievement and the Developmental Study of Music

Chapter 1

Introduction

In American public schools, music is considered to be an "activity" on the periphery of the curriculum. Music takes a back seat to the "serious" subjects required to educate our youth. The available literature demonstrates that, far from being a peripheral activity offered to a few "talented" students with the inclination, interest and cultural exposure, music should be considered as fundamental to the curriculum as reading and mathematics. The literature also reveals that nations whose students consistently out-perform American students in tests assessing science and mathematics achievement are countries where music is not a subsidiary focus of the curriculum. Further, the study of music in a developmental skill-building program is a cost effective way to enhance academic achievement when compared to the costs of remedial programs and expensive technologies.

Focus of the Study

A body of data exists which suggests that the systematic and developmental study of music enhances cognitive development (Rauscher & Shaw, 1994, 1997), (Dickinson, 1993), (ETS, 1995), (Venerable, 1989).

However, in American public schools, music is assigned a subsidiary status in the curriculum to academic subjects and is most often offered as an elective. Developmental music studies are offered primarily to students with the cultural exposure necessary to promote the interest to pursue these studies. Thus the developmental study of music and its cognitive benefits is limited, by default, to a self-selected elite (Eisner, 1985).

In the interest of fiscal responsibility and faced with low academic performance when compared to students of other nations, the music program is often looked upon as a budgetary luxury which must defer to a misplaced emphasis on essential skills (Eisner, 1985). Further, an emphasis on technology in the classroom has diverted funds which, if applied to the developmental study of music, would provide a far more culturally enriching and more cost-effective vehicle for the enhancement of cognitive development and academic achievement (Shaw, 1997).

Local boards of education and state education authorities are committed to the standardization of curricula and the measurement of academic achievement through standardized test scores. The New Jersey Association for Supervision and Curriculum Development (NJASCD) is devoting its 1998 Annual State Conference to the alignment of curricula to state standards and assessment instruments (NJASCD, 1998). The obsession with standardized assessment can is captured in the Safe Havens comic piece:

"According to this, corporations want future employees
who can 'think outside the box.' "

"Creatively, in other words?"

" Yeah, but to do that they need to gauge how well we're
maintaining our individuality."

"How?

"They want us to take a standardized test." (Holbrook, 1998)

Accreditation and funding are often linked to the achievement of specific standardized test benchmarks. Therefore, it is necessary to demonstrate to education authorities that investment in music programs provides cognitive benefits beyond what Americans have traditionally attributed to the developmental study of music.

This study seeks to demonstrate a quantitative relationship between the developmental study of music and academic achievement by comparing California Achievement Test (CAT) scores of students involved in the developmental study of music to test scores of other students who do not study music.

Definitions

The developmental study of music will be defined for the purposes of this study, as the sequential study of vocal or instrumental music with the intent to progress through the sequential development of increasingly sophisticated musical skills and repertoire for the purpose of solo and/or ensemble performance.

Statistical Significance will be defined for the purposes of this study, as a probability of less than 5.0% as a result of the application of the T-test of statistical significance to mean values of test populations.

t- test, (t-Distribution) : The *t* - distribution is parametric analysis used to test the effect of an independent variable on a hypothesized parametric assumption between two populations.

Each *t* - distribution is determined by a degrees-of-freedom (df) value. Like a normal distribution, the *t* - distributions are symmetrical becoming more like a normal distribution as degrees of freedom increase (Wiersma, 1995).

In this study the mean % increase in California Achievement Test scores will be compared between two populations. The independent variable will be the developmental study of music.

The researcher chooses, for philosophical reasons, not to control for IQ. One may reasonably conclude that a statistically significant difference between music and non-music populations may be due simply to academic aptitude based on an assumption that the music groups is more academically as well as more musically gifted than the non-music group. The argument could be made that smart students make music. The researcher is attempting to test the opposite hypothesis, that is, music makes smart students.

Intelligence quotient testing, rather than testing aptitude, tests for cultural exposure. Further, IQ testing fails to consider the broader spectrum of intelligences (multiple intelligences) which cannot be adequately measured through the traditional IQ assessments.

Statistical Definitions:

Probability (p) :

derived from a standard t - table based on a calculated t value and degrees of freedom based on the number of data points.

Degrees of Freedom : data points (n) - 1

t : $[\text{Mean}_1 - \text{Mean}_2] /$ Standard Error of the Difference

Standard Error of the Difference (S_D):

$[(\text{Standard Error of the Mean}_1)^2 + (\text{Standard Error of the Mean}_2)^2]^{0.5}$

Standard Deviation: $(\text{Variance})^{.5}$

Variance : Sum of $(x\text{-mean})^2 / (n-1)$

Mean : Sum of n / n

Mean : Sum of test scores/total number of data points

n : a data point

Limitations of the Study

The study will be limited to students of Rancocas Valley Regional High School for whom CAT scores are available for two consecutive years. Subjects will be students who took the CAT test in grades nine and ten in the years 1995 and 1996. The study will seek to compare the changes in raw scores and national percentiles between 1995 and 1996.

A statistically significant difference in the scores between musicians and non-musicians within a given cohort could be ascribe to a number of uncontrolled variables. These could include intelligence quotient, cultural exposure, and socio-economic factors.

However, a statistically significant difference in year-to-year changes in scores between students involved in music programs compared to students who do not study music would be indicate whether music was a factor in enhancing students' mastery of the objectives of the test instrument independent of IQ or socio-economic comparisons.

It would be reasonable to generalize results to comparable public high school populations taking this nationally normed assessment.

Setting of the Study

Background of the District:

The subjects of this study are students of Rancocas Valley Regional High School located in Mount Holly, New Jersey. The Rancocas Valley Regional High School serves Burlington County New Jersey communities in the Townships of Easthampton, Hainesport, Lumberton, Mount Holly, and Westhampton and is located approximately 20 miles to the northeast of Philadelphia, PA and 20 miles to the south of Trenton, NJ.

In 1934, the townships which sent pupils to the Mount Holly High School held meetings to consider the creation of a regional district for the purpose of erecting a new high school building under a new state law which provided the creation of regional districts.

Ethno-cultural Environment:

The RVRHS students come primarily from residential neighborhoods of established and recent developments. Within an income classification scheme of low, middle and high as defined by the US Census, the majority of families served by the district are low-middle. There is a slightly higher percentage in the low income group than in the high income group. The school district has minority (non-Caucasian) population of 23%, a figure which has remained fairly static over since 1979.

Institutional Climate and Culture:

The Rancocas Valley Regional High School is characterized by a transformational leadership style which has evolved during the tenure of Superintendent Dr. Henry Cram. Faculty members are directly involved most aspects of decision making through active participation in a number of school-wide committees. These include the Climate Committee, Curriculum Committee, Student Activities Committee, and the Staff Development Committee (QAAR, 1998).

Under this transitional leadership model, Rancocas Valley Regional High School has adopted a number of research based policies. RVRHS operates a block schedule wherein students select and focus upon four or five classes per semester. Class meet for seventy-four minutes blocks replacing the forty-four minute periods used before September, 1996.

The process through which the block schedule was adopted reflect the style of leadership. Rather than impose the block schedule and scramble to equip teachers with strategies for coping with longer periods, staff in-service focussed, for a number of years, upon providing teachers with workshops for increasing their repertoire of instructional strategies and modalities including the use of cooperative learning structures and addressing a variety of cognitive styles.

Although fully subscribing to the ideas to which they were exposed, the question would often arise, "This is all very good, but how do I do it all in forty-four minutes?" The block schedule was then implemented as a solution to a well-defined problem.

Other Unique Characteristics

As a by-product of block scheduling and the *Courtesy is Contagious* campaign, state monitors commented upon the unusual degree of courtesy and decorum in the halls between classes and a high level or pupil to teacher rapport within classes.

Apparently, within the block schedule, teachers, with more time to interact with students in class, get to know them better and earlier in the year. Pupils have more time to work collaboratively in classes and, thus, also get the opportunity to know one another better and earlier.

Another policy based upon recent brain research allows RVRHS students to, with the consent of the teacher, take drinks and snacks throughout the building and into classes. Monitors, aware of this policy, saw themselves wading through wrapper strewn hallways. They commented, however, that the RVRHS hallways and classrooms were far more trash free than in most schools where snacks are prohibited (Monitoring, 1998).

Another policy based upon brain research capitalizes upon the *Mozart Effect* (Rauscher/Shaw, 1997) whereby classical music is played continually in the hallways and public spaces throughout the day. This policy has been implemented by Mr. Joel Popler and cited in articles in the Philadelphia Inquirer and the Courier Post.

In summary

Rancocas Valley Regional High School serves a diverse population through creative and innovative policies which set high expectations which are supported by insightful, research-based transformational administrative stewardship.

Significance of the Study

Music is recognized as a key element in promoting cognitive development in countries who consistently out-perform the United States in international assessments of academic achievement in mathematics and science (A Nation at Risk, 1983), (Eisner, 1985).

Many of our current notions about the way the mind acquires and processes information are being challenged by current brain research which suggests that music may be a key element in providing for the kind of hemispheric integration that is needed for kind creative problem solving needed by engineers, physicians, mathematicians and research scientists (Rauscher/Shaw, 1997). Many of the learning disabilities that can be attributed to poor hemispheric integration may be better treated by the developmental study of music rather than our current remedial education practices which continue to place an emphasis upon basic skills drill and practice (Fischer, 1994).

The notion that "music makes you smarter" is moving from the realm of ancient wisdom to quantifiable theory. Quantitative studies are needed to either support or refute this notion using data that is meaningful to education policy makers. This study seeks to contribute to that body of quantitative information.

Organization of the Study

The Following chapter will review research that focuses upon the influence of music on the learning process in non-music disciplines. A growing body of data is re-affirming long held notions about music and cognition through the recent availability of PET scan, CAT scan, and MRI technology while causing us the re-evaluate other long-held beliefs about the nature of musical aptitude and "talent." This research has profound implications with regard to the curriculum priorities we have set for this country and portents a rich intellectual and cultural catalyst if taken seriously.

Chapter Three will delineate the details of the research design, data gathering methodology and data analysis protocols to be used in conducting this quantitative study. Statistical and non-statistical terminology to be used in the research design will be further defined.

Chapter Four will present the data and its analysis. Probability statements and conclusions will be presented here. Examples of these statements may included: *t-distribution - Probability Statement;* The probability that the mean values being compared being due to random chance alone is (greater/less) than .05. *t-distribution - Conclusion;* The influence of the study of music on the increase or decrease of CAT scores from grade nine to grade ten (is/is not) statistically significant.

Chapter Five will present an interpretation of the data and delineate its implications for the support or refutation of the hypothesis, explore reasons why the hypothesis was or was not supported, and make recommendations for further study and experimental design.

Chapter 2

A Review of the Literature

Introduction

In American public schools, music is considered to be an "activity" on the periphery of the curriculum taking a back seat to the serious subjects required to educate our youth. The available literature demonstrates that, far from being a peripheral activity offered to a few "talented" students with the inclination, interest, and exposure, music should be considered as fundamental to the curriculum as reading and mathematics. The literature also reveals that nations whose students consistently out-perform Americans in tests assessing science and mathematics achievement are the countries where music is not a subsidiary focus of the curriculum. Further, the study of music in a developmental skill-building program is a cost effective way to enhance academic achievement when compared to the costs of remedial programs and expensive technologies.

Nations at Risk and Nations Achieving

Test results cited in the 1983 report, A Nation at Risk, showed the United States losing out badly to other countries in mathematics and science (A Nation at Risk). A 1988 test of the *International Association for the Evaluation of Educational Achievement* showed us ranking fourteenth among seventeen countries on an instrument testing the performance of eighth and ninth grade students in science achievement. Our students' scores were similar to those of Thailand, and Singapore while trailing far behind Poland, Italy, Korea, English-speaking Canada and every other participating country with the exception of the Philippines and Hong Kong (IAEEA).

This report was one of the catalysts for many reform efforts of the eighties and nineties which, in New Jersey, included the Governor's State Wide

Systemic Initiative, Core Course Proficiencies, the Core Curriculum Content Standards and The Academy for the Improvement of Teaching accompanied by a flurry of legislative initiatives aimed at tightening the requirements for obtaining and retaining teaching and administrative certifications.

Until recently, one of the most neglected reforms has been a serious examination of the influence of the arts on academic achievement, particularly upon achievement in mathematics and science. The top performing students on the 1988 test were the eighth and ninth graders from Hungary followed by those from the Netherlands and Japan.

In conjunction with recent work in cognitive psychology regarding the relationship between music and academic achievement, it is enlightening to examine the status of music in the curriculum of countries who consistently out pace our students in math and science.

A Misguided Emphasis

The arts have long been regarded as an extra-curricular luxury. Elliot Eisner states:

> "If the arts are regarded as non-intellectual or as essentially emotive in character, they will be considered merely a kind of diversion from the hard subjects, having only the potential for cultivating avocational interests."

For this reason, the arts frequently take a back seat to "academics" in the budget process. According to Eisner,

> "When a nation is at risk, when from virtually all sides we hear of the vast number of functional illiterates leaving our schools, when remedial courses are oversubscribed at even our most selective colleges, the thought of making the case for so seemingly marginal a subject as art and music in our schools is especially daunting. How can we recommend that the school's most precious resource, time, be directed from what is truly basic in education to the luxury of studying the arts?

> How can one propose that teachers divert their attention from the skills that are fundamental to economic well being, to an area of study that 'properly' comes after the basic educational needs have been met? How can one propose a broad course of study when the schools have, apparently, been failing at their more narrowly defined tasks?" (Eisner, 1985).

What Are Other Countries Doing Well?

We see some fascinating parallels between achievement and music education if we examine the top three ranked countries on the 1988 test. In a 1988 study cited by Frank Hodsoll, Chairman of the National Endowment for the Arts, he noted that the Japanese require two class periods per week each in music and art each year in grades one through six. Music includes singing, instrumental performance, and appreciation of both western and Japanese music. In middle school, students learn to sing in a chorus and play instruments in an ensemble. (US Dept. of Ed, 1987).

In Dutch secondary schools, music and art became mandatory subjects in 1968 and in 1976, compulsory examinations in these subjects were implemented (CITO, 1988).

In Hungary, the land of Bela Bartok and Franz List with its number one ranking in science achievement for eighth and ninth graders, music education has long been an essential and developmental program implemented nationally by the composer, Zoltan Kodaly, wherein both voice and instrumental training twice a week is compulsory throughout the first eight years of schooling (Kodaly, 1990). The centrality of music education to learning in the top ranked countries seems to contradict our more rational strategy with its focus on math, science, vocabulary and technology. Yet, we continue to emphasize the need for computers in every classroom, and more academic emphasis upon basic skills.

What's Music Got to Do With It?

With apologies to Tina Turner, I would like to examine some reasons why an emphasis on music pays academic dividends beyond what Americans traditionally tend to expect. Recent work in cognitive psychology is attempting to quantify what many have long recognized and assumed.

An Historical Perspective

Music, one of the medieval quadrivium (Four Pillars of Leaning) along with arithmetic, geometry and astronomy, has, historically, been considered an integral part of learning. According to Plato,

> " ...the decisive importance of education in poetry and music: rhythm and harmony sink deep into the recesses of the soul and take the strongest hold there ...and when reason comes, he (the child) will greet her as a friend with whom his education has made him long familiar." (Plato)

Aristotle said,

> "We become a certain quality in our characters on account of music." (Aristotle)

And according to Allan Bloom,

> "Music is at the center of education, both for giving passions their due and for preparing the soul for the unhampered use of reason." (Bloom, 1987)

Music and the Brain

Because of the close relationship between music and mathematics, it is interesting that the processing of these two activities is attributed to distant locations in the brain. Many functions involved in mathematical, analytic and sequential thinking have been

localized in the Left Hemisphere (LH), whereas the functions associated with artistic, musical and holistic thinking have been demonstrated by the Right Hemisphere (RH). In order to study the effects of music on the brain, I will briefly elaborate on the RH/LH discussion.

The functional separation of the RH and LH has led to many misconceptions and over-simplifications. Publications such as, *Drawing on the Right Side of the Brain*, have attempted to capitalize on the idea by promoting espoused brain booster systems for getting more out of an individual hemisphere. A review of selected writings on hemisphericity is presented here to in an attempt to clarify this issue.

It is known that there are definite differences between the hemispheres in the general right-handed population (Springer & Deutsch, 1985). However, the nature of these differences is still in question. In the Journal of Clinical Psychology, Joseph provides a summative review of the literature on laterality (1988). He provides a long list of functions with which the RH has been shown to dominate: the perception and identification of environmental and nonverbal sounds; somesthesis; steriogenesis; the maintenance of the body image; the comprehension and expression of prosodic, melodic, and emotional features of speech; the analysis of geometric and visual-space; the production of certain forms of visual images; dreams during REM sleep; the perception and expression of visual, facial and verbal affect; the ability to determine a person's mood, attitude and intentions via the analysis of gesture, facial expression, vocal-melodic and intonational qualities; social-emotional functioning; and finally, the perception of most aspects of music (Joseph, 1988).

Joseph states, "Although there is evidence of considerable functional overlap as well as inter-hemispheric cooperation on a number of tasks, it certainly appears that the mental system maintained by the right hemisphere is highly developed, social-emotional, bilateral, and in many ways dominant over the temporal-sequential, language-dependent half of the cerebrum." (Joseph, p. 659).

This is quite a different picture than the idea that the RH is the subordinate to the dominant LH.

Another view is that of Cornock (1984). He warns against making too many conclusions about functional hemispheric laterality based primarily on split brain research. He explains that many of these subjects have many other problems (epilepsy) that may contribute to a relocation of some functions. He also discusses the difficulty in localizing right hemisphere functions as they seem to be more diffuse and integrative. What he will attribute to the RH are the functions of facilitating the immediate recognition of relationships and significant patterns, visuospatial skills, the figurative use and interpretation of language (humor), attaching emotional content to phenomena, performing parallel rather than sequential processing, enabling the appreciation of events, and musical awareness (Cornock, 1984).

More specifically concerned with the laterality differences between musicians and non-musicians Hassler(1990) studied five groups of subjects for lateral dominance, musical talent, spatial processing, handedness, verbal processing, psychological androgyny, and physiological androgyny (Hassler, 1990). One group consisted of musical composers, another group was made up of instrumentalists, the third group were all non-musicians, a fourth group of painters and finally the last group consisted of non musicians with low educational status. Each group was an even mix of males and females. The results demonstrated that females in the artistic groups were more strongly lateralized than both male and female non-musicians. The males in the artistic groups were less lateralized than non musicians. Their data support the assumption that LH and RH functions contributing to processes associated with verbal processing are more effectively integrated in musicians than in non-musicians. These studies confirm earlier research by Hassler that musicians have enhanced spatial abilities compared to non musicians regardless of gender. Hassler goes on to claim that anomalous dominance is assumed to favor special talents (music, math and spatial skills) but also related to developmental learning disorders.

Other, more popular (Shreeve, 1996), examples of the lateralization of musical skills include that of the Russian composer Vissarion Shebelin, who suffered two left hemisphere strokes. Afterwards, he was unable to speak or understand the meaning of words, yet continued to compose and teach music. Another composer, Maurice Ravel, began to make spelling mistakes and eventually lost his ability to read and could no longer sign his name. Yet, unlike Shebelin he could no longer compose, though he persistently said that he had a new opera "in his head". He could still play scales and listen and enjoy musical performances. These different situations suggest the close proximity of areas in the brain that are related to music composition and linguistic abilities, yet they are still separate.

Observing the Brain in Action

Traditional brain research, until recent years, has relied predominantly upon phenomenological models. Phenomenological researchers observe behavior to gain insights about brain function (Levine, 1994). Direct brain research utilizes scanning and sensing technologies to observe the brain directly in the act of receiving and processing information.

An early example of using electroencephalogram (EEG) technology to explore the laterality question in relation to musical experience and behavior is the work done by Davidson & Schwartz (1977). They measured the EEG activity of subjects while they remembered and reproduced music with and without lyrics. All the subjects were right handed. 9 males and 5 females, a mix of both musically trained and untrained subjects, were asked to list 3 familiar songs before the test. They were then asked to first, whistle a melody, then talk the lyrics to a song and finally sing a song. Each task was recorded for one minute with eyes closed. This scenario was repeated twice. Once for recordings done in two LH and RH parietal locations and then again for two occipital locations. The subjects who were not musically trained showed more activity in the RH while whistling vs.

talking the lyrics. The musically trained subjects showed no difference. Also, there were no differences between groups during talking or singing. The authors state that their data are consistent with recent evidence suggesting that musical training is associated with the adoption of an analytic and sequential processing mode toward melodic information (Davidson & Schwartz, 1977).

Zatorre (Shreeve, 1996) has visualized the differences between the hemispheres while they were in action using (positron emission tomography) PET scanning techniques. While Subjects listened to a tune, these scans show activity in the right superior temporal gyrus. When asked to pay special attention to the particular pitches within the tunes and make comparisons, the scans show activity in both the RH and the LH.

In addition to EEG and PET scanning technologies, Schlaug, Jancke, Huang, & Steinmetz (1995) show magnetic resonance imaging (MRI) evidence for increased lateralization in the left planum temporale in musicians with perfect pitch (Shreeve, 1996).

Finally, Damasio & Damasio (1977), present evidence for a dynamic, developing cerebral dominance for certain features of musical faculty. They suggest that there is a RH dominance for musical execution (regardless of training) and a variable dominance for musical perception, starting in the RH in the musically naive and developing into a LH dominance in the musically sophisticated.

