THE CORRELATION OF MUSIC APTITUDE SCORES WITH MATHEMATICAL ACHIEVEMENT SCORES FOR HIGH SCHOOL SENIORS

by

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ABSTRACT

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The purpose of this study was to determine the level of correlation between musical aptitude as measured by the Advanced Measures of Music Audiation and mathematical achievement as measured by the mathematical section of the American College Test (ACT). Research has shown that music instruction can have a positive effect on other areas of learning, like mathematics and spatial-temporal reasoning. Furthermore, the arts as a whole, when integrated into a school's curriculum, has shown great outcomes in student's performance in school and attitudes about school.

Twenty high school seniors volunteered to be subjects. They were given the Advanced Measures of Music Audiation to determine musical aptitude, while the mathematics scores on the ACT were taken from school records. The adjusted scores were correlated using Pearson r. The null hypothesis was that there is no statistically significant correlation between musical aptitude scores and mathematical achievements scores for high school seniors. The null hypothesis was accepted at .05.

Although no statistical significance was found, further investigation should be done concerning the relationship between mathematics and music and the role the arts may play in education.

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CHAPTER I

Introduction

Curriculum and instruction in schools is a controversial topic among many educators. What to teach and how to teach children always seem to be changing. We want what is best, in order to produce intelligent individuals. In many U.S. schools today, programs are being reduced or eliminated due to low funding or declining interest. Since most people agree that students need to learn core subjects such as mathematics, English, and science, cuts are often being made to the arts and music programs. But Gordon Shaw, among many others, concludes that, "School boards make a grave error when they cut out music" (Marsh, 1999). This is because research has shown that music instruction can have a positive effect on other areas of learning, like mathematics and spatial temporal reasoning.

Howard Gardner coined the term "multiple intelligences" about seventeen years ago (Gardner, 1997). He defines intelligence "as the ability to solve problems or fashion products that are valued in at least one cultural setting or community" (p. 34). Gardner identifies seven intelligences:

1. Linguistic - a sensitivity to the meaning of words and verbal memory (Storfer, 1990).

2. Logical/mathematical - ability to create, retain, and use reasoning.

3. Spatial - appreciation of large spaces and/or logical spatial layouts (Gardner, 1997).

4. Musical - capacity to create and perceive musical patterns.

5. Bodily/kinesthetic - ability to solve problems or create products using the whole body or parts of the body.

6. Intrapersonal - the understanding of self.

7. Interpersonal - the understanding of others.

Those are the seven most commonly described, but there may be an eighth and ninth intelligence: naturalistic and existential. Even though each is seen as separate, they work together to produce a particular competency (Storfer, 1990).

Currently in schools, linguistic and logical/mathematical intelligence (and maybe some spatial intelligence) are of greatest interest (Gardner, 1999). But this study is also interested in musical intelligence, because it may have an effect on those intelligences too. Many researchers agree that mathematics and music are very similar because both are concerned with linking abstractions together, with making patterns of ideas (Storr, 1992). Another common fact is that the patterns of relationships with which they are concerned are predominately non-verbal.

Looking at brain activity, the left hemisphere predominates language while the right hemisphere predominates visuospatial (nonlinguistic) skills (Storfer, 1990; Storr, 1992). Music would be included in the right side. If one agrees with the theory that the brain is a muscle and can be strengthened, then strengthening the brain in the area of music may have a carry over effect and strengthen the area in the brain that holds mathematics and spatial skills. Gardner (1999) found that a group of subjects who were taught music before taking a test in spatial skills surpassed a control group on some measures of spatial skill. This study suggests the notion that there may be a connection.

There have been other experiments conducted that demonstrate that music can enhance reasoning. In 1991, Gordon Shaw and Xiaodan Leng first hypothesized that listening to music could stimulate brain development

(Marsh, 1999). They also predicted that music training at an early age (when the child's cortex is very plastic) could enhance the ability to use pattern development in spatial-temporal reasoning (Grandin, Peterson, et al., 1998). Soon after in 1993, the "Mozart effect" was discovered and has been of interest for many ever since. Shaw and his colleagues believe and have found evidence that listening to a Mozart sonata primes the brain's hardware to tackle mathematical skills. Not everyone agrees that the Mozart effect is real. Researchers such as Christopher Chabris and Kenneth Steele have replicated the study from 1993 and could not confirm the findings (Larkin, 1999). They found that the temporary improvements in temporal-spatial processing after listening to Mozart was less than would arise from chance. The findings are controversial and thus the Mozart effect is still being studied.