Many particular functions have been found to be localized in different hemispheres. Musical experience is generally more localized in the RH in naive listeners but in both hemispheres in trained musicians. The developing perception of music seems to involve both hemispheres and increased skill level coincides with an increase in the integration between the two hemispheres. This relocation of cognitive processing associated with music coincides with recent thoughts about developmental stages in skill acquisition.

The serious developmental study of music has cognitive benefits we have only recently begun to quantify. What actually goes on in the brain during musical performance seems to involve a very high level thinking process. According to Howard Gardner, musicians

follow a sequence of notes which is a very sequential left brain process. While seeing patterns in the construction of phrases, seeing the whole for expressive phrasing and interpretation, and dealing with rhythmic patterns are very right brained skills. Additionally, mathematical abilities involved in timing, counting, and the symbolic encoding of time and sound, involve abstract and spatial reasoning. All of this brain activity must be consummated in the form of precise motor skills. Beyond all other musical activities, the playing of stringed instruments without keys or frets involves the estimation of decreasing distances down the finger board for accurate intonation. Bowing technique requires the cultivation of an intuitive sense for pressure, velocity, and acceleration which may later become codified in the symbolic language of the calculus.

Because it pulls on so many different attributes, music develops flexibility in thinking. Musical training is an effective way not only to enhance the conceptual-holistic-creative thinking process, but also to assist in the melding and merging of the mind's capabilities. Although most musical capabilities seem to be represented initially in the right hemisphere, as an individual becomes more skilled, capabilities that were housed in the right hemisphere are found increasingly in the left. It seems as if, with musical training, a significant proportion of skills migrate across the corpus callosum into the linguistically dominant left hemisphere (Gardner, 1982). It appears as though music pre-wires the brain to deal with the kinds of quantitative and spatial analysis required of mathematics.

Does Music Make You Smarter?

Studies suggest that it does. Increasingly, evidence suggests that musical experience directly influences and enhances cognitive skills.

In Nancy Welch's School's Communities and the Arts: A Research Compendium, there are summaries of at least 50 research projects each attempting to prove that arts education is valuable and necessary for students to reach their potentials. The organization and volume of these summaries is impressive at first glance, but upon closer look one finds

that the direct causal relationships between art education and brain development is lacking. Yet, clearly art education does influence a students success.

One example of a persuasive study in this compendium is that done by Carolyn Hudspeth (1986). Two 4th grade language arts classes of low achievers were tested. Each class of 16 students was from a different school though closely matched in socio-economic and achievement levels. The California Achievement Test was used before and after the experiment to assess the influence of an arts education program. One class was taught a traditional language arts program while the other was taught with the SAMPLE method (Suggested Activities of Music and Poetry for Language Enrichment) designed by Hudsepth (1986). The results were positive: SAMPLE classes outperformed the traditional class by 5 years in "language mechanics" and 2.7 years on "total language" (Hudspeth, 1986).

More recently, more controlled efforts at finding a causal link between music and education are being published that better bridge the gaps between the fields of educational research, cognitive psychology and brain development.

In Finland, Kalliopuska & Ruokonen (1993) tested the effects of music exercises in the holistic development of empathy and presociability. Empathy was used as the skill to observe because the authors assume it is an integration of affective, cognitive, kinesthetic and physiological components that can be differentiated upon testing. It is a good example of holistic thinking and behavior.

For their work, 2 groups of 6 year olds were tested on their ability to think empathetically in several varied social situations and problems. One group attended a special Saturday music program for 12 weeks that met for one hour where subjects were involved in singing, playing instruments, listening, music exercise, and discussion about the emotions associated with their musical experiences. The control group had no such training. Before and after the training period subjects were tested with several empathy tests, including evaluations by their parents and teachers. The subjects were tested after 3

months of training and again after 9 months. There was substantial improvement in empathy test scores though these improvements subsided after 9 months and receded to almost the same as control group (Kalliopuska & Ruokonen, 1993).

In 1996, Gardiner, Fox, Knowles & Jeffrey conducted a similar experiment testing mathematics and reading skills. 96 students in 8 different classrooms participated. Four classrooms were dubbed 'test arts' rooms and these were taught the Kodaly method of music and visual arts curriculum which emphasized sequenced skill development (Barkoczi, 1987). The remaining classrooms participated in the standard art curriculum. Other curricula was identical for all classrooms. After 7 months all students took standardized achievement tests. Students in the test arts classes had been behind controls in the previous year but after the 7 months were at least equal and often ahead in reading skills and mathematics. From the report, "Learning arts skills forces mental 'stretching' useful to other areas of learning: the maths learning advantage in our data could, for example, reflect the development of mental skills such as ordering, and other elements of thinking on which mathematical learning at this age also depends" (Gardiner et al., p. 284). They make a direct relationship between the musical experience and the developmental skills needed to solve mathematical problems.

The so-called "Mozart Effect" (Rideout, 1997) that has been described in various popular media circles (Shreeve, 1996) is the result of research initiated by Frances Rauscher and others that attempt to probe deeper into the general positive results described above. Rauscher recognized the lack of causal evidence for the relationship between music cognition and other higher brain functions. The term "Mozart Effect" was coined after Rauscher presented evidence that demonstrated how subjects improved on their ability to solve spatial reasoning problems after listening to a Mozart sonata (Rauscher, Shaw, & Ky, 1993). This causal relationship was demonstrated by testing 36 college students after they listened 10 minutes of Mozart's sonata for two pianos in D major; a relaxation tape, and silence. After each listening experience they were given standard IQ spatial reasoning

tasks. Performance improved immediately following the Mozart sonata but not after the other two listening conditions. Arousal was discounted as the cause as pulse was also measured and no change was found. The effect lasted for 10 or 15 minutes but subsided thereafter.

In order to experiment with more lasting effects, Rauscher also did another similar study where musical training of preschoolers was shown to improve spatial processing in a more permanent manner over a period of months (Rauscher, Shaw, Levine, Ky, & Wright, 1994).

Rideout & Laubach expanded Rauscher's research ideas in 1996 by using EEG technology to measure the Mozart Effect. This study had two purposes. The authors wanted to replicate the improved spatial performance following exposure to music in adults and to examine the EEG correlates of performance changes after listening to music. They were interested in whether the specific association exist between changes in EEG characteristics and changes in performance on the spatial task. For this study, four men and four woman with a mean age of 21.1, each having no more than two years of music study were tested after listening to music and after listening to a relaxation tape. Again, spatial reasoning was tested after listening times. The EEG was recorded while they engaged in the spatial reasoning tasks.

Spatial performance was again much improved. Subjects with generally lower alpha peak frequencies and higher beta were more likely to improve performance. This increased separation between peak frequencies may imply easier frequency discrimination. This may, in turn, facilitate music's enhancement of firing patterns used in spatial reasoning. Also, improved performance was correlated with increased alpha power in the left temporal area. The results suggest that the music had its effect by facilitating specific changes in brain state and associated EEG power which mediated improved performance. They hypothesized that the similar cognitive enhancements that are shown in spatial reasoning in children and in adults may be due to different developmental

mechanisms (Rideout & Laubach, 1996). Though the sample tested in the research was much smaller than Rauscher's, this experiment stands as a model for further study into finding a direct causal connection between brain and behavior relationships.

In summary, there is correlational and causal evidence for the improvement of cognitive skills after musical training.

The 1997 study by psychologist Dr. Frances Raucher of the University of Wisconsin at Oshkosh and physicist Dr. Gordon Shaw of the University of California at Irvine, indicated how music can enhance spatial reasoning ability.

The experiment included four groups of preschoolers. One group received private piano/keyboard lessons. A second group received singing lessons. A third group received private computer lessons and a fourth group received no training beyond the regular curriculum. Children receiving the piano/keyboard training performed 34% higher on tests measuring spatial-temporal ability than the other groups. They concluded that instrumental music training uniquely enhances higher brain functions required for mathematics, science and engineering (Shaw, et. al., 1997). This study confirmed an earlier study which demonstrated a 46% increasing in spatial reasoning in a group provided with eight months of keyboard lessons (Rauscher, et. al., 1994). Students in two Rhode Island elementary schools who were given an enriched, sequential, skill-building music program showed marked improvement in reading and math skills. Students in the enriched program who had started out behind the control group caught up to statistical equality with the control group in reading and pulled ahead of the control group in mathematics (Fox, 1996).

Students with course work and experience in music performance and music appreciation scored higher on the Scholastic Aptitude Test as reported by the Education Testing Service. Students who studied music performance scored an average 51 points higher on the Verbal test and 39 points higher on the Mathematics Test than students without music study. Students who studied music appreciation in addition to music performance scored

61 points higher on the Verbal and 46 points higher on the Mathematics test than student without music study (ETS, 1995).

The mental flexibility that is developed by the study of music is reflected in industrial applications. One of the most innovative and entrepreneurial centers of American commerce is the Silicon Valley of California.

Grant Venerable, in his book The Paradox of the Silicon Savior, says,

> "One of the most striking facts in Silicon Valley industry is that the very best engineers and technical designers are, nearly without exception, practicing musicians." (Venerable, 1989).

Physician and biologist Lewis Thomas studied the undergraduate majors of medical school applicants. He found that 66% of music majors who applied to medical school were admitted. This was the highest of any group while only 44% of the biochemistry majors were admitted (Thomas, 1994).

Music as a Window into Higher Brain Function

What we do as administrators in our schools must be directly related to the practice of teaching and learning. Decisions we make and policies we implement must take into account what the cognitive sciences have learned within the last five to ten years about the brain and how we learn. Many of these studies deal directly with the relationship between music and cognition. If our goal as administrators and policy makers is to maximize human potential, the brain research offers help in making very practical decisions. For example, in a time of fiscal restraint, would my students and their tax-paying parents be best served by a $3000 Macintosh computer requiring specialized facilities, expensive maintenance, and which would be obsolete within five years, or a $300 student grade violin usable anywhere and base upon technology essentially unchanged in 400 years?

Following, is a condensed chronology of research linking music to higher cognitive functioning.

1985 - Gordon Shaw, Dennis Silverman and John Pearson present the trion model of the brain's neuronal structure (Shaw, 1985).

1989 - Experiments in which musicians perform mental rehearsals of music indicated the extremely precise firing patterns by the billions of the same neurons involved in skills such as solving problems in higher mathematics and playing chess (Brothers and Shaw, 1989).

1990 - Computer experiments revealed that trion firing patterns can be mapped onto pitches and instrument timbres to produce music. This suggests that the trion model is a viable model for the coding of certain aspects of musical structure in human composition and perception, and that the trion model is relevant for examining creativity in higher cognitive functions such as mathematics that are similar to music (Leng, 1990)

1991 - Xiaodan Leng and Gordon Shaw proposed that music may be considered a "pre-language", and that early music training may be useful in "exercising" the brain in preparation for higher cognitive functions (Leng, 1991).

1993 - A pilot study by Frances Rauscher, Gordon Shaw and Katherine Ky found that children given music training displayed significant improvement in spatial reasoning ability. Experiments with college students found that after listening to a Mozart piano sonata, they experienced a significant although temporary gain in spatial reasoning skills (Rauscher, 1992).

1994 - A follow-up study conducted by Rauscher, Shaw, Ky, and Linda Levine found that music training improved spatial reasoning. These improvements did not occur in control groups without music training (Rauscher, 1994).

1995 - Rauscher, Shaw and Ky, in a follow-up study to their 1993 study with college students found that listening to Mozart improved spatial reasoning and that the effect can

increase with repeated testing over several days. They noted that the effect may not occur when music lacks sufficient complexity (Rauscher et. al., 1995)

1997 - With Wendy Dennis, Eric Wright, and Robert Newcomb, researchers Shaw, Rauscher and Levine conducted a more refined investigations of their 1994 study of pre-school children. Their findings indicated that children receiving instrumental keyboard music training showed significant improvements in their spatial-temporal reasoning skills above those in their peer group who received computer training or no training (Rauscher/Shaw, 1997).

Summary

The research emerging from the cognitive sciences gives us useful information to explain the connections between music and learning. EEG, CAT scan and PET scan Technologies allowing us to see the human brain while in the process of thinking show us that when people listen to music with appropriate complexity, and a variety of pitch and timbre, the right hemisphere is activated as it is when one plays by ear or improvises. When music is read, the player must understand key signatures, notation, and other details of scores and follow the sequence of notes activating the left hemisphere in the same area that is involved in analytical and mathematical thinking (Dickinson, 1993).

This mental multi-tasking seems to enhance cognitive ability in powerful ways that we must not ignore. The studies cited here seem to present a compelling argument in favor of the implementation of long-term developmental instrumental music programs for all students, not just those students with an obvious aptitude and interest. These programs should also include appreciation and theoretical components for all students.

Talent is not bred, it is learned.

Talent is not a gift, it is earned.

The Developmental Study of Music and Standardized Test Scores

Although we may wish to debate the philosophical merits and the efficacy of various formats of standardized tests, the reality remains that school districts in New Jersey and elsewhere judge the merits of curriculum reform initiatives against their ability to raise test scores. Therefore, it is the purpose of this study to undertake a quantitative investigation of the effects of the developmental study of instrumental and vocal music on student performance on selected standardized test instruments. This researcher will seek to refute the hypothesis that students in similar demographic factor groups (DFG's) involved in the formal and developmental study of instrumental and vocal music will demonstrate a statistically significant difference in higher test scores in the areas of reading, writing and mathematics when compared to students in corresponding DFG's who are not involved in the study of music. Data from a variety of test instruments will be used from various grade 8, 10, and 11 population groupings as described in Chapter Three.

Implications for Further Research and Policy

Investigations of Haggler (1990), Davidson & Schwartz (1977), and Damasio (1977) all point toward the developmental study of music as a catalyst for hemispheric integration. Some learning disabilities and attention disorders may be attributable to poor LH/RH integration. Levine (1994) testifies to the strong remedial effects of the study of music and other forms of artistic endeavor (Levine, 1994). We may well find that some learning disabilities and attention disorders attributable to poor LH/RH integration may prove to be more successfully treated through keyboard classes, violin lessons, or formal vocal training than through traditional remedial classes with their emphasis upon basic skills.

"Music is the manifestation of the human spirit, similar to language. Its greatest practitioners have conveyed to mankind things not possible to say in any other language. If we do not want these things to remain dead treasures, we must do our utmost to make the greatest possible number of people understand their idiom."

- Zoltan Kodaly

"I would teach children music, physics, and philosophy; but most importantly music, for in the patterns of music are the keys to learning."

- Plato

Chapter 3

Design of the Study

General Description of the Research Design

This study will attempt to provide a quantitative justification for the claims made by the author that the developmental study of music enhances academic achievement. This broad generalization is narrowed for the purpose of this study to focus on student scores on standardized test instruments administered to ninth and tenth grade students at Rancocas Valley Regional High School.

Statement of the Hypothesis

The hypothesis to be tested in this study will be stated as:

Students who are involved in the developmental study of music will exhibit a statistically significant difference in the percent increase in their scores on the California Achievement Test Version Five (CAT-5) between grade 9 and grade 10 when compared to students not involved in such developmental music study.

The researcher chooses, for philosophical reasons, not to control for IQ believing that, rather than measuring aptitude or intelligence (however that may be defined) Stanford Binet and other instruments, commonly available for the measurement of intelligence quotients, actually measure cultural exposure rather than native ability, talent, or mental acuity.

Measuring the Assumption

One may reasonably conclude that a statistically significant difference between music and non-music populations may be due simply to academic aptitude based on an assumption that the music groups is more academically as well as more musically gifted than the non-music group. The argument could be made that smart students make music. The researcher is attempting to test the opposite hypothesis, that is, music makes smart students.

Intelligence quotient testing, rather than testing aptitude, tests for cultural exposure. Further, IQ testing fails to consider the broader spectrum of intelligences (multiple intelligences) which cannot be adequately measured through the traditional IQ assessments.

Therefore, rather than controlling for IQ, the researcher chooses to control for academic aptitude using the NJ Eighth Grade Early Warning Test, (EWT), scores as the covariate.

Definitions

The developmental study of music will be defined for the purposes of this study, as the sequential study of vocal or instrumental music with the intent to progress through the progressive development of increasingly sophisticated musical skills and repertoire for the purpose of solo and/or ensemble performance.

Participation and Involvement in the developmental study of music will considered, for the purposes of this study, as occurring at least by the beginning of the freshman (grade 9) year and continuing throughout the course of the study.

Statistical Significance will be defined for the purposes of this study, as
1) a probability of less than 5.0% as a result of the application of the T-test of statistical significance to mean values of test populations.
2) a probability of less than 5.0% as a result of the application of the Analysis of Covariance test to the mean values of the adjusted test populations.

t- test, (t-Distribution) : The *t* - distribution is parametric analysis used to test the effect of an independent variable on a hypothesized parametric assumption between two populations. Each *t* - distribution is determined by a degrees-of-freedom (df) value. Like a normal distribution, the *t* - distributions are symmetrical becoming more like a normal distribution as degrees of freedom increase (Wiersma, 1995).

In this study the mean % increase in California Achievement Test scores will be compared between two populations. The independent variable will be the developmental study of music.

Statistical Definitions:

Probability (p) :

derived from a standard t - table based on a calculated t value and degrees of freedom based on the number of data points.

Degrees of Freedom : data points (n) - 1

t : $[\text{Mean}_1 - \text{Mean}_2] /$ Standard Error of the Difference

Standard Error of the Difference (S_D):

$[(\text{Standard Error of the Mean}_1)^2 + (\text{Standard Error of the Mean}_2)^2]^{0.5}$

Standard Deviation: $(\text{Variance})^{.5}$

Variance : Sum of $(x\text{-mean})^2 / (n-1)$

Mean : Sum of n / n

Mean : Sum of test scores/total number of data points

n : a data point

Impact of the Study upon Perception and Practice

Music is recognized as a key element in promoting cognitive development in countries who consistently out-perform the United States in international assessments of academic achievement in mathematics and science (A Nation at Risk, 1983), (Eisner, 1985).

Many of our current notions about the way the mind acquires and processes information are being challenged by current brain research which suggests that music may be a key element in providing for the kind of hemispheric integration that is needed for the kinds creative problem solving skills needed by engineers, physicians, mathematicians and research scientists (Rauscher/Shaw, 1997). Many of the learning disabilities that can be attributed to poor hemispheric integration may be better treated by the developmental study of music rather than our current remedial education practices which continue to place an emphasis upon basic skills drill and practice (Fischer, 1994).

The notion that "music makes you smarter" is moving from the realm of ancient wisdom to quantifiable theory. Quantitative studies are needed to either support or refute this notion using data that is meaningful to education policy makers. This study seeks to contribute to that body of quantitative information.

Research focuses upon the influence of music on the learning process in non-music disciplines. A growing body of data is re-affirming long held notions about music and cognition through the recent availability of PET scan, CAT scan, and MRI technology while causing us the re-evaluate other long-held beliefs about the nature of musical aptitude and "talent." This research has profound implications with regard to the curriculum priorities we have set for this country and portents a rich intellectual and cultural catalyst if taken seriously.

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Chapter 4

Presentation and Analysis of the Data

In this study, data was gathered to compare and contrast standardized test scores of students engaged in the developmental study of music to those not engaged in music study. Subjects were selected based upon the availability of test data from both ninth and tenth grade students as well as data with regard to involvement in music study through the twelfth grade. These criteria limited the study to 170 subjects who attended Rancocas Valley Regional High School from at least from the sophomore through the senior year.

Confidentiality

Data was logged for each student. Each student was assigned a data log number, and a music code which delineated the type of music study engaged in by the subject. Names were then eliminated from the data tables after the establishment of codes.

Types of music study were delineated using the following codes:

1 = Instrumental Music Study.

2 = Vocal Music Study

3 = Both Instrumental and Vocal Music Study.

Data Compilation and Analysis

Data was compiled using a Quattro-Pro spreadsheet. Formulae embedded in the spreadsheet may be accessed to verify computations for future replication of this research. Formulae for mean, variance, standard deviation, standard error of the mean, standard error of the difference, and t-test t values were used to determine whether statistically significant differences could be detected between groups defined by the study.

The (t) value was used with a standard (t) table to generate a probability value. The probability value (p) derived from the table was used to determine the probability that the difference in a mean value from groups being compared was due to random chance alone. A standard of $p < 0.05$ was interpreted to indicate that the probability of the difference between mean values was less than five percent.

Data Categories

Data from the California Achievement Test Level 20, (CAT-5) was from the freshman class of 1995. These students were tested again as sophomores and grade 10 data was used to compare the percentage of improvement that occurred in music versus non-music students, regardless of their initial score.

CTB/McGraw Hill Inc. formats their score report in the following categories:

Classification	Abbreviation Used in Tables
1. Reading Vocabulary	Read Vocab
2. Reading Comprehension	Read Comp
3. Total Reading Score	Read Total
4. Language Mechanics	Lang Mech
5. Language Expression	Lang Expr
6. Language Total	Lang Tot
7. Mathematics Computation	Math Comp
8. Mathematics Concepts and Applications	Math C & A
9. Mathematics Total	Math Tot
10. Total Battery	

The t-test analysis was applied to selected categories and student groupings base on their relevance to the hypothesis and for the purpose of developing future research questions.

Summative Data

Raw Scores Sorted by Musical Involvement

This section compiles the raw California Achievement Test Level 20 (CAT-5) data for each student. The data is sorted by student record number and by a "Music Involvement Type" value which serves to order fields and ranges for further analysis. Names have been deleted before inclusion to protect the confidentiality of the subjects.

Mean Scores by Music Involvement

This chart delineates the raw mean scores of students on the CAT-5 based upon each of the music involvement groupings. These groupings included: All Students, Non-music, Instrumental, Choral, Instrumental + Choral, and All Music categories. Mean scores were compiled for each of the skills arrays in mathematics, language arts, and mathematics, composite scores in each area, and total battery scores. These scores were reported separately for grades nine and ten.

Preliminary examination of summative mean data revealed:

1) Non-music students had the lowest mean score in each skill array in both grade levels.
2) Non-music students had the lowest total battery score in both grade levels.
3) For grade nine results, **Instrumental + Choral** students had the highest scores in each array.
4) For grade nine results, **Instrumental + Choral** students had the highest total battery score.
5) In grade ten, **Instrumental** students had the highest mean scores in each skill array.
6) In grade ten, **Instrumental** students had the highest total battery score.

Summary of Mean Score Comparisons

Students with the least exposure to developmental music study had the lowest mean scores. In grade nine, mean scores were proportional the exposure with the higher mean scores being associated with the developmental study of instrumental music.

In grade nine, students with both choral and instrumental music involvement had the highest mean scores. Students involved in instrumental music had higher mean scores than students involved in choral music. Students involved in choral music had higher mean scores than student with no music involvement.

In grade ten, students with instrumental music involvement had higher mean scores than students dividing their study between choral and instrumental music.

Percent Change in CAT-5 Scores from Ninth Grade to Tenth Grade

In an attempt to limit intelligence and/or aptitude as a variable, the magnitude of change of mean scores from ninth grade to tenth grade was examined for each music category revealing the following preliminary findings:

1) Students involved in the developmental study of choral music alone had the highest average percent increases in Reading Vocabulary, Reading Comprehension, Total Reading, Language Mechanics, and Language Expression.

2) Students involved in the developmental study of instrumental music had the highest average percent increase in Mathematics Concepts and Applications, Total Mathematics, Total Language and Total Battery.

Interpretation of t-Test Analyses for the Comparison of Mean Scores

Comparison of Mean Scores: Grade Nine (Total Battery)
All Music Students vs. Non-Music Students

Using the t-test analysis, the probability that difference in the mean Total Battery Score of All Music Students when compared to Non-Music Students being due to random probability is less than 1%.

Comparison of Mean Scores: Grade Ten (Total Battery)
All Music Students vs. Non-Music Students

Using the t-test analysis, the probability that difference in the mean Total Battery Score of All Music Students when compared to Non-Music Students being due to random probability is less than 1%.

Comparison of Mean Scores: Grade Nine (Total Mathematics)
All Music Students vs. Non-Music Students

Using the t-test analysis, the probability that difference in the mean Total Battery Score of All Music Students when compared to Non-Music Students being due to random probability was greater than 30%.

Comparison of Mean Scores: Grade Ten (Total Mathematics)

All Music Students vs. Non-Music Students

Using the t-test analysis, the probability that difference in the mean Total Battery Score of All Music Students when compared to Non-Music Students being due to random probability was less than 5 %.

Chapter 5

Conclusions and Recommendations for Further Study

Conclusions

Grade Nine Total Battery

Data presented in Chapter Four indicated that students involved in the developmental study of music had mean scores in Grade Nine for in the following categories conceptual categories tested by the California Achievement Test - Level 20 (CAT-5).

Conceptual Category	Compared Populations	*t* - Test Probability
Total Battery	Non-Music vs. All Music	$p < 0.05$
Total Battery	Non-Music vs. Instrumental	$p < 0.2$
Total Battery	Non-Music vs. Vocal	$p > 0.5$
Total Battery	Non-Music vs. Instr. & Vocal	$p < 0.01$
Total Battery	Vocal Music vs. Instrumental	$p < 0.4$

Students who studied instrumental music as a component of their developmental music program had higher mean CAT-5 Total Battery scores then student who studied no music. There was no statistically significant difference in mean Total Battery scores between vocal music students and non-music students. The difference between the mean Total Battery scores of instrumental students and non-music students in grade nine was not statistically significant according to the criteria established for this study.

Grade Ten Total Battery

Data presented in Chapter Four indicated that students involved in the developmental study of music had mean scores in Grade Ten for in the following categories conceptual categories tested by the California Achievement Test - Level 20 (CAT-5).

Conceptual Category	Compared Populations	*t* - Test Probability
Total Battery	Non-Music vs. All Music	$p < 0.01$
Total Battery	Non-Music vs. Instrumental	$p < 0.05$
Total Battery	Non-Music vs. Vocal	$p > 0.4$
Total Battery	Non-Music vs. Instr. & Vocal	$p < 0.01$
Total Battery	Vocal Music vs. Instrumental	$p < 0.3$

Students who studied instrumental music as a component of their developmental music program had higher mean CAT-5 Total Battery scores then student who studied no music. This difference in mean scores was statistically significant to the $p < 0.01$ level.

Although vocal music students had a higher mean Total Battery score than non-music students, this was not statistically significant. The difference between the mean Total Battery scores of instrumental students and non-music students in grade nine was not statistically significant according to the criteria established for this study. However the mean difference increased from Grade Nine to Grade Ten and the probability that this mean difference was due to random chance decreased from $p > 0.4$ to $p > 0.3$.

Interpretation of Mean Total Battery Score *t*-Test Comparisons

From grade Nine to Grade Ten, the mean difference in Total Battery scores for music students as compared to non-music students increased. Further, the statistical significance of these mean scores increased from Grade Nine to Grade Ten. This effect was most profound for students who where involved in the study of instrumental music or both instrumental and vocal music.

The difference in mean scores for students who studied vocal music only where greater than for students who studied no music but these differences were not statistically significant in either Grade Nine or Grade Ten.

The results of these analyses can be interpreted to suggest that students with the longest exposure to the study of instrumental music had the highest mean Total Battery CAT-5 scores.

Grade Nine Total Mathematics

Data presented in Chapter Four indicated that students involved in the developmental study of music had mean scores in Grade Nine for in the following categories conceptual categories tested by the California Achievement Test - Level 20 (CAT-5).

Conceptual Category	Compared Populations	*t* - Test Probability
Total Mathematics	Non-Music vs. All Music	$p > 0.5$
Total Mathematics	Non-Music vs. Instrumental	$p > 0.5$
Total Mathematics	Non-Music vs. Vocal	$p > 0.5$
Total Mathematics	Non-Music vs. Instr. & Vocal	$p < 0.05$
Total Mathematics	Vocal Music vs. Instrumental	$p > 0.5$

Students who studied instrumental music and vocal music together in Grade Nine had higher mean CAT-5 Total Mathematics scores then student who studied no music. There was no statistically significant difference in mean Total Mathematics scores between non-music students and any other category. The difference between the mean Total Mathematics scores of instrumental students and vocal music students in grade nine was not statistically significant according to the criteria established for this study.

Grade Ten Total Mathematics

Data presented in Chapter Four indicated that students involved in the developmental study of music had mean scores in Grade Ten for in the following categories conceptual categories tested by the California Achievement Test - Level 20 (CAT-5).

Conceptual Category	Compared Populations	*t* - Test Probability
Total Mathematics	Non-Music vs. All Music	$p < 0.05$
Total Mathematics	Non-Music vs. Instrumental	$p < 0.05$
Total Mathematics	Non-Music vs. Vocal	$p > 0.5$
Total Mathematics	Non-Music vs. Instr. & Vocal	$p < 0.1$
Total Mathematics	Vocal Music vs. Instrumental	$p < 0.2$

Students who studied instrumental music as a component of their developmental music program had higher mean CAT-5 Total Mathematics scores then student who studied no music. This difference in mean scores was statistically significant to the $p < 0.05$ level for students who studied instrumental music only, and to the $p < 0.1$ level for student who studied both instrumental and vocal music.

Mean Total Mathematics scores of vocal music students and non-music students in grade Ten were nearly identical.

Interpretation of Mean Total Mathematics Score *t*-Test Comparisons

In Grade Nine there was no statistically significant difference in mean Total Mathematics scores in any category except for students who studied both instrumental and vocal music together. From grade Nine to Grade Ten, the mean difference in Total Mathematics scores for music students as compared to non-music students increased only for students involved in instrumental music. Further, the statistical significance of these mean scores increased from Grade Nine to Grade Ten. The difference in mean scores for students who studied vocal music only where no greater than for students who studied no music.

The results of these analyses can be interpreted as providing evidence that students with the longest exposure to the study of instrumental music had the highest mean Total Mathematics CAT-5 scores.

Percent Change in Mean CAT-5 Scores

Grade Nine to Grade Ten

Total Battery

Data presented in Chapter Four indicated that students involved in the developmental study of music had mean percent score increases for in the following conceptual categories tested by the California Achievement Test - Level 20 (CAT-5).

Conceptual Category	Compared Populations	*t* - Test Probability
Total Battery	Non-Music vs. All Music	$p < 0.01$
Total Battery	Non-Music vs. Instrumental	$p < 0.05$
Total Battery	Non-Music vs. Vocal	$p < 0.01$
Total Battery	Non-Music vs. Instr. & Vocal	$p < 0.05$

When mean percentage changes in CAT-5 Total Battery scores from Grade Nine to Grade Ten were subjected to *t*-Test analysis, score increases for students involved in the developmental study of music were greater than for students who were not involved in the study of music. These differences were statistically significant to at least the $p < 0.05$ level.

Summary of the Conclusions

Mean CAT-5 scores for students in Grade Nine showed less differentiation between music and non-music students than did scores for Grade Ten students. The differentiation between music and non-music mean scores increased in Grade Ten most significantly for students who were involved in the developmental study of instrumental music.

An examination of mean CAT-5 scores between Grades nine and ten (Appendix H) reveals that students exposed to the developmental study of music experienced significant changes in mean scores from Grade Nine to Ten while student who were not involved in demonstrated relatively more static scores and in several cases, lower scores in the second year of CAT-5 testing. Students involved only in vocal music began with lower scores in many categories and demonstrated many of the most dramatic increases. However, in no testing category did students studying only vocal music exceed scores attained by instrumental music students. Vocal music students' scores exceeded those on instrumental students only when vocal music student was combined with instrumental music in Grade Nine. In Grade Ten, scores for students studying instrumental music only where consistently the highest of any other group suggesting that regardless of the starting point, the study of instrumental music has the most profound effect upon achievement and cognitive development.

Conclusions

A comparison of *California Achievement Test Level 20* scores between students involved in and students not involved in the developmental study of music was conducted by comparing the scores of a cohort of 170 ninth grade students to their scores attained a year later in grade ten. Of these 170 students, 15 were involved in the developmental study of instrumental music, 16 studied vocal music, and 9 students studied both instrumental and vocal music.

The *developmental study of music* was defined as the study of music in a developmental, skill-building program leading to the acquisition of increasingly complex knowledge base and increasingly sophisticated skills leading to a goal of ensemble and/or solo performance. The data presented here, excludes students involved in both instrumental and vocal music. Scores of music students were compared to those of

students who were not involved in the high school music program. Students were not grouped by IQ, socio-economic, or any other instructional or demographic classifications.

Grade nine data shows that:

1. Vocal music students in grade nine had lower Mathematics Concepts and Applications and Total Mathematics scores than non-music students, and nearly identical Mathematics Computation scores.
2. In grade nine, vocal music students had nominally higher scores than non-music students in all other testing categories.
3. Instrumental music students had the highest grade nine scores in every testing category.

Grade ten data shows that:

1. In spite of lower grade nine scores in Mathematics Applications, vocal music students demonstrated dramatic improvement in all mathematics scores as compared to marginal improvement by non-music students.
2. Score improvement from grade nine to grade ten was significantly higher for music vocal music students than for non-music students.
3. Instrumental music students had the highest mean scores in both grade nine and grade ten.

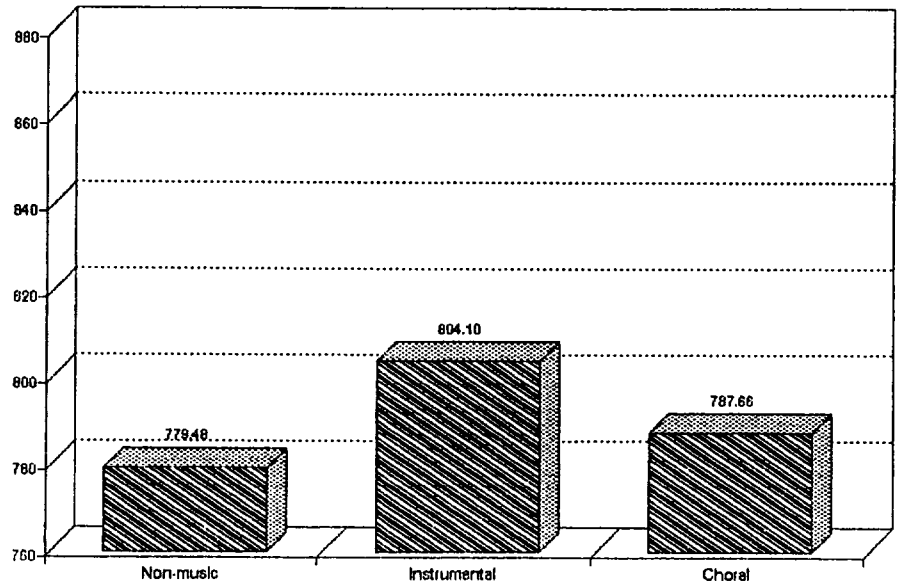
The data does not refute the hypothesis that students who participate in developmental music programs demonstrate significantly higher increases in CAT-5 scores when compared to students who were not engaged in developmental music study. Further, the data presented could be interpreted to indicate that:

1. The developmental study of music enhances the ability to demonstrate proficiency to master the skills and concepts involved in language arts mechanics and expression, reading comprehension, reading vocabulary, mathematics computation, and mathematics concepts, and applications as assessed by the *California Achievement Test Level 20.*

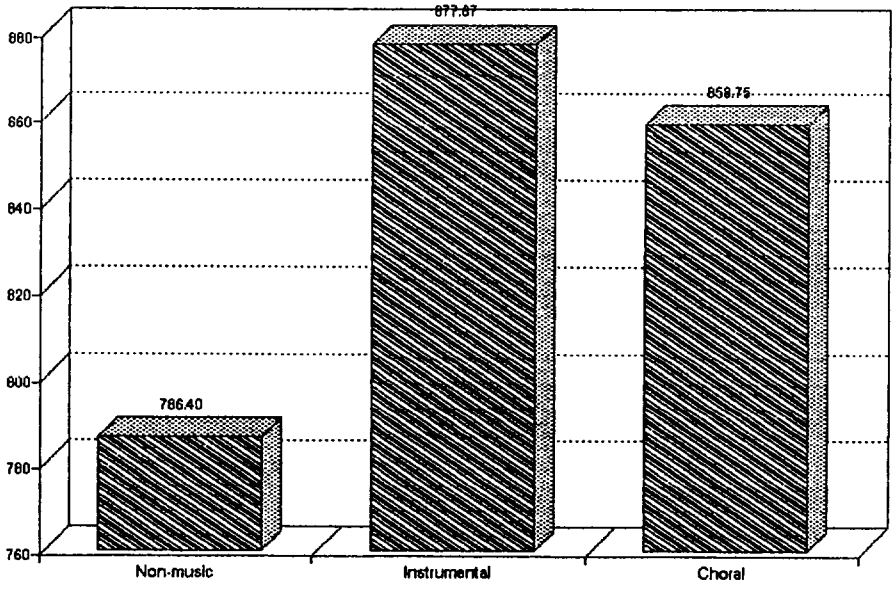
2. Since instrumental music students generally became involved in their music studies at a younger age than vocal music students, the cognitive benefits of music study were accrued prior to testing in grade nine as reflected by their superior scores in each testing category.

3. Some vocal music students began their developmental music studies in the middle school years but most began in grade nine through participation in high school choir or chorus programs. The significant improvements in the scores of vocal music students attests to the powerful cognitive benefits to be derived from the developmental study of music just through April of grade ten.

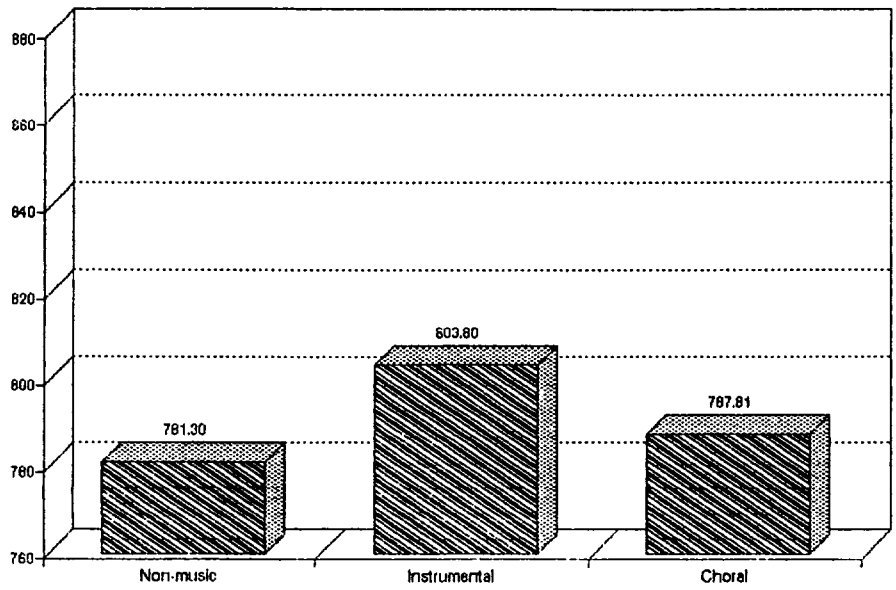
California Achievement Test Mean Scores
Grade 9 - Total Language



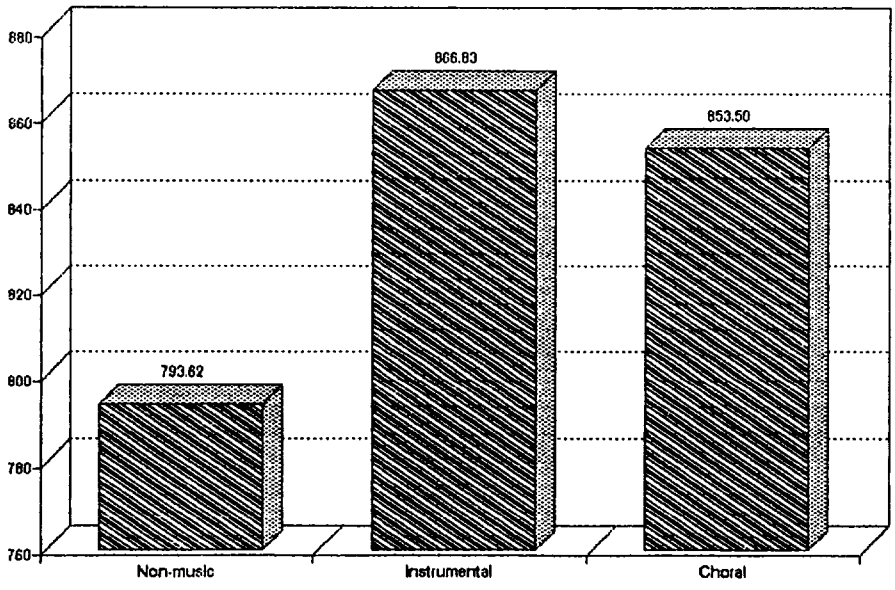
California Achievement Test Mean Scores
Grade 10 - Total Language



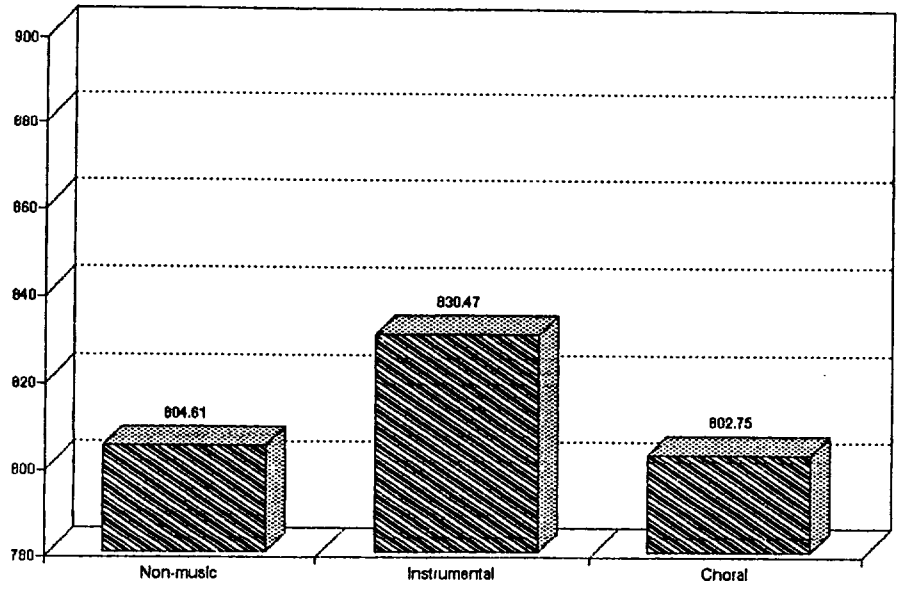
California Achievement Test Mean Scores
Grade 9 - Total Reading