Shaw and Francine Rauscher found that piano lessons for preschool children dramatically improved their performance on a spatial-temporal reasoning task. If this is true, it would be a mistake to eliminate music programs from schools, because many students may benefit in other areas of academics.

Even thought music is often compared to mathematics, it is still uncertain as to whether there are serious educational implications involving the instruction of music and improvements in certain areas of mathematics. If there is a connection, it would be valuable to emphasize music programs and the instruction of music in schools. Enthusiasm for learning music seems to be lower for students today. The U.S. Department of Education has found that the number of music education degrees awarded in the United States is continuing to decline ("Music education", 1997). And since the United States (compared to forty-five other countries) is below average in mathematics, a finding that linked music and mathematics could help educators make some important decisions (Temple, Peterson, et al., 1998). Stressing the importance of music education could motivate educators to teach music and students to want to learn music.

A review of the literature shows that there is a possible connection between mathematics and music. Studies have also shown that music instruction can enhance the hardware in the brain for spatial-temporal reasoning. Therefore, the research hypothesis for this study is that there will be a positive correlation between musical aptitude scores and mathematical achievement scores for high school seniors.

Statement of the Problem

The purpose of the study is to determine the level of correlation between musical aptitude as measured by the Advanced Measures of Music Audiation and mathematical achievement as measured by the mathematical section of the American College Test (ACT).

Null Hypothesis

The null hypothesis is that there is no statistically significant correlation between musical aptitude scores and mathematical achievement scores for high school seniors.

CHAPTER II

Review of Literature

Many agree that there is evidence of some type of connection between mathematics and music. If this is true and strengthening intelligence in one can help strengthen the other, the educational implications should not be ignored. Chapter two will cover the role that the arts play in education, past and present. Furthermore, the history of the relationship between mathematics and music is given with an explanation on how they are both similar and different. The Mozart effect will be discussed, along with Howard Gardner's multiple intelligences theory. Also included are the influences of early home environment on people's cognitive abilities and the current teaching trends of mathematics in schools. Because there is contradicting evidence among researchers, both evidence for and evidence against the relationship will be discussed.

Purpose of Education

Many educational psychologists have been debating for years about the meaning and purpose of education in America's schools. At the end of the 19th Century, United States teachers began to view the mind as a muscle, but people differed on how to help strengthen that muscle. In 1896, Albion Small stated that "education connotes the evolution of the whole personality, not merely of intelligence" (Kliebard, 1995, p. 53). He feels that the emphasis of education is not on a person's individual development, but on society and social terms.

Traditional subjects taught in 1910 were History and Social Studies for students to learn about citizenship. The first junior high Superintendent Frank F. Bunker reported that curriculum for his school in Berekely, California reflected vocational orientation to eliminate the waste from many failing students (Kliebard, 1995). It was important for young adults to work to make a contribution to society. No emphasis seemed to be placed on individual development. In 1941, during World War II, vocational training and subject matter of courses like Physics and Mathematics were changed to reflect what was happening to society. Greater stress was placed upon aeromechanics, aeronautics, navigation, gunnery, and other modern warfare aspects.

Not everybody agreed with curriculum designed only to serve society. William Torrey Harris believes that Humanistic Curriculum is the most appropriate and desirable for schools (Kliebard, 1995). It is a curriculum which is sensitive to social changes, but is maintained around the finest resources of Western Civilization. Harris named five “windows of the soul” (p. 15). They are: arithmetic/mathematics, geography, history, grammar, and literature/art. These are “the means by which the culture of the race would be transmitted to the vast majority of Americans” (p. 15). The window that permits us to see life as a totality and to appreciate human character is literature. Harris proposed certain changes in the curriculum of the late 19th Century and early 20th Century, such as the systematic instruction in art.

John Dewey also placed emphasis on the child and felt that in the late 19th Century, the three R’s (reading, ‘riting, and ‘rithmatic) were not enough. He felt they crowded out other important activities that children between ages four and nine could be engaging in. For example, the various forms of art--music, drawing, modeling, etc.--were more what children needed at that age, than a concentration on written symbols.

The Role of the Arts

Elliot Eisner (1992) wrote “A school in which the arts are absent or poorly taught is unlikely to provide the genuine opportunities children need to use the arts in the service of their own development" (p. 592). Researchers have found a number of positive outcomes when the arts are integrated into the school curriculum, yet many American schools do not reflect the importance of the arts. For example, a typical elementary school will focus on the arts for only about two hours a week, and it is not required at the secondary level. The arts include music, poetry, drawing, painting, dance, fiction, sculptured, and photography (Goldberg, 1992). It is unfortunate that Judith Hanna (1992) found that disbelieving parents feel that an education focusing on the arts will divert attention and resources from other subjects that prepare students for high-paying jobs later in life. But the arts have an opportunity to teach students so much more.