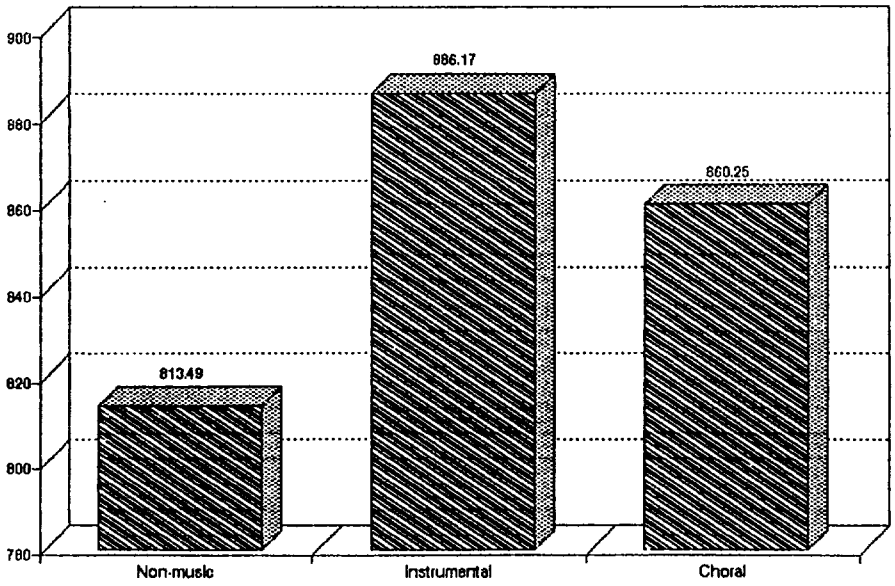
California Achievement Test Mean Scores
Grade 10 - Total Reading



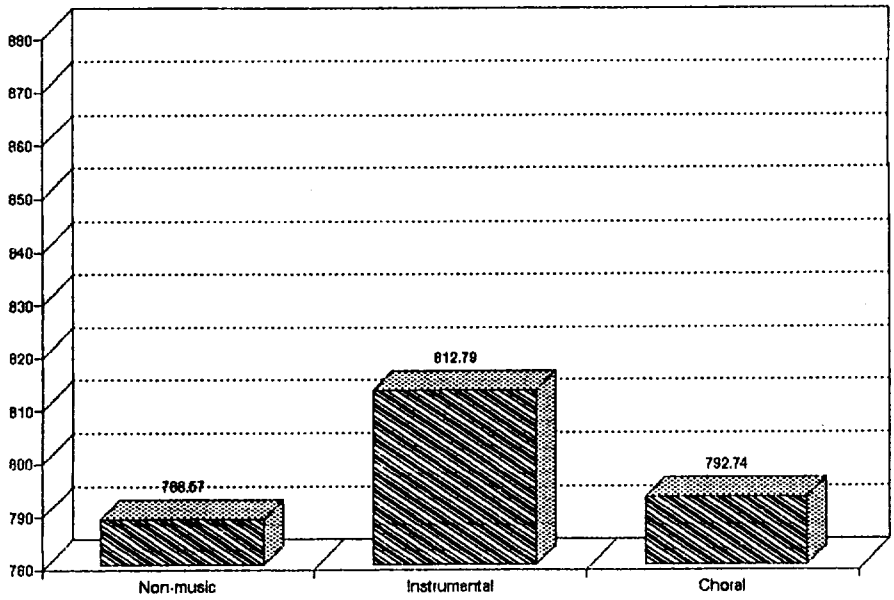
CAT-5 Mean Scores
Grade 9 - Total Mathematics



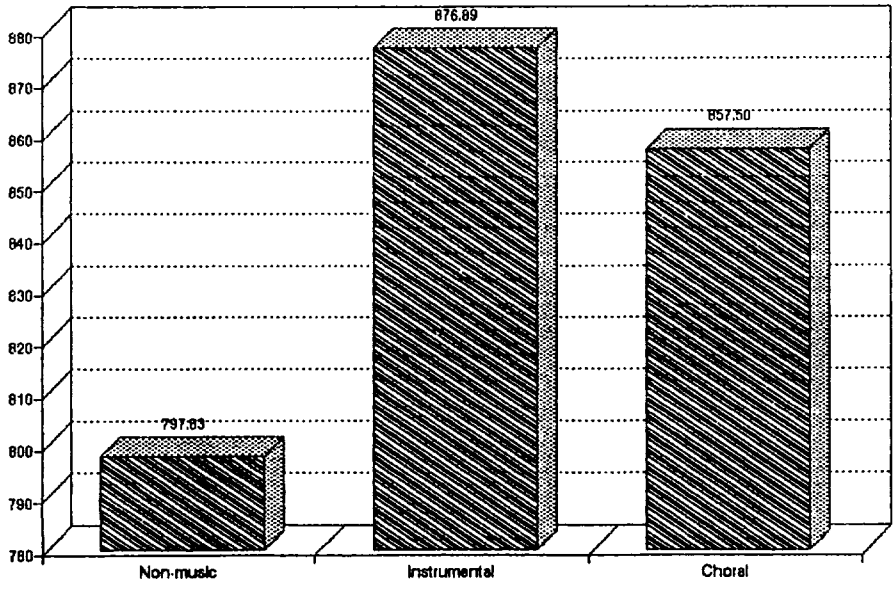
CAT-5 Mean Scores
Grade 10 - Total Mathematics



CAT-5 Mean Scores
Grade 9 - Total Battery



CAT-5 Mean Scores
Grade 10 - Total Battery



Professional Growth

The researcher's experiences during the course of this study led to a number of interesting and enriching encounters. Excepts from *Review of the Literature* were used to support a music curriculum revision proposal that was approved by the Collingswood Publics Schools Board of Education and adopted at that school. An article base upon the literature review was submitted and accepted for publication by the National Association of Secondary School Principals' in their *NASSP Bulletin.* The article entitled "The Relationship Between Music and Academic Achievement," appeared in the February, 1999 edition of that journal.

Board members from Glassboro Public Schools have expressed an interest in using the article in support of continued funding of their fine instrumental and vocal music programs.

The Iowa Bandmaster's Association has requested permission to reprint the article in their monthly journal.

The researcher hopes that the impact of this research will influence decision makers toward the realization that the developmental study of music enhances cognitive abilities in ways we are only beginning to comprehend. Further, the researchers hopes that data presented here will encourage school teachers and administrators to engage in their own research to confirm or refute the notions put forth in this thesis.

Appendix A

California Achievement Test

Grade Nine Individual Score Data

* All primary data has been provided in this and following appendices in the interest of reproducibility of these results. The researcher invites subsequent investigations and analysis of this data.

California Achievement Test: Individual Scores
Grade Nine Data

		Read Vocab	Read Comp.	Read Total	Lang Mech.	Lang Expr	Lang Total	Math Comp	Math C & A	Math Total	Total Battery
Average Scores by Music Classification - Grade 9											
All Students		789	782	786	782	786	785	806	793	801	791
Non-music		783	777	781	774	782	779	800	794	799	787
Instrumental		809	798	804	805	803	804	838	776	807	805
Choral		792	783	788	787	788	788	808	797	803	793
Inst + Choral		830	814	822	838	820	829	841	814	827	826
All Music		807	796	802	806	801	803	827	793	810	805
Student Number	Music Type	Individual Scores - Grade 9									
1	0	795	782	789	799	809	804	867	862	865	819
2	0	796	794	795	780	803	792	840	822	831	806
3	0	770	731	751	708	753	731	767	757	762	748
4	0	813	813	813	808	804	806	836	840	838	819
5	0	809	803	806	767	825	796	835	829	832	811
6	0	744	763	754	766	750	758	762	760	761	758
7	0	778	769	774	789	791	790	828	785	807	790
8	0	809	777	793	759	801	780	768	775	772	782
9	0	772	772	772	736	768	752	743	762	753	759
10	0	811	787	799	806	809	808	832	815	824	810
11	0	712	745	729	733	733	733	751	737	744	735
12	0	851	834	843	787	802	795	841	814	828	822
13	0	762	771	767	781	769	775	804	795	800	780
14	0	795	783	789	779	786	783	841	814	828	800
15	0	746	784	765	744	767	756	831	786	809	776
16	0	789	766	778	779	775	777	767	804	786	780
17	0	790	771	781	784	795	790	824	798	811	794
18	0	813	787	800	738	807	773	792	775	784	785
19	0	740	707	724	735	727	731	735	757	746	734
20	0	768	748	758	766	783	775	815	806	811	781
21	0	800	756	778	773	764	769	801	789	795	781
22	0	748	731	740	756	744	750	765	739	752	747
23	0	746	743	745	756	737	747	767	764	766	752
24	0	774	787	781	802	799	801	813	798	806	796
25	0	746	735	741	747	742	745	749	765	757	747
26	0	805	796	801	827	816	822	831	845	838	820
27	0	809	791	800	803	811	807	847	850	849	819
28	0	807	806	807	803	811	807	847	850	849	821
29	0	762	761	762	729	752	741	824	768	796	766
30	0	795	814	805	778	791	785	823	788	806	798
31	0	782	766	774	789	769	779	743	767	755	769

32	0	793	790	792	804	797	801	812	798	805	799
33	0	769	734	752	745	748	747	819	802	811	770
34	0	803	749	776	763	796	780	826	795	811	789
35	0	828	795	812	832	805	819	841	854	848	826
36	0	795	796	796	767	817	792	810	793	802	796
37	0	747	737	742	754	744	749	779	784	782	758
38	0	805	759	782	808	774	791	789	795	792	788
39	0	775	779	777	810	759	785	805	795	800	787
40	0	814	800	807	793	779	786	816	785	801	798
41	0	788	757	773	771	757	764	831	812	822	786
42	0	756	768	762	749	753	751	793	777	785	766
43	0	756	750	753	759	772	766	765	778	772	763
44	0	774	757	766	748	752	750	738	775	757	757
45	0	783	773	778	789	807	798	844	810	827	801
46	0	806	797	802	805	817	811	840	815	828	813
47	0	825	840	833	757	797	777	797	795	796	802
48	0	758	754	756	730	773	752	765	760	763	757
49	0	795	781	788	796	779	788	819	816	818	798
50	0	787	783	785	805	765	785	469	786	778	783
51	0	818	817	818	816	809	813	840	831	836	822
52	0	790	801	796	777	796	787	858	816	837	806
53	0	798	796	797	768	795	782	835	805	820	800
54	0	801	801	801	804	817	811	824	835	830	814
55	0	770	749	760	758	747	753	829	786	808	773
56	0	747	759	753	766	754	760	774	789	782	765
57	0	772	781	777	778	795	787	824	809	817	793
58	0	796	778	787	796	778	787	822	823	823	799
59	0	742	725	734	713	742	728	757	760	759	740
60	0	784	762	773	786	764	775	835	830	833	794
61	0	748	751	750	776	757	767	774	751	763	760
62	0	701	741	721	733	731	732	774	756	765	739
63	0	700	700	829	700	700	860	700	700	838	842
64	0	768	767	768	790	796	793	834	784	809	790
65	0	723	764	744	765	777	771	805	819	812	776
66	0	742	720	731	756	743	750	770	742	756	746
67	0	802	793	798	814	811	813	813	796	805	805
68	0	700	700	700	700	700	700	700	700	700	700
69	0	819	806	813	788	789	789	832	822	827	827
70	0	792	780	786	762	774	768	784	783	784	779
71	0	783	789	786	817	772	795	809	787	798	793
72	0	802	759	781	754	756	755	805	807	806	781
73	0	737	745	741	731	719	725	751	759	755	740
74	0	822	801	812	792	806	799	786	797	792	801
75	0	799	800	800	783	794	789	859	837	848	812
76	0	758	740	749	767	761	764	772	784	778	764
77	0	828	763	796	785	795	790	851	808	830	805
78	0	787	781	784	779	790	785	825	794	810	793

79	0	767	771	769	730	791	761	781	780	781	770
80	0	769	760	765	759	771	765	851	823	837	789
81	0	752	733	743	738	717	728	815	807	811	760
82	0	794	766	780	802	836	819	841	829	835	811
83	0	826	816	821	785	818	802	841	822	832	818
84	0	788	795	792	798	821	810	808	804	806	802
85	0	782	779	781	808	824	816	871	816	844	813
86	0	844	898	871	793	863	828	853	834	844	848
87	0	840	799	820	870	877	874	862	880	871	855
88	0	742	744	743	740	718	729	769	779	774	749
89	0	792	788	790	799	806	803	803	829	816	803
90	0	813	774	794	800	819	810	839	794	817	807
91	0	757	774	766	755	785	770	818	806	812	783
92	0	751	788	770	776	760	768	774	789	782	773
93	0	787	771	779	773	780	777	845	835	840	799
94	0	741	753	747	761	736	749	781	771	776	757
95	0	818	813	816	779	809	794	844	828	836	815
96	0	838	822	830	809	823	816	839	853	846	831
97	0	776	810	793	783	787	785	807	812	810	796
98	0	793	787	790	767	788	778	762	804	783	784
99	0	855	787	821	798	804	801	809	826	818	813
100	0	792	794	793	756	756	756	779	787	783	777
101	0	812	823	818	775	814	795	837	818	828	813
102	0	751	777	764	750	755	753	772	805	789	768
103	0	745	729	737	781	752	767	814	788	801	768
104	0	664	756	710	740	748	744	781	791	786	747
105	0	791	821	806	762	792	777	786	786	786	790
106	0	833	827	830	775	828	802	852	865	859	830
107	0	815	817	816	845	829	837	845	842	844	832
108	0	809	801	805	768	785	777	804	803	804	795
109	0	752	760	756	676	762	719	728	720	724	733
110	0	800	779	790	805	767	786	829	839	834	803
111	0	794	806	800	783	779	781	843	817	830	804
112	0	828	766	797	783	837	810	854	837	846	818
113	0	803	791	797	834	829	832	830	809	820	816
114	0	738	747	743	764	775	770	825	799	812	775
115	0	802	808	805	783	812	798	829	861	845	816
116	0	846	836	841	809	822	816	889	832	861	839
117	0	807	786	797	795	811	803	842	803	823	807
118	0	810	798	804	832	798	815	879	802	841	820
119	0	776	771	774	733	754	744	768	765	767	761
120	0	782	768	775	742	756	749	788	775	782	769
121	0	740	747	744	790	753	772	825	771	798	771
122	0	791	771	781	781	772	777	794	776	785	781
123	0	811	776	794	772	801	787	836	835	836	805
124	0	803	828	816	791	816	804	83	82	83	567
125	0	758	776	767	764	783	774	776	774	775	772
126	0	770	783	777	734	761	748	808	809	809	778

127	0	764	796	780	758	782	770	770	779	775	775
128	0	786	749	768	752	757	755	776	771	774	765
129	0	811	789	800	793	825	809	823	853	838	816
130	0	798	794	796	769	772	771	785	799	792	786
131	1	872	886	879	847	849	848	889	857	873	867
132	1	782	782	782	810	835	823	823	814	819	808
133	1	787	793	790	820	793	807	832	838	835	811
134	1	907	861	884	810	826	818	846	832	839	847
135	1	837	805	821	786	813	800	850	886	868	830
136	1	832	806	819	801	834	818	823	790	807	814
137	1	828	797	813	932	824	878	858	835	847	846
138	1	767	760	764	784	784	784	848	816	832	793
139	1	737	751	744	753	752	753	799	78	439	645
140	1	824	802	813	796	813	805	871	801	836	818
141	1	786	746	766	782	768	775	811	805	808	783
142	1	747	759	753	799	762	781	800	821	811	781
143	1	816	808	812	809	822	816	880	869	875	834
144	1	805	808	807	765	774	770	817	780	799	792
145	1	814	809	812	784	796	790	822	813	818	806
146	2	838	823	831	838	821	830	833	828	831	830
147	2	759	753	756	767	763	765	756	760	758	760
148	2	772	775	774	767	778	773	760	759	760	769
149	2	790	783	787	790	777	784	860	797	829	800
150	2	745	754	750	750	736	743	769	754	762	751
151	2	853	800	827	815	825	820	857	835	846	831
152	2	781	765	773	767	809	788	823	794	809	790
153	2	804	791	798	821	810	816	851	871	861	825
154	2	809	804	807	932	814	873	814	833	824	834
155	2	755	750	753	736	753	745	746	721	734	744
156	2	786	775	781	799	781	790	881	840	861	810
157	2	907	835	871	794	825	810	797	834	816	832
158	2	777	768	773	781	784	783	796	767	782	779
159	2	742	800	771	736	777	757	772	776	774	767
160	2	767	770	769	737	754	746	813	771	792	769
161	2	793	785	789	767	801	784	807	812	810	794
162	3	794	774	784	785	797	791	773	759	766	780
163	3	808	828	818	932	831	882	892	838	865	855
164	3	802	855	829	896	823	860	855	821	838	842
165	3	843	815	829	823	849	836	879	850	865	843
166	3	789	754	772	813	799	806	843	794	819	799
167	3	813	831	822	787	806	797	793	795	794	804
168	3	907	838	873	844	832	838	881	816	849	853
169	3	907	853	880	870	849	860	833	838	836	858
170	3	807	781	794	796	792	794	818	811	815	801

Appendix B

California Achievement Test

Grade Ten Individual Score Data

Grade Ten Data

		Read Vocab	Read Comp.	Read Total	Lang Mech.	Lang Expr	Lang Total	Math Comp	Math C & A	Math Total	Total Battery
Average Scores by Music Classification - Grade 10											
All Students		801	795	798	793	796	795	820	814	817	803
Non-music		797	790	794	782	790	786	816	811	813	798
Instrumental		815	812	812	825	820	826	838	827	833	824
Choral		802	800	802	812	807	810	817	810	814	809
Inst + Choral		829	819	824	864	832	848	859	831	845	839
All Music		813	809	811	829	817	825	835	821	828	821
Student Number	Music Type										
Individual Scores - Grade 10											
1	0	792	810	801	863	811	837	878	855	867	835
2	0	778	814	796	805	816	811	831	834	833	813
3	0	800	781	791	716	787	752	766	798	782	775
4	0	824	809	817	814	801	808	849	857	853	826
5	0	811	809	810	793	794	794	846	862	854	819
6	0	755	779	767	793	770	782	775	767	771	773
7	0	785	775	780	785	767	776	796	773	785	780
8	0	815	812	814	772	771	791	803	775	789	798
9	0	767	770	769	760	777	788	788	765	777	778
10	0	835	806	821	771	834	803	832	829	831	818
11	0	755	760	758	758	769	764	750	764	757	759
12	0	864	858	861	807	837	822	847	806	827	837
13	0	792	808	800	778	794	786	785	818	802	796
14	0	803	788	796	743	762	753	781	794	788	779
15	0	764	790	777	794	788	791	837	790	814	794
16	0	800	767	784	791	782	787	794	783	789	786
17	0	810	788	799	796	805	801	826	809	818	806
18	0	811	780	796	789	787	788	806	790	798	794
19	0	778	727	753	762	754	758	795	777	786	766
20	0	769	771	770	768	784	776	824	818	821	789
21	0	807	781	794	790	801	796	810	800	805	798
22	0	790	793	792	843	772	808	771	794	783	794
23	0	784	782	783	780	782	781	796	785	791	785
24	0	782	805	794	798	803	801	816	794	805	800
25	0	736	739	738	751	741	746	762	760	761	748
26	0	831	858	845	786	823	805	933	899	916	855
27	0	806	783	795	755	757	756	785	814	800	783
28	0	845	835	840	801	814	808	845	837	841	830
29	0	782	794	788	720	767	744	786	800	793	775
30	0	816	831	824	804	794	799	821	821	821	815
31	0	798	798	798	813	786	800	803	793	798	799
32	0	796	786	791	774	794	784	800	792	796	790

33	0	788	759	774	784	702	743	805	802	804	773
34	0	788	773	781	766	797	782	816	819	818	793
35	0	823	818	821	788	809	799	854	862	858	826
36	0	797	786	792	843	804	824	820	781	801	805
37	0	783	752	768	782	747	765	803	808	806	779
38	0	774	752	763	765	793	779	783	802	793	778
39	0	782	791	787	799	785	792	824	810	817	799
40	0	833	770	802	798	780	789	814	792	803	798
41	0	776	749	763	724	753	739	831	829	830	777
42	0	755	778	767	751	754	753	767	785	776	765
43	0	763	782	773	757	768	763	791	789	790	775
44	0	776	762	769	734	743	739	770	775	773	760
45	0	803	807	805	792	806	799	788	824	806	803
46	0	803	794	799	831	797	814	862	850	856	823
47	0	827	803	815	767	803	785	797	808	803	801
48	0	782	759	771	771	755	763	794	752	773	769
49	0	796	791	794	811	806	809	803	805	804	802
50	0	773	765	769	788	786	787	784	789	787	781
51	0	838	830	834	856	822	839	876	891	884	852
52	0	835	838	837	784	836	810	813	821	817	821
53	0	799	806	803	767	812	790	870	839	855	816
54	0	826	819	823	814	836	825	841	820	831	826
55	0	790	753	772	696	784	740	810	800	805	772
56	0	760	791	776	767	753	760	825	817	821	786
57	0	804	819	812	758	833	796	860	870	865	824
58	0	786	825	806	804	802	803	809	852	831	813
59	0	773	757	765	712	737	725	749	758	754	748
60	0	794	767	781	792	780	786	827	839	833	800
61	0	769	785	777	791	755	773	833	792	813	788
62	0	733	734	734	701	720	711	777	770	774	739
63	0	846	852	849	814	835	825	891	868	880	851
64	0	795	785	790	787	804	796	816	791	804	796
65	0	764	763	764	789	779	784	814	843	829	792
66	0	725	738	732	771	758	765	761	754	758	751
67	0	800	824	812	807	837	822	811	806	809	814
68	0	765	754	760	775	764	770	782	790	786	772
69	0	805	787	796	776	805	791	805	804	805	797
70	0	810	816	813	784	814	799	831	808	820	811
71	0	790	799	795	784	799	792	810	812	811	799
72	0	801	808	805	766	772	769	795	803	799	791
73	0	734	711	723	747	734	741	737	750	744	736
74	0	833	826	830	822	809	816	801	798	800	815
75	0	818	821	820	773	823	798	933	861	897	838
76	0	771	766	769	774	762	768	781	777	779	772
77	0	806	789	798	771	788	780	826	816	821	799
78	0	811	809	810	766	824	795	813	819	816	807
79	0	811	821	816	752	802	777	799	827	813	802

80	0	774	781	778	766	771	769	830	813	822	789
81	0	774	720	747	718	736	727	790	790	790	755
82	0	821	828	825	842	798	820	870	850	860	835
83	0	826	830	828	776	875	826	824	847	836	830
84	0	816	797	807	835	829	832	844	816	830	823
85	0	808	791	800	842	792	817	820	839	830	815
86	0	887	831	859	786	892	839	861	830	846	848
87	0	888	834	861	939	830	885	873	848	861	869
88	0	749	737	743	746	750	748	792	761	777	756
89	0	817	791	804	831	808	820	832	828	830	818
90	0	806	832	819	816	831	824	822	826	824	822
91	0	784	765	775	771	779	775	806	825	816	788
92	0	770	779	775	806	774	790	792	803	798	787
93	0	807	807	807	760	789	775	859	852	856	812
94	0	742	752	747	785	753	769	807	797	802	773
95	0	819	789	804	779	792	786	830	826	828	806
96	0	868	846	857	863	826	845	855	875	865	856
97	0	807	800	804	786	788	787	794	822	808	800
98	0	817	797	807	788	814	801	795	811	803	804
99	0	874	846	860	806	852	829	849	822	836	842
100	0	795	793	794	729	792	761	798	805	802	785
101	0	824	816	820	774	811	793	836	822	829	814
102	0	758	756	757	773	757	765	807	783	795	772
103	0	733	758	746	791	748	770	816	806	811	775
104	0	748	787	768	759	766	763	788	774	781	770
105	0	801	787	794	752	793	773	773	767	770	779
106	0	855	828	842	824	901	863	903	892	898	867
107	0	838	831	835	810	830	820	842	842	842	832
108	0	817	821	819	752	811	782	818	834	826	809
109	0	738	761	750	730	782	756	794	782	788	765
110	0	804	633	719	798	798	798	831	823	827	781
111	0	804	818	811	787	781	784	870	823	847	814
112	0	826	808	817	783	790	787	831	831	831	812
113	0	809	806	809	833	815	824	853	854	854	829
114	0	780	763	772	770	758	764	812	806	809	782
115	0	815	811	813	774	783	779	838	849	844	812
116	0	826	815	821	809	821	815	857	847	852	829
117	0	809	799	804	817	776	797	851	849	850	817
118	0	811	817	814	833	850	842	852	834	843	833
119	0	777	774	776	753	763	758	772	772	772	769
120	0	799	797	798	773	791	782	808	792	800	793
121	0	770	763	767	771	767	769	814	753	784	773
122	0	803	807	805	777	786	782	786	791	789	792
123	0	724	672	698	683	683	683	763	770	767	716
124	0	834	832	833	792	837	815	798	822	810	819
125	0	756	801	779	757	765	761	813	789	801	780
126	0	795	778	787	760	752	756	800	801	801	781
127	0	791	822	807	751	769	760	786	790	788	785
128	0	770	761	766	728	719	724	768	784	776	755

129	0	812	795	804	816	852	834	865	888	877	838
130	0	822	811	817	778	766	772	793	800	797	795
131	1	852	838	845	894	846	870	878	868	873	863
132	1	812	818	801	801	836	839	855	839	847	829
133	1	816	813	815	833	823	828	842	822	832	825
134	1	838	842	840	793	826	844	846	833	844	843
135	1	864	927	896	939	843	891	874	879	877	888
136	1	826	803	815	841	807	824	844	799	822	820
137	1	843	860	852	939	921	930	890	841	866	882
138	1	774	761	768	777	788	783	824	833	829	793
139	1	743	718	731	727	740	734	791	792	792	752
140	1	860	826	843	896	886	891	864	818	841	858
141	1	776	764	770	779	790	785	799	800	800	785
142	1	769	769	769	763	727	745	761	768	765	760
143	1	826	797	812	810	832	821	873	912	893	842
144	1	806	816	811	788	810	799	804	798	801	804
145	1	819	824	822	802	819	811	826	810	818	817
146	2	815	819	817	850	821	836	858	861	860	837
147	2	779	777	778	763	770	767	786	773	780	775
148	2	757	775	789	749	778	770	777	759	768	776
149	2	796	841	819	810	824	817	799	819	809	815
150	2	735	760	748	727	764	746	809	766	788	760
151	2	874	815	845	939	838	889	847	897	872	868
152	2	798	799	799	794	798	796	817	796	807	800
153	2	825	828	827	939	921	930	844	852	848	868
154	2	799	816	808	939	846	893	894	845	870	857
155	2	768	764	766	744	744	744	751	757	754	755
156	2	789	788	789	813	793	803	883	851	867	820
157	2	887	855	871	811	832	822	831	835	833	842
158	2	821	784	803	842	799	821	786	769	778	800
159	2	781	779	780	738	771	755	775	767	771	769
160	2	785	796	791	759	782	771	801	792	797	786
161	2	818	797	808	779	827	803	816	820	818	810
162	3	822	824	823	767	796	782	760	735	748	784
163	3	821	827	824	841	827	834	871	826	849	836
164	3	831	828	830	939	828	884	933	837	885	866
165	3	861	831	846	939	887	913	933	904	919	893
166	3	786	773	780	809	802	806	835	815	825	803
167	3	850	820	835	796	833	815	788	802	795	815
168	3	838	819	829	939	849	894	933	870	902	875
169	3	841	842	842	939	848	894	861	878	870	868
170	3	807	809	808	803	816	810	821	813	817	812

Appendix C

California Achievement Test

Mean Score and Score Change Data

From Grade Nine to Grade Ten

California Achievement Test Data Analysis
Mean Scores by Music Involvement

Grade Nine Data	Reading Vocab.	Reading Comp.	Reading Total	Language Mech.	Language Expr	Language Total	Math Compu.	Math C & A	Math Total	Total Battery
All Students	788.94	781.60	786.06	781.68	786.46	785.05	810.41	801.92	807.91	793.09
Non-music	783.31	777.22	781.30	774.34	782.06	779.48	805.38	799.29	804.61	788.57
Instrumental	809.40	798.20	803.80	805.20	803.00	804.10	837.93	823.00	830.47	812.79
Choral	792.38	783.19	787.81	787.31	788.00	787.66	806.44	797.00	802.75	792.74
Inst + Choral	830.00	814.33	822.22	838.44	819.78	829.17	840.78	813.56	827.17	826.15
All Music	807.23	795.83	801.55	805.53	800.78	803.16	826.78	810.48	818.64	807.78

Grade Ten Data	Reading Vocab.	Reading Comp.	Reading Total	Language Mech.	Language Expr	Language Total	Math Compu.	Math C & A	Math Total	Total Battery
All Students	800.59	794.64	797.67	793.25	796.30	795.36	820.00	813.75	816.90	803.31
Non-music	796.87	790.36	793.62	782.32	789.87	786.40	815.54	811.44	813.49	797.83
Instrumental	869.73	865.80	866.83	877.33	870.67	877.67	890.93	880.80	886.17	876.89
Choral	853.06	851.06	853.50	860.19	856.50	858.75	864.63	855.88	860.25	857.50
Inst + Choral	828.56	819.22	823.89	863.56	831.78	847.67	859.44	831.11	845.28	838.94
All Music	812.70	808.55	810.85	826.75	817.20	824.51	834.50	821.26	828.00	821.12

Change in CAT-5 Scores from Grade 9 => 10

	Reading Vocab.	Reading Comp.	Reading Total	Language Mech.	Language Expr	Language Total	Math Compu.	Math C & A	Math Total	Total Battery
All Students	11.66	13.04	11.61	11.57	9.84	10.31	9.59	11.83	8.99	10.22
Non-music	13.56	13.14	12.32	7.98	7.81	6.92	10.16	12.15	6.88	9.26
Instrumental	60.33	67.60	63.03	72.13	67.67	73.57	53.00	57.80	55.70	64.10
Choral	60.69	67.88	65.69	72.88	68.50	71.09	56.19	58.88	57.50	64.76
Inst + Choral	-1.44	4.89	1.67	25.11	12.00	16.50	18.67	17.56	18.11	12.80
All Music	5.48	12.72	9.30	23.23	16.43	21.35	7.73	10.80	9.36	13.35

Percent Change in CAT-5 Scores from Grade 9 => 10

	Reading Vocab.	Reading Comp.	Reading Total	Language Mech.	Language Expr	Language Total	Math Compu.	Math C & A	Math Total	Total Battery
All Students	1.48	1.67	1.48	1.48	1.25	1.31	1.18	1.48	1.11	1.29
Non-music	1.73	1.69	1.58	1.03	1.00	0.89	1.26	1.52	1.10	1.17
Instrumental	7.45	8.47	7.84	8.96	8.43	9.15	6.33	7.02	6.71	7.89
Choral	7.66	8.67	8.34	9.26	8.69	9.03	6.95	7.39	7.16	8.17
Inst + Choral	-0.17	0.60	0.20	2.99	1.46	2.23	2.22	2.16	2.19	1.55
All Music	0.68	1.60	1.16	2.88	2.05	2.66	0.93	1.33	1.14	1.65

Appendix D

California Acheivement Test

Individual Score Changes from

Grade Nine to Grade Ten

California Achievement Test
Individual Score Changes Grade 9 => 10

	Read Voceb.	Read Comp.	Read Total	Lang Mech.	Lang Expr	Lang Total	Math Compu.	Math C & A	Math Total	Total Battery
All Students	11.66	13.04	11.61	11.57	9.84	10.31	9.59	11.83	8.99	10.22
Non-Music	13.56	13.14	12.32	7.98	7.81	6.92	10.16	12.15	8.88	9.26
Instrumental	5.53	13.53	8.60	20.27	16.60	22.10	0.13	4.47	2.60	11.10
Vocal	9.31	16.38	14.25	24.94	18.75	22.25	8.69	12.94	10.78	15.76
Inst + Vocal	-1.44	4.89	1.67	25.11	12.00	18.50	18.67	17.56	18.11	12.80
All Music	5.48	12.73	9.30	23.23	16.43	21.35	7.73	10.80	9.36	13.35

#	Type									
1	0	-3.00	28.00	12.50	64.00	2.00	33.00	11.00	-7.00	2.00	15.83
2	0	-18.00	20.00	1.00	25.00	13.00	19.00	-9.00	12.00	1.50	7.17
3	0	30.00	50.00	40.00	8.00	34.00	21.00	-1.00	41.00	20.00	27.00
4	0	11.00	-4.00	3.50	6.00	-3.00	1.50	13.00	17.00	15.00	6.67
5	0	2.00	6.00	4.00	26.00	-31.00	-2.50	11.00	33.00	22.00	7.83
6	0	11.00	16.00	13.50	27.00	20.00	23.50	13.00	7.00	10.00	15.67
7	0	7.00	6.00	6.50	-4.00	-24.00	-14.00	-32.00	-12.00	-22.00	-9.83
8	0	6.00	35.00	20.50	13.00	-30.00	11.00	35.00	0.00	17.50	16.33
9	0	-5.00	-2.00	-3.50	24.00	9.00	36.00	45.00	3.00	24.00	18.83
10	0	24.00	19.00	21.50	-35.00	25.00	-5.00	0.00	14.00	7.00	7.83
11	0	43.00	15.00	29.00	25.00	36.00	30.50	-1.00	27.00	13.00	24.17
12	0	13.00	24.00	18.50	20.00	35.00	27.50	6.00	-8.00	-1.00	15.00
13	0	30.00	37.00	33.50	-3.00	25.00	11.00	-19.00	23.00	2.00	15.50
14	0	8.00	5.00	6.50	-36.00	-24.00	-30.00	-60.00	-20.00	-40.00	-21.17
15	0	18.00	6.00	12.00	50.00	21.00	35.50	6.00	4.00	5.00	17.50
16	0	11.00	1.00	6.00	12.00	7.00	9.50	27.00	-21.00	3.00	6.17
17	0	20.00	17.00	18.50	12.00	10.00	11.00	2.00	11.00	8.50	12.00
18	0	-2.00	-7.00	-4.50	51.00	-20.00	15.50	14.00	15.00	14.50	8.50
19	0	38.00	20.00	29.00	27.00	27.00	27.00	60.00	20.00	40.00	32.00
20	0	1.00	23.00	12.00	2.00	1.00	1.50	9.00	12.00	10.50	8.00
21	0	7.00	25.00	16.00	17.00	37.00	27.00	9.00	11.00	10.00	17.67
22	0	42.00	62.00	52.00	87.00	28.00	57.50	6.00	55.00	30.50	46.67
23	0	38.00	39.00	38.50	24.00	45.00	34.50	29.00	21.00	25.00	32.67
24	0	8.00	18.00	13.00	-4.00	4.00	0.00	3.00	-4.00	-0.50	4.17
25	0	-10.00	4.00	-3.00	4.00	-1.00	1.50	13.00	-5.00	4.00	0.83
26	0	26.00	62.00	44.00	-41.00	7.00	-17.00	102.00	54.00	78.00	35.00
27	0	-3.00	-8.00	-5.50	-48.00	-54.00	-51.00	-62.00	-36.00	-49.00	-35.17
28	0	38.00	29.00	33.50	-2.00	3.00	0.50	-2.00	-13.00	-7.50	8.83
29	0	20.00	33.00	26.50	-9.00	15.00	3.00	-38.00	32.00	-3.00	8.83
30	0	21.00	17.00	19.00	26.00	3.00	14.50	-2.00	33.00	15.50	16.33
31	0	16.00	32.00	24.00	24.00	17.00	20.50	60.00	26.00	43.00	29.17
32	0	3.00	-4.00	-0.50	-30.00	-3.00	-16.50	-12.00	-6.00	-9.00	-8.67
33	0	19.00	25.00	22.00	39.00	-46.00	-3.50	-14.00	0.00	-7.00	3.83
34	0	-15.00	24.00	4.50	3.00	1.00	2.00	-10.00	24.00	7.00	4.50
35	0	-5.00	23.00	9.00	-44.00	4.00	-20.00	13.00	8.00	10.50	-0.17
36	0	2.00	-10.00	-4.00	76.00	-13.00	31.50	10.00	-12.00	-1.00	8.83
37	0	36.00	15.00	25.50	28.00	3.00	15.50	24.00	24.00	24.00	21.67
38	0	-31.00	-7.00	-19.00	-43.00	19.00	-12.00	-8.00	7.00	0.50	-10.17
39	0	7.00	12.00	9.50	-11.00	26.00	7.50	19.00	15.00	17.00	11.33
40	0	19.00	-30.00	-5.50	5.00	1.00	3.00	-2.00	7.00	2.50	0.00
41	0	-12.00	-8.00	-10.00	-47.00	-4.00	-25.50	0.00	17.00	8.50	-9.00
42	0	-1.00	10.00	4.50	2.00	1.00	1.50	-26.00	8.00	-9.00	-1.00
43	0	7.00	32.00	19.50	-2.00	-4.00	-3.50	26.00	11.00	18.00	12.00
44	0	2.00	5.00	3.00	-14.00	-9.00	-11.50	32.00	0.00	15.50	3.00
45	0	20.00	34.00	27.00	3.00	-1.00	1.00	-56.00	14.00	-21.00	2.33
46	0	-3.00	-3.00	-3.50	26.00	-20.00	3.00	22.00	35.00	28.00	9.83
47	0	2.00	-37.00	-18.00	10.00	6.00	8.00	0.00	13.00	6.50	-1.17
48	0	24.00	5.00	14.50	41.00	-18.00	11.00	29.00	-8.00	10.00	11.83
49	0	1.00	10.00	5.50	15.00	27.00	20.50	-16.00	-11.00	-14.00	4.00
50	0	-14.00	-18.00	-16.00	-17.00	21.00	2.00	315.00	3.00	8.50	-2.17

51	0	20.00	13.00	16.00	40.00	13.00	26.00	36.00	60.00	47.50	30.17
52	0	45.00	37.00	40.50	7.00	40.00	23.00	-45.00	5.00	-20.00	15.17
53	0	1.00	10.00	5.50	-1.00	17.00	7.50	35.00	34.00	34.50	15.50
54	0	25.00	18.00	21.50	10.00	19.00	14.00	17.00	-15.00	0.50	12.00
55	0	20.00	4.00	11.50	-62.00	37.00	-13.00	-19.00	14.00	-3.00	-0.83
56	0	13.00	32.00	22.50	1.00	-1.00	0.00	51.00	26.00	39.00	20.50
57	0	32.00	38.00	34.50	-20.00	38.00	8.50	36.00	61.00	48.00	31.00
58	0	-10.00	47.00	18.50	8.00	24.00	16.00	-13.00	29.00	7.50	14.00
59	0	31.00	32.00	31.00	-1.00	-5.00	-3.50	-8.00	-2.00	-5.50	7.67
60	0	10.00	5.00	7.50	6.00	16.00	11.00	-8.00	9.00	0.00	5.83
61	0	21.00	34.00	27.00	15.00	-2.00	6.00	59.00	41.00	49.50	27.50
62	0	32.00	-7.00	12.50	-32.00	-11.00	-21.50	3.00	14.00	8.50	0.17
63	0	146.00	152.00	20.00	114.00	135.00	-35.50	191.00	168.00	41.50	9.00
64	0	27.00	18.00	22.00	-3.00	8.00	2.50	-18.00	7.00	-5.50	6.33
65	0	41.00	-1.00	19.50	24.00	2.00	13.00	9.00	24.00	16.50	16.00
66	0	-17.00	18.00	0.50	15.00	15.00	14.50	-9.00	12.00	1.50	5.17
67	0	-2.00	31.00	14.50	-7.00	26.00	9.50	-2.00	10.00	4.00	9.33
68	0	65.00	54.00	59.50	75.00	64.00	69.50	82.00	90.00	86.00	71.67
69	0	-14.00	-19.00	-16.50	-12.00	16.00	2.00	-27.00	-18.00	-22.50	-30.00
70	0	18.00	36.00	27.00	22.00	40.00	31.00	47.00	25.00	36.00	31.33
71	0	7.00	10.00	8.50	-33.00	27.00	-3.00	1.00	25.00	13.00	6.17
72	0	-1.00	49.00	24.00	12.00	16.00	14.00	-10.00	-4.00	-7.00	10.33
73	0	-3.00	-34.00	-18.50	16.00	15.00	15.50	-14.00	-9.00	-11.50	-4.83
74	0	11.00	25.00	18.00	30.00	3.00	16.50	15.00	1.00	8.00	14.17
75	0	19.00	21.00	20.00	-10.00	29.00	9.50	74.00	24.00	49.00	26.17
76	0	13.00	26.00	19.50	7.00	1.00	4.00	9.00	-7.00	1.00	8.17
77	0	-22.00	26.00	2.00	-14.00	-7.00	-10.50	-25.00	8.00	-8.50	-5.67
78	0	24.00	28.00	26.00	-13.00	34.00	10.50	-12.00	25.00	6.50	14.33
79	0	44.00	50.00	47.00	22.00	11.00	16.50	18.00	47.00	32.50	32.00
80	0	5.00	21.00	13.00	7.00	0.00	3.50	-21.00	-10.00	-15.50	0.33
81	0	22.00	-13.00	4.50	-20.00	19.00	-0.50	-25.00	-17.00	-21.00	-5.67
82	0	27.00	62.00	44.50	40.00	-38.00	1.00	29.00	21.00	25.00	23.50
83	0	0.00	14.00	7.00	-9.00	57.00	24.00	-17.00	25.00	4.00	11.67
84	0	28.00	2.00	15.00	37.00	8.00	22.50	36.00	12.00	24.00	20.50
85	0	26.00	12.00	19.00	34.00	-32.00	1.00	-51.00	23.00	-14.00	2.00
86	0	43.00	-67.00	-12.00	-7.00	29.00	11.00	8.00	-4.00	2.00	0.33
87	0	48.00	35.00	41.50	69.00	-47.00	11.00	11.00	-32.00	-10.50	14.00
88	0	7.00	-7.00	0.00	6.00	32.00	19.00	23.00	-18.00	2.50	7.17
89	0	25.00	3.00	14.00	32.00	2.00	17.00	29.00	-1.00	14.00	15.00
90	0	-7.00	58.00	25.50	16.00	12.00	14.00	-17.00	32.00	7.50	15.67
91	0	27.00	-9.00	9.00	16.00	-6.00	5.00	-12.00	19.00	3.50	5.83
92	0	19.00	-9.00	5.00	30.00	14.00	22.00	18.00	14.00	16.00	14.33
93	0	20.00	36.00	28.00	-13.00	9.00	-2.00	14.00	17.00	15.50	13.83
94	0	1.00	-1.00	0.00	24.00	17.00	20.50	26.00	26.00	26.00	15.50
95	0	1.00	-24.00	-11.50	0.00	-17.00	-8.50	-14.00	-2.00	-8.00	-9.33
96	0	30.00	24.00	27.00	54.00	3.00	28.50	16.00	22.00	19.00	24.83
97	0	31.00	-10.00	10.50	3.00	1.00	2.00	-13.00	10.00	-1.50	3.67
98	0	24.00	10.00	17.00	21.00	26.00	23.50	33.00	7.00	20.00	20.17
99	0	19.00	59.00	39.00	8.00	48.00	28.00	40.00	-4.00	18.00	28.33
100	0	3.00	-1.00	1.00	-27.00	36.00	4.50	19.00	18.00	18.50	8.00
101	0	12.00	-7.00	2.50	-1.00	-3.00	-2.00	-1.00	4.00	1.50	0.67
102	0	7.00	-21.00	-7.00	23.00	2.00	12.50	35.00	-22.00	6.50	4.00
103	0	-12.00	29.00	8.50	10.00	-4.00	3.00	2.00	18.00	10.00	7.17
104	0	84.00	31.00	57.50	19.00	18.00	18.50	7.00	-17.00	-5.00	23.67
105	0	10.00	-34.00	-12.00	-10.00	1.00	-4.50	-13.00	-19.00	-16.00	-10.83
106	0	22.00	1.00	11.50	49.00	73.00	61.00	51.00	27.00	39.00	37.17
107	0	23.00	14.00	18.50	-35.00	1.00	-17.00	-3.00	0.00	-1.50	0.00
108	0	8.00	20.00	14.00	-16.00	26.00	5.00	14.00	31.00	22.50	13.83
109	0	-14.00	1.00	-6.50	54.00	20.00	37.00	66.00	62.00	64.00	31.50
110	0	4.00	-146.00	-71.00	-7.00	31.00	12.00	2.00	-16.00	-7.00	-22.00
111	0	10.00	12.00	11.00	4.00	2.00	3.00	27.00	6.00	16.50	10.17
112	0	-2.00	42.00	20.00	0.00	-47.00	-23.50	-23.00	-6.00	-14.50	-6.00
113	0	6.00	17.00	11.50	-1.00	-14.00	-7.50	23.00	45.00	34.00	12.67
114	0	42.00	16.00	29.00	6.00	-17.00	-5.50	-13.00	7.00	-3.00	6.83
115	0	13.00	3.00	8.00	-9.00	-29.00	-19.00	9.00	-12.00	-1.50	-4.17