The arts can open up new possibilities for working with ideas and expression of knowledge (Goldberg, 1992). An education focused on the arts can improve cognition, promote social relations, stimulate personal development, and foster the productivity of citizens (Hanna, 1992). Twenty-five years of experience and research concludes that the arts help unlock the curiosity, energy, and imagination of young people and help build basic academic skills (Sautter, 1994). Art integrated schools show that students benefit in subjects like reading, writing, social science, mathematics, and science when the arts are integrated into the "formal" curriculum.

A program in New York City called LEAP (Learning through an Expanded Arts Program) improved the quality of education in the city's five boroughs by integrating the arts (Dean & Gross, 1992). This non-profit organization found that hands on experience with the arts can help students in other subjects. First, the materials and projects are interesting to ensure an exciting learning experience. Second, the sense of accomplishment from successfully completing a creative task helps students develop self-confidence and self-esteem. An evaluation of the program found that 93.4% of participating students developed a better understanding of the subject matter, 95% strengthened problem solving skills, 96% strengthened creative thinking skills, 93% gained self discipline, and 97% felt more positively towards school. Using the arts to teach basic skills makes learning possible and fun.

Music is one important part of the arts. The founder of our American school system, Horace Mann, believed that "music was essential to education for the development of aesthetic appreciation, citizenship, and thinking" (Miller & Coen, 1994, p. 459). Unfortunately, school boards and administrators often do not consider the study of music to be one of the basics of education; it is valued more for entertainment. But of all the disciplines, music has the most experience with cooperative learning. Marching bands, choirs, orchestras, and musicals need cooperation of individuals and large groups to be successful. Music and the arts are an important part of a school's whole curriculum. Schools need to be aware of the benefits of the arts, before making cuts to the essential programs.

<u>Mathematics and Music</u>

In 1925, Whitehead stated, "The Science of Pure Mathematics . . . may claim to be the most original creation of the human spirit. Another claimant for this position is music" (Storr, 1992, p. 178). It was evident early on that there is a relationship between mathematics and music. They both seem to be centralized in the right hemisphere of the brain and are concerned with linking together abstractions. Dewey believed that mathematics is the most abstract of the subjects commonly taught in schools (Kliebard, 1995). Other similarities are unmistakable. The Western tonal system, which includes the diatonic scale and the major triad, is directly derived from acoustic principles that can be mathematically demonstrated and are not man-made (Storr, 1992). Also, the octave is mathematically related. An octave divides two of the same notes in which the pitches are widely separated. The frequencies are simply doubled, with the ratio being 2:1. The octave was also not created by man. Marsh (1999) writes that “the musical scale is close to a neat logarithmic progression of frequencies.”

Even though they have some comparable qualities, G.H. Hardy pointed out that while “music can be used to stimulate mass emotion . . . mathematics cannot” (Storr, 1992, p. 3). Music is seen as less abstract than mathematics because it can cause physiological arousal. Music can be both intellectual and emotional, linking the mind and body. Because of this, music is usually more personally significant than mathematics.

The Mozart Effect

The fields of mathematics and music are both known for their child prodigies (Marsh, 1999). Wolfgang Amadeus Mozart (1756-1791) was a musical genius from Austria (Seligmann & Danziger, 1966). By age six Mozart was playing the piano and giving concerts in Vienna. At age seven he was writing and playing his own compositions, as well as those of other composers. Cross-over talent is also evident between the two fields (March, 1999). For example, Einstein played the violin. It was the physicist, Gordon Shaw, who was interested in the brain’s connection between mathematics and music and discovered what is known as the “Mozart effect.”

The Mozart effect is defined as the ability of a Mozart sonata to improve the listener’s mathematical and reasoning abilities (Marsh,1999). Shaw and

Rauscher's first study was done in 1993 and involved college students. The subjects improved their scores on a spatial-temporal test after listening to Mozart's "Sonata for Two Pianos in D Major." This piece of work was chosen for its complexity. Unfortunately, the effect only lasted 10 to 15 minutes. Their next study involved three-year-olds. The children who were given piano lessons improved their test scores by 35% compared to control groups, and the effect lasted for days. Shaw concluded that music can help children learn mathematics, along with proper training.