116	0	-20.00	-21.00	-20.50	0.00	-1.00	-0.50	-32.00	15.00	-8.50	-8.83
117	0	2.00	13.00	7.50	22.00	-35.00	-6.50	9.00	46.00	27.50	9.50
118	0	1.00	19.00	10.00	1.00	52.00	26.50	-27.00	32.00	2.50	13.00
119	0	1.00	3.00	2.00	20.00	9.00	14.50	4.00	7.00	5.50	7.33
120	0	17.00	29.00	23.00	31.00	35.00	33.00	20.00	17.00	18.50	24.83
121	0	30.00	16.00	23.00	-19.00	14.00	-2.50	-11.00	-18.00	-14.50	2.00
122	0	12.00	36.00	24.00	-4.00	14.00	5.00	-8.00	15.00	3.50	10.83
123	0	-87.00	-104.00	-95.50	-89.00	-118.00	-103.50	-73.00	-65.00	-69.00	-89.33
124	0	31.00	4.00	17.50	1.00	21.00	11.00	-32.00	-3.00	-17.50	3.67
125	0	-2.00	25.00	11.50	-7.00	-18.00	-12.50	37.00	15.00	26.00	8.33
126	0	25.00	-5.00	10.00	26.00	-9.00	8.50	-8.00	-8.00	-8.00	3.50
127	0	27.00	26.00	26.50	-7.00	-13.00	-10.00	16.00	11.00	13.50	10.00
128	0	-16.00	12.00	-2.00	-24.00	-38.00	-31.00	-8.00	13.00	2.50	-10.17
129	0	1.00	6.00	3.50	23.00	27.00	25.00	42.00	35.00	38.50	22.33
130	0	24.00	17.00	20.50	9.00	-6.00	1.50	8.00	1.00	4.50	8.83
131	1	-20.00	-48.00	-34.00	47.00	-3.00	22.00	-11.00	11.00	0.00	-4.00
132	1	30.00	36.00	19.00	-9.00	1.00	16.50	32.00	25.00	28.50	21.33
133	1	29.00	20.00	24.50	13.00	30.00	21.50	10.00	-16.00	-3.00	14.33
134	1	-69.00	-19.00	-44.00	-17.00	0.00	26.00	0.00	1.00	5.00	-4.33
135	1	27.00	122.00	74.50	153.00	30.00	91.50	24.00	-7.00	8.50	58.17
136	1	-6.00	-3.00	-4.50	40.00	-27.00	6.50	21.00	9.00	15.00	5.67
137	1	15.00	63.00	39.00	7.00	97.00	52.00	32.00	6.00	19.00	36.67
138	1	7.00	1.00	4.00	-7.00	4.00	-1.50	-24.00	17.00	-3.50	-0.33
139	1	6.00	-33.00	-13.50	-26.00	-12.00	-19.00	-8.00	4.00	-2.00	-11.50
140	1	36.00	24.00	30.00	100.00	73.00	86.50	-7.00	17.00	5.00	40.50
141	1	-10.00	18.00	4.00	-3.00	22.00	9.50	-12.00	-5.00	-8.50	1.67
142	1	22.00	10.00	16.00	-36.00	-35.00	-35.50	-39.00	-53.00	-46.00	-21.83
143	1	10.00	-11.00	-0.50	1.00	10.00	5.50	-7.00	43.00	18.00	7.67
144	1	1.00	8.00	4.50	23.00	36.00	29.50	-13.00	18.00	2.50	12.17
145	1	5.00	15.00	10.00	18.00	23.00	20.50	4.00	-3.00	0.50	10.33
146	2	-23.00	-4.00	-13.50	12.00	0.00	6.00	25.00	33.00	29.00	7.17
147	2	20.00	24.00	22.00	-4.00	7.00	1.50	30.00	13.00	21.50	15.00
148	2	-15.00	0.00	15.50	-18.00	0.00	-2.50	17.00	0.00	8.50	7.17
149	2	6.00	58.00	32.00	20.00	47.00	33.50	-61.00	22.00	-19.50	15.33
150	2	-10.00	6.00	-2.00	-23.00	28.00	2.50	40.00	12.00	26.00	8.83
151	2	21.00	15.00	17.50	124.00	13.00	68.50	-10.00	62.00	26.00	37.33
152	2	17.00	34.00	25.50	27.00	-11.00	8.00	-6.00	2.00	-2.50	10.33
153	2	21.00	37.00	29.00	118.00	111.00	114.50	-7.00	-19.00	-13.00	43.50
154	2	-10.00	12.00	1.00	7.00	32.00	19.50	80.00	12.00	46.00	22.17
155	2	13.00	14.00	13.50	8.00	-9.00	-0.50	5.00	36.00	20.50	11.17
156	2	3.00	13.00	8.00	14.00	12.00	13.00	2.00	11.00	6.50	9.17
157	2	-20.00	20.00	0.00	17.00	7.00	12.00	34.00	1.00	17.50	9.83
158	2	44.00	16.00	30.00	61.00	15.00	38.00	-10.00	2.00	-4.00	21.33
159	2	39.00	-21.00	9.00	2.00	-6.00	-2.00	3.00	-9.00	-3.00	1.33
160	2	18.00	26.00	22.00	22.00	28.00	25.00	-12.00	21.00	4.50	17.17
161	2	25.00	12.00	18.50	12.00	26.00	19.00	9.00	8.00	8.50	15.33
162	3	26.00	50.00	39.00	-18.00	-1.00	-9.50	-13.00	-24.00	-18.50	3.67
163	3	13.00	-1.00	6.00	-91.00	-4.00	-47.50	-21.00	-12.00	-16.50	-19.33
164	3	29.00	-27.00	0.50	43.00	5.00	23.50	78.00	16.00	47.00	24.00
165	3	18.00	16.00	17.00	116.00	38.00	77.00	54.00	54.00	54.00	49.33
166	3	-3.00	19.00	8.00	-4.00	3.00	-0.50	-8.00	21.00	6.50	4.67
167	3	37.00	-11.00	13.00	9.00	27.00	18.00	-5.00	7.00	1.00	10.67
168	3	-69.00	-19.00	-44.00	95.00	17.00	56.00	52.00	54.00	53.00	21.67
169	3	-66.00	-11.00	-38.50	69.00	-1.00	34.00	28.00	40.00	34.00	9.83
170	3	0.00	28.00	14.00	7.00	24.00	15.50	3.00	2.00	2.50	10.67

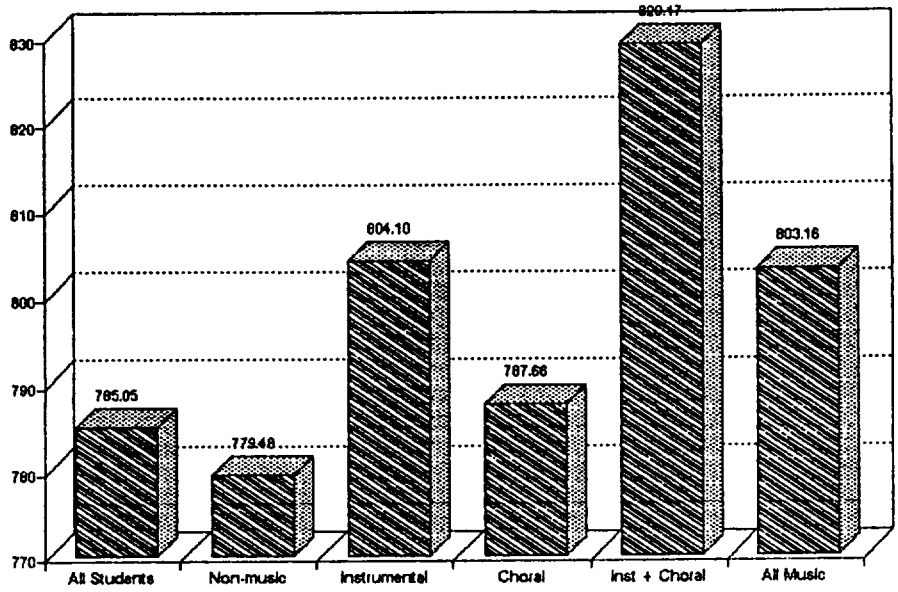
Appendix E

Graphic Comparison of

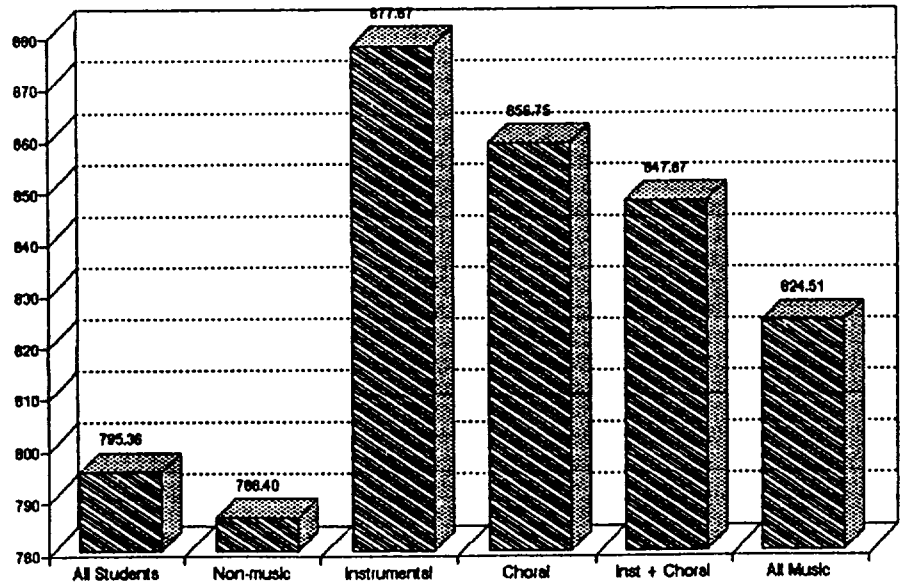
Mean California Achievement Test Cohort Scores

Between Grade Nine and Grade Ten

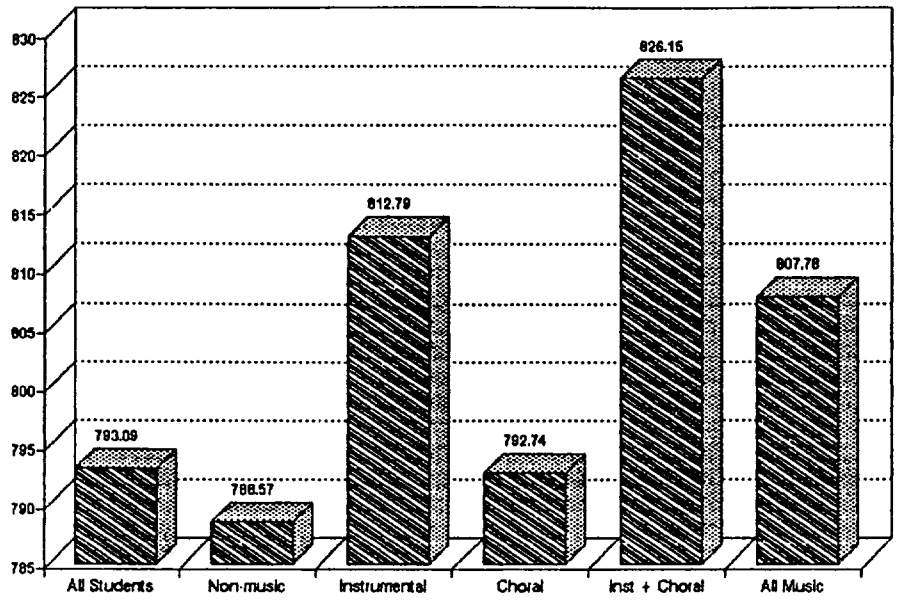
California Achievement Test Mean Scores
Grade 9 - Total Language



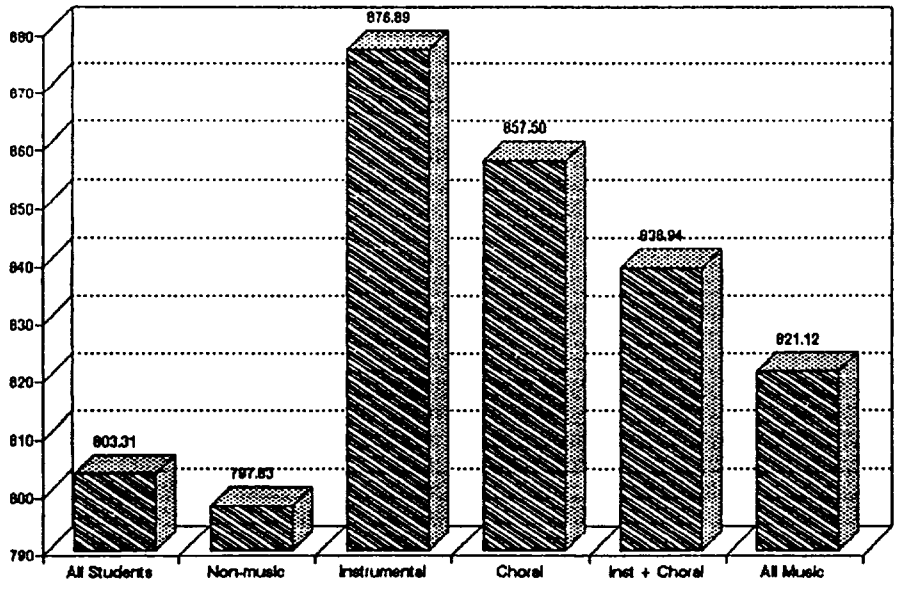
California Achievement Test Mean Scores
Grade 10 - Total Language



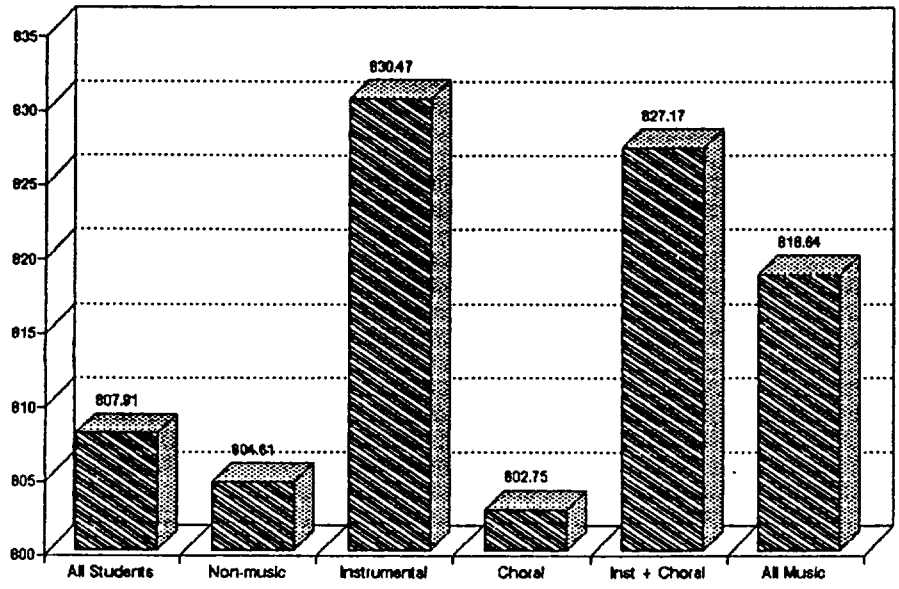
California Achievement Test Mean Scores
Grade 9 - Total Battery



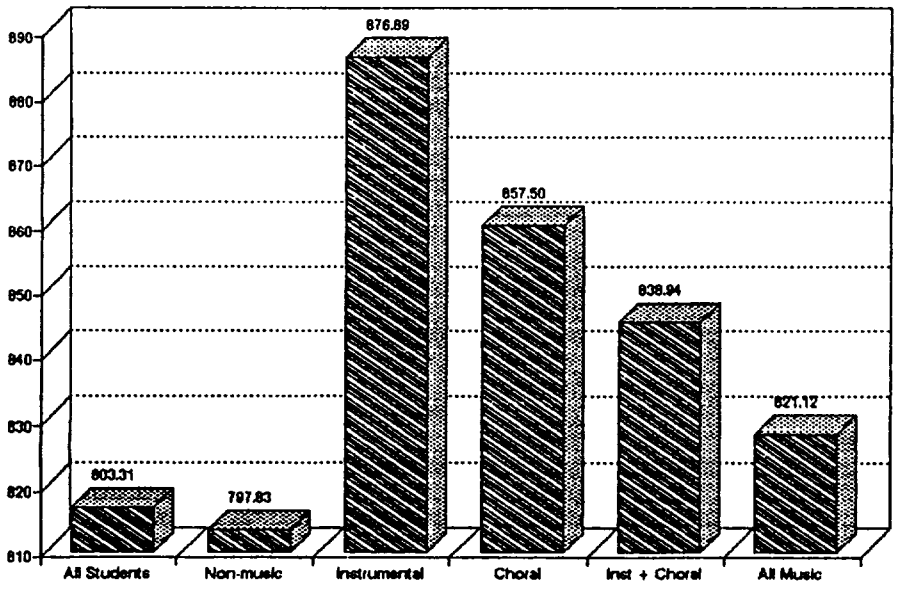
CAT-5 Mean Scores
Grade 10 - Total Battery



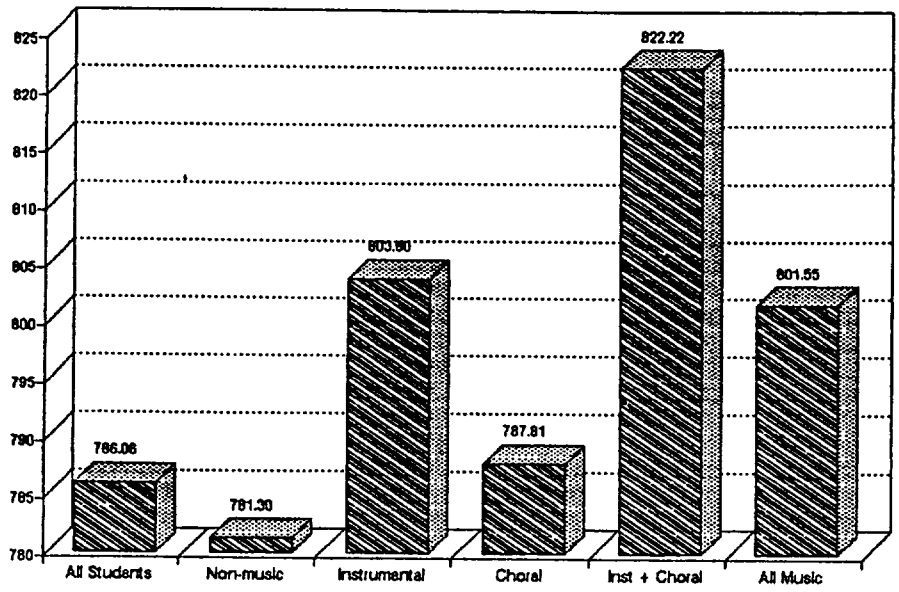
California Achievement Test Mean Scores
Grade 9 - Total Mathematics