Since the first studies were published, many others have conducted similar studies on the relationship between mathematics and music. Steele, Bass, and Crook (1999) attempted to produce the Mozart effect by replicating one of the original positive experiments. The 125 college students in their study failed to produce a statistically significant effect or even an effect to suggest practical significance. They feel their lack of significance was consistent with previous work by other investigators. Nantais and Schellenberg (1999) also replicated a study with college students to attempt to find a Mozart effect. They found that performance on a spatial-temporal task was better after subjects listened to music composed by Mozart or Schubert, but they also found that listening to a narrated story instead of silence before the test also produced better results. Other researchers, like Chabris and Steele, have also failed to confirm the findings of the 1993 study.

Rauscher has been quick to defend the findings. She claims that the work done by Chabris "is incomplete in that it includes inappropriate studies and excludes some that showed an effect" (Larkin, 1999). Rauscher noted that Steele's work had methodological problems and does not replicate the original design. Shaw also argues that other researchers were unclear about what he and Rauscher meant by spatial-temporal reasoning, so their experiments were conducted without full knowledge. Steele, Brown, & Stoecker (1999) note that Shaw and Rauscher also suggest that failure to bring about a Mozart effect could come from carryover effects from a pretest of spatial reasoning that could interfere with the effects of listening to Mozart before a posttest.

There is inconclusive evidence about a Mozart effect. Many of the studies were conducted with college students as subjects. But there are also many studies done with young children that produced positive results after some type of music exposure. As noted above, preschool children that received piano lessons for six months did better on a test of spatial-temporal reasoning than control groups, including one group who were given computer lessons (Grandin, Peterson, et al., 1998). Much of the Mozart effect phenomenon has been applied toward children. A pamphlet developed by the Wisconsin Council on Children and Families encourages parents to expose their babies to Mozart music because research has show that it may "stimulate higher level thinking - the type of brainpower required to solve complex mathematical and engineering problems."

Multiple Intelligences and Cognitive Abilities

In addition to the concepts that relate the fields of music and mathematics, research shows that these areas in the brain may also be linked. Gardener's multiple intelligence theory shows some evidence that certain faculties of the mind are related (Gardner, 1995). His theory concludes that the senses must work together with intellect to construct meaning (Oddleifson, 1994). Many neurologists, physicists, and cognitive psychologists also believe this. Gardner states that the multiple intelligence theory is based entirely on empirical evidence (Gardner, 1995). Because new findings continue to develop and conclusions are never permanent, the theory can be revised. Gardner (1999) does note a possible connection between the spatial cortex and musical cortex areas of the brain. In one study, subjects who were taught music were compared to a control group on a test that measures spatial skill. The subjects who were taught music surpassed the control group on the test.

A group who works with Gardner in Harvard's Project Zero has been investigating Gardner's theory for 20 years (Oddleifson, 1994). The members agree with the multiple intelligence theory. They also feel that people have at least seven intelligences: verbal, logical/mathematical, visual/spatial, musical, kinesthetic, intrapersonal, and interpersonal, rather than the two that schools cater to: verbal and logical/mathematical. Project Zero feels the arts represent these other intelligences. They stress that these cognitive domains are just as important as those that are traditionally emphasized.

Many people believe that children are born not as blank slates, but as complex creatures with a detailed mental apparatus (Gardner, 1997). Research shows that three and four month old babies have a strong sense of physical objects and have a sense of numbering. A baby will treat two elements the same, even if they have been rearranged spatially. A baby can also notice if something has been added or taken away. Furthermore, it has been found that infants can remember tonal sequences and recognize if the tones have been altered in tempo or in pitch. Harmonic versus dissonant chords can be distinguished by infants. Grandin, Peterson, et al. (1998) support this with research that demonstrates that “sophisticated cognitive abilities” are present in children as young as five months (p.12). Similarly, musical abilities are evident in infants and neonates.

Early home environment can greatly influence people's cognitive abilities.

In Japan, a man named Shinichi Suzuki has taught many young children to play the violin (Gardner, 1997). His method is what has come to be known as the Suzuki method. In Asian societies, the focus in the first years of life is in art, music, and dance. They believe the first years are crucial for these and place less emphasis on scholastic mastery. It is interesting to note that Japanese people as a group excel on the section of IQ tests that measure spatial intelligence (Storfer, 1990). They also are superior in solving logical-mathematical problems by using a structural reasoning approach. This is another piece of evidence that suggests that learning a musical instrument at an early age may yield positive consequences in other cognitive domains, including those valued in school (Gardner, 1999).