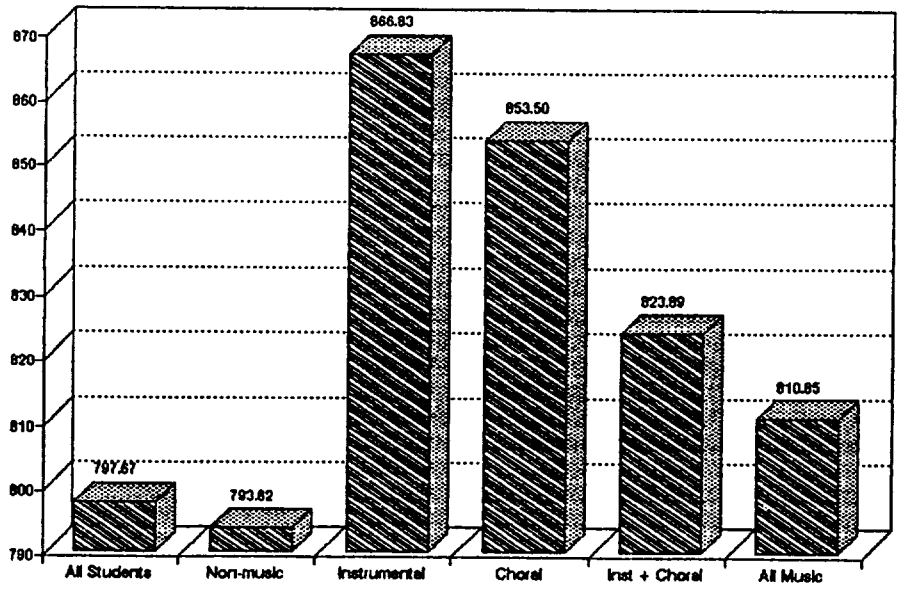
California Achievement Test Mean Scores
Grade 10 - Total Mathematics



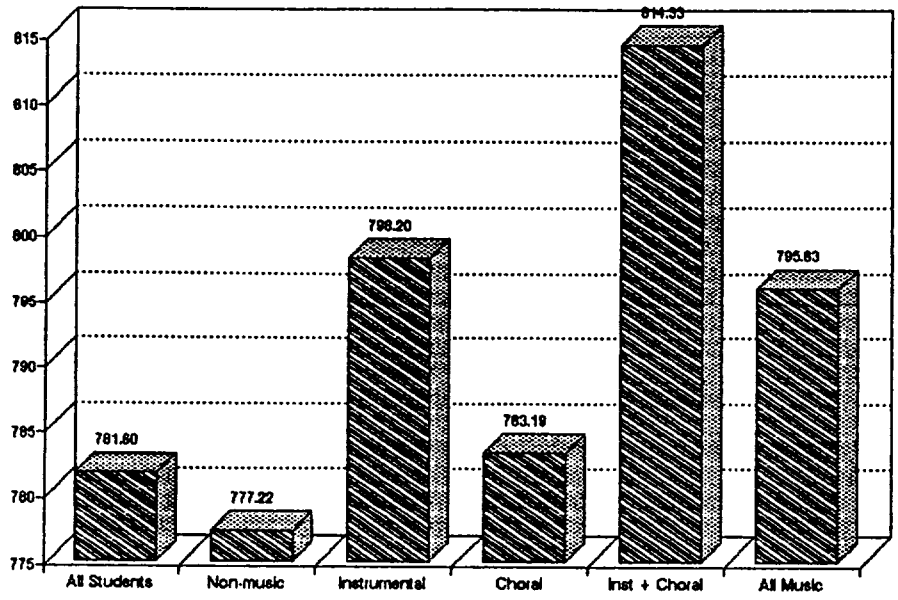
California Achievement Test Mean Scores
Grade 9 - Total Reading



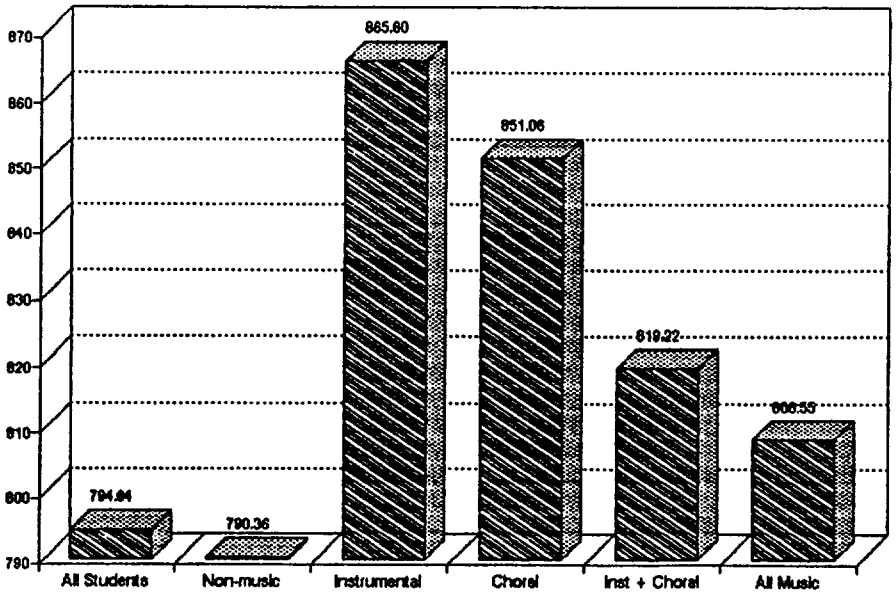
California Achievement Test Mean Scores
Grade 10 - Total Reading



California Achievement Test Mean Scores
Grade 9 - Reading Comprehension



California Achievement Test Mean Scores
Grade 10 - Reading Comprehension



Appendix F

t - Table

t - Table

Probability (P) for values of *t* at various degrees of freedom (*d.f.*)

d.f. \P	0.5	0.4	0.3	0.2	0.1	0.05	0.01
1	1.000	1.376	1.963	3.078	6.314	12.706	63.657
2	0.816	1.061	1.386	1.886	2.920	4.303	9.925
3	0.765	0.978	1.250	1.638	2.353	3.182	5.841
4	0.741	0.941	1.190	1.533	2.132	2.776	4.604
5	0.727	0.920	1.156	1.476	2.015	2.571	4.032
6	0.718	0.906	1.134	1.440	1.943	2.447	3.707
7	0.711	0.896	1.119	1.415	1.895	2.365	3.499
8	0.706	0.889	1.108	1.397	1.860	2.306	3.355
9	0.703	0.883	1.100	1.383	1.833	2.626	3.250
10	0.700	0.879	1.093	1.372	1.812	2.228	3.169
15	0.691	0.866	1.074	1.341	1.753	2.131	2.947
20	0.687	0.860	1.064	1.325	1.725	2.086	2.845
25	0.684	0.856	1.058	1.316	1.708	2.060	2.787
30	0.683	0.854	1.055	1.310	1.697	2.042	2.750
50	0.680	0.849	1.047	1.299	1.676	2.008	2.678
100	0.677	0.846	1.042	1.290	1.661	1.984	2.626
~	0.674	0.842	1.036	1.282	1.645	1.960	2.576

(Gardner, Edon J., 1972)

Appendix G

t - Test Analyses

Comparison of Mean

California Achievement Test Scores

Grade Nine

Comparison of Mean Scores - Grade 9

Total Battery

Non-Music Students vs All Music Students

	Non-Music	All Music
Mean	786.66	804.82
Variance	1110.46	2054.09
Stan Dev	33.32	45.32
Standard Error of the Mean	2.92	7.17
Standard Error of the Difference	7.74	
t	2.35	
degrees of freedom	> 100	
p	< 0.05	

Comparison of Mean Scores - Grade 9

Total Battery

Non-Music Students vs Instrumental

	Non-Music	Instrumental
Mean	786.66	804.90
Variance	1217.28	2394.61
Stan Dev	34.89	48.93
Standard Error of the Mean	3.06	12.63
Standard Error of the Difference	13.00	
t	1.40	
degrees of freedom	> 100	
p	< 0.20	

Comparison of Mean Scores - Grade 9

Total Battery

Non-Music Students vs Vocal

	Non-Music		Vocal
Mean	786.66		792.74
Variance	1217.28		1640.95
Stan Dev	34.89		40.51
Standard Error of the Mean	3.06		10.13
Standard Error of the Difference		10.58	
t		0.57	
degrees of freedom		> 100	
p		> 0.50	

Comparison of Mean Scores - Grade 9

Total Battery

Non-Music Students vs Instrumental % Vocal

	Non-Music		Inst. & Vocal
Mean	786.66		826.15
Variance	1110.46		788.79
Stan Dev	33.32		28.09
Standard Error of the Mean	2.92		9.36
Standard Error of the Difference		9.81	
t		4.03	
degrees of freedom		> 100	
p		< 0.01	

Comparison of Mean Scores - Grade 9

Total Battery

Vocal Music vs. Instrumental

	Vocal	Instrumental
Mean	792.74	804.90
Variance	941.12	2394.61
Standard Dev	30.68	48.93
Standard Error of the Mean	7.67	12.63
Standard Error of the Difference	14.78	
t	0.82	
degrees of freedom	> 100	
p	< 0.4	

Comparison of Mean Scores - Grade 9

Total Mathematics

Non-Music vs. All Music Students

	Non-Music		All Music
Mean	798.88		809.76
Variance	4956.88		4706.29
Standard Dev	70.41		68.60
Standard Error of the Mean	6.17		10.85
Standard Error of the Difference		12.48	
t		0.87	
degrees of freedom		> 100	
p		> 0.50	

Comparison of Mean Scores - Grade 9

Total Mathematics

Non-Music vs. Instrumental Music Students

	Non-Music		Instrumental
Mean	798.88		806.80
Variance	4956.88		10249.40
Standard Dev	70.41		101.24
Standard Error of the Mean	6.17		26.14
Standard Error of the Difference		26.86	
t		0.29	
degrees of freedom		> 100	
p		> 0.50	

Comparison of Mean Scores - Grade 9

Total Mathematics

Non-Music vs. Vocal Music Students

	Non-Music		Vocal
Mean	798.88		802.75
Variance	4956.88		2875.81
Standard Dev	70.41		53.63
Standard Error of the Mean	6.17		13.41
Standard Error of the Difference		14.76	
t		0.26	
degrees of freedom		> 100	
p		> 0.5	

Comparison of Mean Scores - Grade 9

Total Mathematics

Non-Music vs. Inst. & Vocal Students

	Non-Music		Inst. & Vocal
Mean	798.88		827.17
Variance	4956.88		1244.03
Standard Dev	70.41		35.27
Standard Error of the Mean	6.17		11.76
Standard Error of the Difference		13.28	
t		2.13	
degrees of freedom		> 100	
p		< 0.05	

Comparison of Mean Scores - Grade 9

Total Mathematics

Instrumental Music vs. Vocal Music

	Inst. Music	Vocal Music
Mean	806.80	802.75
Variance	10239.20	1404.66
Stan Dev	101.19	37.48
Standard Error of the Mean	26.13	9.37
Standard Error of the Difference	27.76	
t	0.15	
degrees of freedom	> 100	
p	> 0.5	

Comparison of Mean Scores - Grade 9

Mathematics Concepts and Applications

Non-Music vs. All Music Students

	Non-Music	All Music
Mean	793.58	792.73
Variance	4929.44	14325.83
Standard Dev	70.21	119.69
Standard Error of the Mean	6.16	18.92
Standard Error of the Difference	19.90	
t	0.04	
degrees of freedom	> 100	
p	> 0.50	

Comparison of Mean Scores - Grade 9

Mathematics Concepts and Applications

Non-Music vs. Instrumental Music Students

	Non-Music		Instrumental
Mean	793.58		775.67
Variance	4929.44		35539.40
Standard Dev	70.21		188.52
Standard Error of the Mean	6.16		48.68
Standard Error of the Difference		49.06	
t		0.37	
degrees of freedom		> 100	
p		> 0.50	

Comparison of Mean Scores - Grade 9

Mathematics Computation

Non-Music vs. All Music Students

	Non-Music	All Music
Mean	799.63	826.78
Variance	6309.91	1496.93
Standard Dev	79.43	38.69
Standard Error of the Mean	6.97	6.12
Standard Error of the Difference	9.27	
t	2.93	
degrees of freedom	> 100	
p	< 0.05	

Comparison of Mean Scores - Grade 9

Mathematics Computation

Non-Music vs. Instrumental Music Students

	Non-Music		Instrumental
Mean	799.63		837.93
Variance	6309.91		735.93
Standard Dev	79.43		27.13
Standard Error of the Mean	6.97		7.00
Standard Error of the Difference		9.88	
t		3.88	
degrees of freedom		> 100	
p		< 0.01	

Comparison of Mean Scores - Grade 9

Total Reading

Non-Music vs. All Music Students

	Non-Music	All Music
Mean	781.30	801.55
Variance	831.60	1408.95
Standard Dev	28.84	37.54
Standard Error of the Mean	2.53	5.93
Standard Error of the Difference	6.45	
t	3.14	
degrees of freedom	> 100	
p	< 0.01	

Comparison of Mean Scores - Grade 9

Total Reading

Non-Music vs. Instumental Music Students

	Non-Music		Instrumental
Mean	781.30		803.80
Variance	831.60		1518.93
Standard Dev	28.84		38.97
Standard Error of the Mean	2.53		10.06
Standard Error of the Difference		10.38	
t		2.17	
degrees of freedom		> 100	
p		< 0.05	

Comparison of Mean Scores - Grade 9

Mathematics Computation

Non-Music vs. Vocal Music Students

	Non-Music		Vocal Music
Mean	799.63		808.44
Variance	6309.91		1570.56
Standard Dev	79.43		39.63
Standard Error of the Mean	6.97		9.91
Standard Error of the Difference		12.11	
t		0.73	
degrees of freedom		> 100	
p		> 0.4	

Appendix H

t - Test Analyses

Comparison of Mean

California Achievement Test Scores

Grade Ten

Comparison of Mean Scores - Grade 10

Total Battery

All Music Students vs. Non-Music Students

	Non-Music	All Music
Mean	797.83	821.12
Variance	768.36	1533.21
Standard Dev	27.72	39.16
Standard Error of the Mean	2.43	6.19
Standard Error of the Difference	6.65	
t	3.50	
degrees of freedom	> 100	
p	< 0.01	

Comparison of Mean Scores - Grade 10

Total Battery

Non-Music vs. Instrumental

	Non-Music		Instrumental
Mean	797.83		823.89
Variance	768.36		1545.76
Standard Dev	27.72		39.32
Standard Error of the Mean	2.43		10.15
Standard Error of the Difference		10.44	
t		2.50	
degrees of freedom		> 100	
p		< 0.05	

Comparison of Mean Scores - Grade 10

Total Battery

Non-Music vs. Vocal Music Students

	Non-Music		Vocal
Mean	797.83		808.50
Variance	768.36		1328.72
Stand Dev	27.72		36.45
Standard Error of the Mean	2.43		9.11
Standard Error of the Difference		9.43	
t		1.13	
degrees of freedom		> 100	
p		> 0.2	

Comparison of Mean Scores - Grade 10

Total Battery

Non-Music Students vs. Inst. & Vocal

	Non-Music	Inst. & Vocal
Mean	797.83	838.94
Variance	768.36	1262.63
Standard Dev	27.72	35.53
Standard Error of the Mean	2.43	11.84
Standard Error of the Difference	12.09	
t	3.40	
degrees of freedom	> 100	
p	< 0.01	

Comparison of Mean Scores - Grade 10

Total Battery

Vocal Music vs. Instrumental

	Vocal		Instrumental
Mean	808.50		823.89
Variance	1328.72		1545.76
Standard Dev	36.45		39.32
Standard Error of the Mean	9.11		10.15
Standard Error of the Difference		13.64	
t		1.13	
degrees of freedom		> 100	
p		< 0.3	

Comparison of Mean Scores - Grade 10

Total Mathematics

Non-Music vs. All Music

	Non-Music	All Music
Mean	813.49	828.00
Variance	1007.14	1796.43
Standard Dev	31.74	42.38
Standard Error of the Mean	2.78	6.70
Standard Error of the Difference	7.26	
t	2.00	
degrees of freedom	> 100	
p	< 0.05	

Comparison of Mean Scores - Grade 10

Total Mathematics

Non-Music vs. All Music

	Non-Music		Instrumental
Mean	813.49		833.07
Variance	1007.14		1186.27
Standard Dev	31.74		34.44
Standard Error of the Mean	2.78		8.89
Standard Error of the Difference		9.32	
t		2.10	
degrees of freedom		> 100	
p		< 0.05	

Comparison of Mean Scores - Grade 10

Total Mathematics

Non-Music vs. Vocal Music Students

	Non-Music		Vocal
Mean	813.49		813.53
Variance	1007.14		1711.23
Standard Dev	31.74		41.37
Standard Error of the Mean	2.78		10.34
Standard Error of the Difference		10.71	
t		0.00	
degrees of freedom		> 100	
p		> 0.5	

Comparison of Mean Scores - Grade 10

Total Mathematics

Non-Music vs. Vocal & Inst. Students

	Non-Music		Inst. & Vocal
Mean	813.49		845.28
Variance	1007.14		2964.81
Standard Dev	31.74		54.45
Standard Error of the Mean	2.78		18.15
Standard Error of the Difference		18.36	
t		1.73	
degrees of freedom		> 100	
p		< 0.1	

Comparison of Mean Scores - Grade 10

Total Mathematics

Instrumental Music vs. Vocal Music

	Inst. Music	Vocal Music
Mean	833.07	813.53
Variance	1160.60	1358.72
Stan Dev	34.07	36.86
Standard Error of the Mean	8.80	9.22
Standard Error of the Difference	12.74	
t	1.53	
degrees of freedom	> 100	
p	< 0.2	

Comparison of Mean Scores - Grade 10

Mathematics Concepts and Applications

Non-Music vs. All Music Students

	Non-Music		All Music
Mean	811.44		821.28
Variance	1013.30		1778.68
Standard Dev	31.83		42.17
Standard Error of the Mean	2.79		6.67
Standard Error of the Difference		7.23	
t		1.36	
degrees of freedom		> 100	
p		< 0.2	

Comparison of Mean Scores - Grade 10

Mathematics Concepts and Applications

Non-Music vs. Instrumental Music Students

	Non-Music		Instrumental
Mean	811.44		827.47
Variance	1013.30		1298.47
Standard Dev	31.83		36.03
Standard Error of the Mean	2.79		9.30
Standard Error of the Difference		9.71	
t		1.65	
degrees of freedom		> 100	
p		< 0.1	

Comparison of Mean Scores - Grade 10

Mathematics Computation

Non-Music vs. Vocal Music Students

	Non-Music	Vocal Music
Mean	815.54	817.13
Variance	1013.30	1825.56
Standard Dev	31.83	42.73
Standard Error of the Mean	2.79	10.68
Standard Error of the Difference	11.04	
t	0.14	
degrees of freedom	> 100	
p	> 0.5	

Comparison of Mean Scores - Grade 10

Mathematics Computation

Non-Music vs. All Music Students

	Non-Music	All Music
Mean	815.54	838.07
Variance	1013.30	1298.47
Standard Dev	31.83	36.03
Standard Error of the Mean	2.79	9.30
Standard Error of the Difference	9.71	
t	2.32	
degrees of freedom	> 100	
p	< 0.05	

Comparison of Mean Scores - Grade 10

Mathematics Computation

Non-Music vs. Instrumental Music Students

	Non-Music		Instrumental
Mean	815.54		838.07
Variance	1013.30		1409.20
Standard Dev	31.83		37.54
Standard Error of the Mean	2.79		9.69
Standard Error of the Difference		10.09	
t		2.23	
degrees of freedom		> 100	
p		< 0.05	

Comparison of Mean Scores - Grade 10

Total Reading

Non-Music vs. All Music Students

	Non-Music	All Music
Mean	793.62	810.85
Variance	925.86	1084.34
Standard Dev	30.43	32.93
Standard Error of the Mean	2.67	5.21
Standard Error of the Difference	5.85	
t	2.95	
degrees of freedom	> 100	
p	< 0.05	

Comparison of Mean Scores - Grade 10

Total Reading

Non-Music vs. Instrumental Music Students

	Non-Music		Instrumental
Mean	793.62		812.40
Variance	925.86		1588.47
Standard Dev	30.43		39.86
Standard Error of the Mean	2.67		10.29
Standard Error of the Difference		10.63	
t		1.77	
degrees of freedom		> 100	
p		< 0.1	

Appendix I

California Achievement Test Scores

Individual Percent Change from

Grade Nine to Grade Ten

Percent Change in CAT-5 Scores (Grade 9 => 10)

	Read Vocab.	Read Comp.	Read Total	Lang Mech.	Lang Expr	Lang Total	Math Compu.	Math C & A	Math Total	Total Battery
	Mean Scores Changes									
All Students	1.56	1.73	1.51	1.50	1.28	1.32	1.43	1.52	1.14	1.30
Non-Music	1.79	1.75	1.60	1.08	1.05	0.91	1.57	1.58	1.14	1.20
Instrumental	0.78	1.74	1.12	2.53	2.05	2.69	0.00	0.54	0.30	1.34
Vocal	1.23	2.11	1.83	3.09	2.37	2.77	1.15	1.64	1.36	1.97
Inst + Vocal	0.02	0.71	0.31	3.06	1.46	2.24	2.14	2.10	2.12	1.54
All Music	0.79	1.65	1.22	2.87	2.04	2.62	0.94	1.33	1.13	1.63

#	Type	Individual Student Scores Changes									
1	0	-0.38	3.58	1.59	8.01	0.25	4.10	1.27	-0.81	0.23	1.93
2	0	-2.26	2.52	0.13	3.21	1.62	2.40	-1.07	1.46	0.18	0.89
3	0	3.90	6.84	5.33	1.13	4.52	2.87	-0.13	5.42	2.62	3.61
4	0	1.35	-0.49	0.43	0.74	-0.37	0.19	1.56	2.02	1.79	0.81
5	0	0.25	0.75	0.50	3.39	-3.76	-0.31	1.32	3.98	2.64	0.97
6	0	1.48	2.10	1.79	3.52	2.87	3.10	1.71	0.92	1.31	2.07
7	0	0.90	0.78	0.84	-0.51	-3.03	-1.77	-3.86	-1.53	-2.73	-1.24
8	0	0.74	4.50	2.59	1.71	-3.75	1.41	4.56	0.00	2.27	2.09
9	0	-0.65	-0.26	-0.45	3.26	1.17	4.79	6.06	0.39	3.19	2.48
10	0	2.96	2.41	2.69	-4.34	3.09	-0.62	0.00	1.72	0.85	0.97
11	0	6.04	2.01	3.98	3.41	4.91	4.16	-0.13	3.66	1.75	3.29
12	0	1.53	2.88	2.20	2.54	4.36	3.46	0.71	-0.98	-0.12	1.83
13	0	3.94	4.80	4.37	-0.38	3.25	1.42	-2.36	2.89	0.25	1.99
14	0	1.01	0.64	0.82	-4.62	-3.06	-3.83	-7.13	-2.46	-4.83	-2.65
15	0	2.41	0.77	1.57	6.72	2.74	4.70	0.72	0.51	0.62	2.25
16	0	1.39	0.13	0.77	1.54	0.90	1.22	3.52	-2.61	0.38	0.79
17	0	2.53	2.20	2.37	1.53	1.26	1.39	0.24	1.38	0.80	1.51
18	0	-0.25	-0.89	-0.56	6.91	-2.48	2.01	1.77	1.94	1.85	1.09
19	0	5.14	2.83	4.01	3.67	3.71	3.69	8.16	2.64	5.36	4.36
20	0	0.13	3.07	1.58	0.26	0.13	0.19	1.10	1.49	1.30	1.02
21	0	0.88	3.31	2.06	2.20	4.84	3.51	1.12	1.39	1.26	2.26
22	0	5.61	8.48	7.03	11.51	3.76	7.67	0.78	7.44	4.06	6.25
23	0	5.09	5.25	5.17	3.17	6.11	4.62	3.78	2.75	3.27	4.34
24	0	1.03	2.29	1.67	-0.50	0.50	0.00	0.37	-0.50	-0.06	0.52
25	0	-1.34	0.54	-0.41	0.54	-0.13	0.20	1.74	-0.65	0.53	0.11
26	0	3.23	7.79	5.50	-4.96	0.86	-2.07	12.27	6.39	9.31	4.27
27	0	-0.37	-1.01	-0.69	-5.98	-6.66	-6.32	-7.32	-4.24	-5.77	-4.30
28	0	4.71	3.60	4.15	-0.25	0.37	0.06	-0.24	-1.53	-0.88	1.08
29	0	2.62	4.34	3.48	-1.23	1.99	0.41	-4.61	4.17	-0.38	1.15
30	0	2.64	2.09	2.36	3.34	0.38	1.85	-0.24	4.19	1.92	2.05
31	0	2.05	4.18	3.10	3.04	2.21	2.63	8.06	3.39	5.70	3.79
32	0	0.38	-0.51	-0.06	-3.73	-0.38	-2.06	-1.48	-0.75	-1.12	-1.06
33	0	2.47	3.41	2.93	5.23	-6.15	-0.47	-1.71	0.00	-0.86	0.50
34	0	-1.87	3.20	0.58	0.39	0.13	0.26	-1.21	3.02	0.86	0.57
35	0	-0.60	2.89	1.11	-5.29	0.50	-2.44	1.55	0.94	1.24	-0.02
36	0	0.25	-1.26	-0.50	9.91	-1.59	3.98	1.23	-1.51	-0.12	1.11
37	0	4.82	2.04	3.44	3.71	0.40	2.07	3.08	3.06	3.07	2.86
38	0	-3.85	-0.92	-2.43	-5.32	2.45	-1.52	-0.76	0.88	0.06	-1.29
39	0	0.90	1.54	1.22	-1.36	3.43	0.96	2.38	1.89	2.13	1.44
40	0	2.33	-3.75	-0.68	0.63	0.13	0.38	-0.25	0.89	0.31	0.00
41	0	-1.52	-1.06	-1.29	-6.10	-0.53	-3.34	0.00	2.08	1.03	-1.15
42	0	-0.13	1.30	0.59	0.27	0.13	0.20	-3.28	1.03	-1.15	-0.13
43	0	0.93	4.27	2.59	-0.26	-0.52	-0.46	3.40	1.41	2.33	1.57
44	0	0.26	0.66	0.39	-1.87	-1.20	-1.53	4.34	0.00	2.05	0.40
45	0	2.55	4.40	3.47	0.38	-0.12	0.13	-6.64	1.73	-2.54	0.29
46	0	-0.37	-0.38	-0.44	3.23	-2.45	0.37	2.62	4.29	3.38	1.21
47	0	0.24	-4.40	-2.16	1.32	0.75	1.03	0.00	1.64	0.82	-0.15
48	0	3.17	0.66	1.92	5.62	-2.33	1.46	3.79	-1.05	1.31	1.56
49	0	0.13	1.26	0.70	1.68	3.47	2.60	-1.95	-1.35	-1.71	0.50
50	0	-1.78	-2.30	-2.04	-2.11	2.75	0.25	67.16	0.38	1.09	-0.28

51	0	2.44	1.59	1.96	4.90	1.61	3.20	4.29	7.22	5.68	3.67
52	0	5.70	4.62	5.09	0.90	5.03	2.92	-5.24	0.61	-2.39	1.88
53	0	0.13	1.26	0.69	-0.13	2.14	0.96	4.19	4.22	4.21	1.94
54	0	3.12	2.25	2.68	1.24	2.33	1.73	2.06	-1.80	0.06	1.47
55	0	2.60	0.53	1.51	-8.18	4.95	-1.73	-2.29	1.78	-0.37	-0.11
56	0	1.74	4.22	2.99	0.13	-0.13	0.00	6.59	3.55	4.99	2.68
57	0	4.15	4.87	4.44	-2.57	4.78	1.08	4.37	7.54	5.88	3.91
58	0	-1.26	6.04	2.35	1.01	3.08	2.03	-1.58	3.52	0.91	1.75
59	0	4.18	4.41	4.22	-0.14	-0.67	-0.48	-1.08	-0.26	-0.72	1.04
60	0	1.28	0.68	0.97	0.78	2.09	1.42	-0.96	1.08	0.00	0.73
61	0	2.81	4.53	3.60	1.93	-0.26	0.78	7.62	5.46	6.49	3.62
62	0	4.56	-0.94	1.73	-4.37	-1.50	-2.94	0.39	1.85	1.11	0.02
63	0	20.86	21.71	2.41	16.29	19.29	-4.13	27.29	24.00	4.95	1.07
64	0	3.52	2.35	2.86	-0.38	1.01	0.32	-2.16	0.89	-0.68	0.80
65	0	5.67	-0.13	2.62	3.14	0.26	1.69	1.12	2.93	2.03	2.06
66	0	-2.29	2.50	0.07	1.98	2.02	1.93	-1.17	1.82	0.20	0.69
67	0	-0.25	3.91	1.82	-0.66	3.21	1.17	-0.25	1.26	0.50	1.16
68	0	9.29	7.71	8.50	10.71	9.14	9.93	11.71	12.86	12.29	10.24
69	0	-1.71	-2.36	-2.03	-1.52	2.03	0.25	-3.25	-2.19	-2.72	-3.63
70	0	2.27	4.62	3.44	2.89	5.17	4.04	5.99	3.19	4.59	4.02
71	0	0.89	1.27	1.08	-4.04	3.50	-0.36	0.12	3.18	1.63	0.78
72	0	-0.12	6.46	3.07	1.59	2.12	1.85	-1.24	-0.50	-0.87	1.32
73	0	-0.41	-4.56	-2.50	2.19	2.09	2.14	-1.86	-1.19	-1.52	-0.65
74	0	1.34	3.12	2.22	3.79	0.37	2.07	1.91	0.13	1.01	1.77
75	0	2.38	2.63	2.50	-1.28	3.65	1.20	8.61	2.87	5.78	3.22
76	0	1.72	3.51	2.60	0.91	0.13	0.52	1.17	-0.89	0.13	1.07
77	0	-2.66	3.41	0.25	-1.78	-0.88	-1.33	-2.84	0.99	-1.02	-0.70
78	0	3.05	3.59	3.32	-1.67	4.30	1.34	-1.45	3.15	0.80	1.81
79	0	5.74	6.49	6.11	3.01	1.39	2.17	2.30	6.03	4.16	4.16
80	0	0.65	2.76	1.70	0.92	0.00	0.46	-2.47	-1.22	-1.85	0.04
81	0	2.93	-1.77	0.61	-2.71	2.65	-0.07	-3.07	-2.11	-2.59	-0.75
82	0	3.40	8.09	5.71	4.99	-4.55	0.12	3.45	2.53	2.99	2.90
83	0	0.00	1.72	0.85	-1.15	6.97	2.99	-2.02	3.04	0.48	1.43
84	0	3.55	0.25	1.90	4.64	0.97	2.78	4.46	1.49	2.98	2.56
85	0	3.32	1.54	2.43	4.21	-3.88	0.12	-5.86	2.82	-1.66	0.25
86	0	5.09	-7.46	-1.38	-0.88	3.36	1.33	0.94	-0.48	0.24	0.04
87	0	5.71	4.38	5.06	7.93	-5.36	1.26	1.28	-3.64	-1.21	1.64
88	0	0.94	-0.94	0.00	0.81	4.46	2.61	2.99	-2.31	0.32	0.96
89	0	3.16	0.38	1.77	4.01	0.25	2.12	3.61	-0.12	1.72	1.87
90	0	-0.86	7.49	3.21	2.00	1.47	1.73	-2.03	4.03	0.92	1.84
91	0	3.57	-1.16	1.18	2.12	-0.76	0.65	-1.47	2.36	0.43	0.75
92	0	2.53	-1.14	0.65	3.87	1.84	2.86	2.33	1.77	2.05	1.85
93	0	2.54	4.67	3.59	-1.68	1.15	-0.26	1.66	2.04	1.85	1.73
94	0	0.13	-0.13	0.00	3.15	2.31	2.74	3.33	3.37	3.35	2.05
95	0	0.12	-2.95	-1.41	0.00	-2.10	-1.07	-1.66	-0.24	-0.96	-1.14
96	0	3.58	2.92	3.25	6.67	0.36	3.49	1.91	2.58	2.25	2.99
97	0	3.99	-1.23	1.32	0.38	0.13	0.25	-1.61	1.23	-0.19	0.46
98	0	3.03	1.27	2.15	2.74	3.30	3.02	4.33	0.87	2.55	2.57
99	0	2.22	7.50	4.75	1.00	5.97	3.50	4.94	-0.48	2.20	3.48
100	0	0.38	-0.13	0.13	-3.57	4.76	0.60	2.44	2.29	2.38	1.03
101	0	1.48	-0.85	0.31	-0.13	-0.37	-0.25	-0.12	0.49	0.18	0.08
102	0	0.93	-2.70	-0.92	3.07	0.26	1.66	4.53	-2.73	0.82	0.52
103	0	-1.61	3.98	1.15	1.28	-0.53	0.39	0.25	2.28	1.25	0.93
104	0	12.65	4.10	8.10	2.57	2.41	2.49	0.90	-2.15	-0.64	3.17
105	0	1.26	-4.14	-1.49	-1.31	0.13	-0.58	-1.65	-2.42	-2.04	-1.37
106	0	2.64	0.12	1.39	6.32	8.82	7.61	5.99	3.12	4.54	4.48
107	0	2.82	1.71	2.27	-4.14	0.12	-2.03	-0.36	0.00	-0.18	0.00
108	0	0.99	2.50	1.74	-2.06	3.31	0.64	1.74	3.86	2.80	1.74
109	0	-1.86	0.13	-0.86	7.99	2.62	5.15	9.07	8.61	8.84	4.30
110	0	0.50	-18.74	-8.99	-0.87	4.04	1.53	0.24	-1.91	-0.84	-2.74
111	0	1.26	1.49	1.38	0.51	0.26	0.38	3.20	0.73	1.99	1.27
112	0	-0.24	5.48	2.51	0.00	-5.62	-2.90	-2.69	-0.72	-1.71	-0.73
113	0	0.75	2.15	1.44	-0.12	-1.69	-0.90	2.77	5.56	4.15	1.55
114	0	5.69	2.14	3.91	0.79	-2.19	-0.71	-1.58	0.88	-0.37	0.88

115	0	1.62	0.37	0.99	-1.15	-3.57	-2.38	1.09	-1.39	-0.16	-0.51
116	0	-2.36	-2.51	-2.44	0.00	-0.12	-0.06	-3.60	1.60	-0.99	-1.17
117	0	0.25	1.65	0.94	2.77	-4.32	-0.81	1.07	5.73	3.34	1.16
118	0	0.12	2.36	1.24	0.12	6.52	3.25	-3.07	3.99	0.30	1.59
119	0	0.13	0.39	0.26	2.73	1.19	1.95	0.52	0.92	0.72	0.96
120	0	2.17	3.76	2.97	4.18	4.63	4.41	2.54	2.19	2.37	3.23
121	0	4.05	2.14	3.09	-2.41	1.66	-0.32	-1.33	-2.33	-1.82	0.26
122	0	1.52	4.67	3.07	-0.51	1.81	0.64	-1.01	1.93	0.45	1.39
123	0	-10.73	-13.40	-12.04	-11.53	-14.73	-13.16	-8.73	-7.78	-8.26	-11.10
124	0	3.66	0.48	2.15	0.13	2.57	1.37	-3.66	-0.36	-2.11	0.45
125	0	-0.26	3.22	1.50	-0.92	-2.30	-1.62	4.77	1.94	3.35	1.06
126	0	3.25	-0.64	1.29	3.54	-1.16	1.14	-0.99	-0.99	-0.99	0.45
127	0	3.53	3.27	3.40	-0.92	-1.66	-1.30	2.06	1.41	1.74	1.29
128	0	-2.04	1.60	-0.26	-3.19	-5.02	-4.11	-1.03	1.69	0.32	-1.33
129	0	0.12	0.76	0.44	2.90	3.27	3.09	5.10	4.10	4.59	2.74
130	0	3.01	2.14	2.58	1.17	-0.78	0.19	1.02	0.13	0.57	1.12
131	1	-2.29	-5.42	-3.87	5.55	-0.35	2.59	-1.24	1.26	0.00	-0.46
132	1	3.84	4.60	2.43	-1.11	0.12	2.01	3.89	3.07	3.48	2.64
133	1	3.68	2.52	3.10	1.59	3.78	2.67	1.20	-1.91	-0.36	1.77
134	1	-7.61	-2.21	-4.96	-2.10	0.00	3.16	0.00	0.12	0.60	-0.51
135	1	3.23	15.16	9.07	19.47	3.69	11.44	2.82	-0.79	0.96	7.01
136	1	-0.72	-0.37	-0.55	4.99	-3.24	0.80	2.55	1.14	1.68	0.70
137	1	1.61	7.90	4.60	0.75	11.77	5.92	3.73	0.72	2.24	4.34
138	1	0.91	0.13	0.52	-0.69	0.51	-0.19	-2.83	2.08	-0.42	-0.04
139	1	0.81	-4.39	-1.81	-3.45	-1.60	-2.52	-1.00	0.51	-0.25	-1.51
140	1	4.37	2.99	3.69	12.56	8.98	10.75	-0.80	2.12	0.60	4.95
141	1	-1.27	2.41	0.52	-0.38	2.66	1.23	-1.48	-0.62	-1.05	0.21
142	1	2.95	1.32	2.12	-4.51	-4.59	-4.55	-4.88	-6.46	-5.68	-2.79
143	1	1.23	-1.36	-0.06	0.12	1.22	0.67	-0.80	4.95	2.06	0.92
144	1	0.12	0.99	0.56	3.01	4.65	3.83	-1.59	2.31	0.31	1.54
145	1	0.61	1.85	1.23	2.30	2.89	2.59	0.49	-0.37	0.06	1.28
146	2	-2.74	-0.49	-1.63	1.43	0.00	0.72	3.00	3.99	3.49	0.86
147	2	2.64	3.19	2.91	-0.52	0.92	0.20	3.97	1.71	2.84	1.97
148	2	-1.94	0.00	2.00	-2.35	0.00	-0.32	2.24	0.00	1.12	0.93
149	2	0.76	7.41	4.07	2.53	6.05	4.26	-7.09	2.76	-2.35	1.92
150	2	-1.34	0.60	-0.27	-3.07	3.80	0.34	5.20	1.59	3.41	1.16
151	2	2.46	1.98	2.12	15.21	1.58	8.35	-1.17	7.43	3.07	4.49
152	2	2.18	4.44	3.30	3.52	-1.36	1.02	-0.73	0.25	-0.31	1.31
153	2	2.61	4.68	3.64	14.37	13.70	14.04	-0.82	-2.18	-1.51	5.27
154	2	-1.24	1.49	0.12	0.75	3.93	2.23	9.83	1.44	5.59	2.66
155	2	1.72	1.87	1.79	1.09	-1.20	-0.07	0.67	4.99	2.79	1.50
156	2	0.36	1.68	1.02	1.75	1.54	1.65	0.23	1.31	0.76	1.13
157	2	-2.21	2.40	0.00	2.14	0.85	1.48	4.27	0.12	2.15	1.16
158	2	5.66	2.06	3.68	7.61	1.91	4.66	-1.26	0.26	-0.51	2.74
159	2	5.26	-2.63	1.17	0.27	-0.77	-0.26	0.39	-1.16	-0.39	0.17
160	2	2.35	3.36	2.66	2.99	3.71	3.35	-1.46	2.72	0.57	2.23
161	2	3.15	1.53	2.34	1.58	3.25	2.42	1.12	0.99	1.05	1.93
162	3	3.53	6.46	4.97	-2.29	-0.13	-1.20	-1.68	-3.16	-2.42	0.47
163	3	1.61	-0.12	0.73	-8.76	-0.48	-5.39	-2.35	-1.43	-1.91	-2.26
164	3	3.62	-3.16	0.06	4.80	0.61	2.73	9.12	1.95	5.61	2.85
165	3	2.14	1.96	2.05	14.09	4.48	9.21	6.14	6.35	6.25	5.85
166	3	-0.36	2.52	1.04	-0.49	0.38	-0.06	-0.95	2.64	0.79	0.58
167	3	4.55	-1.32	1.58	1.14	3.35	2.26	-0.63	0.68	0.13	1.33
168	3	-7.61	-2.27	-5.04	11.26	2.04	6.68	5.90	6.62	6.25	2.54
169	3	-7.26	-1.29	-4.38	7.93	-0.12	3.96	3.36	4.77	4.07	1.15
170	3	0.00	3.59	1.76	0.88	3.03	1.95	0.37	0.25	0.31	1.33

Appendix J

t - Test Analyses

Comparison of % Mean Change in Cohort

California Achievement Test Scores

Grade Nine to Ten

Comparison of Mean % Change

Total Battery

Non-Music vs. All Music Students

	Non-Music		All Music
Mean	1.20		1.63
Variance	4.65		3.99
Stan Dev	2.16		2.00
Standard Err of Mean	0.19		0.32
Standard Error of Difference		0.37	
t		4.44	
p		< 0.01	

Comparison of Mean % Change

Total Battery

Non-Music vs. Instrumental Music Students

	Non-Music	Instrumental
Mean	1.20	1.34
Variance	4.65	6.12
Stan Dev	2.16	2.47
Standard Error of Mean	0.19	0.64
Standard Error of Difference	0.67	
t	2.01	
p	< 0.05	

Comparison of Mean % Change

Total Battery

Non-Music vs. Vocal Music Students

	Non-Music		Vocal
Mean	1.20		1.97
Variance	4.65		1.66
Stan Dev	2.16		1.29
Standard Error of Mean	0.19		0.32
Standard Error of Difference		0.37	
	t	5.27	
	p	< 0.01	

Comparison of Mean % Change

Total Battery

Non-Music vs. Vocal & Inst. Students

	Non-Music		Inst. & Vocal
Mean	1.20		1.54
Variance	4.65		4.23
Stan Dev	2.16		2.06
Standard Error of Mean	0.19		0.69
Standard Error of Difference		0.71	
	t	2.16	
	p	< 0.05	

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