Current Trends and Implications

Since the United States values mathematical ability in students, it would be of value to conduct more extensive research on the relationship between music and mathematics and how mathematics is currently being taught in today's schools. Battista (1999) feels that mathematics is a form of reasoning and the traditional ways of teaching mathematics is not working. Currently, most schools teach mathematics by sequence and memorization, and many students forget the facts. Battista argues that this parrot learning risks stunting students' growth of mathematical reasoning and problem solving. Grandin, Peterson, et al. (1998) agree. They distinguish between two types of reasoning: spatial-temporal and language-analytic. U.S. schools typically teach students by using traditional language-analytic methods. But spatial-temporal reasoning is crucial in mathematics and for learning proportional reasoning. It was found that proportional reasoning is difficult to teach to U.S. students because they are learning by language-analytic methods. They conclude that if music education is present in schools for children at an early age (preferably preschool), the “hardware” in the brain for spatial-temporal reasoning can be developed, and thus may improve other areas of learning.

The connection between music and mathematics is inconclusive. There is much research that indicates that there is some sort of similarity. Whether there is a Mozart effect will need to be retested again and again because of the contradictions. The evidence found with young children and the early influence of music should, however, be explored because of the educational implications it might have. Evidence shows that the arts can greatly influence children in many ways. If music education does really have a positive effect, music programs should not be cut from schools, but added and enhanced, and not just for improvements in mathematics and spatial-temporal reasoning, but also for the appreciation of the arts as a whole.

CHAPTER III

Methodology

Description of Variables

It is not easy to distinguish between a person's "aptitude" and a person's "achievement." Typically, aptitude is described as a person's potential. For example, if a person is born with a high music aptitude, he or she has the potential to achieve and be successful in music, considering the right circumstances are present. Achievement is what a person has already accomplished or learned. Likewise, if a person has achieved musically, one could assume he or she has a high music aptitude. A gray area lies between aptitude and achievement and it is often difficult for tests to measure just one or the other. The two testing instruments use in this study claims to measure one or the other. The Advanced Measures of Music Audiation measures a person's music aptitude and the American College Test (mathematics section) measures his or her mathematics achievement or ability.

The Advanced Measures of Music Audiation by Edwin E. Gordon is a short music aptitude test administered through a compact disc. Thirty short musical phrases are followed by short musical answers. Subjects were expected to audiate concurrently; tonality, keyality, melody, implied harmony, rhythm, meter, and tempo. Answers were given by filling in A, B, or C on the answer sheet (Appendix A). Formal music achievement is not a requirement for taking the test. Regardless of whether students can play a musical instrument, sing, read notation, or have taken courses in music theory, they may score high on the test. The test measures potential for music achievement.

The Advanced Measures of Music Audiation was nationally standardized in the 1988-1989 school year (Gordon, 1989). There was a standardization program specialized for high school students. Reliability coefficients typically range from .00 and .95, and the higher the coefficient, the more stable the test. Gordon's test has a reliability coefficient of .84 for high school students and a standard error of difference of 1.9.

The American College Test (ACT) Assessment is a nationally used standardized instrument that includes four tests that measure students' educational development and achievement. The four tests are: English, mathematics, reading, and science reasoning. Generally, the ACT is voluntarily taken by college bound high school juniors and seniors. ACT Assessment results are used by students and counselors for planning future careers and college attendance. For this study, only the mathematics test scores were used. The mathematics test is a multiple choice test designed to assess the mathematical skills that students have typically acquired in courses taken up to the beginning of grade 12 (ACT, 1999). Students are required to use their reasoning skills to solve practical problems in the areas of: pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry.

Reliability information is summarized into three categories: internal consistency, stability (test-retest), and parallel-forms reliability (Keyser & Sweetland, 1984). For mathematics usage, internal consistency is .89, stability is .77, and parallel-forms reliability equals .79. Dozens of validity studies have been conducted and lend credibility to the test. For example, the ACT Assessment correlates positively with high school grades. The ACT Assessment is a widely used and fair testing instrument.

Subjects

Twenty 12th grade students attending a public high school in Wisconsin were subjects in the study. All students had taken the ACT within the past year. Subjects volunteered to participate and signed consent forms before information on the ACT was collected and testing of music aptitude was done.

Instrumentation

Scores from the Advanced Measures of Music Audiation were used to determine musical aptitude. The mathematics test scores from the ACT Assessment were used to determine mathematics achievement.

Procedure

After obtaining permission from the school, the seniors who have taken the ACT were asked to volunteer to be subjects in the study. The study and their participation responsibilities were explained to them. Information was also given to them about the consent forms and confidentiality. Twenty students volunteered and gave consent by signing the form (Appendix B). Subjects who were under 18 years of age also had a parent or guardian sign the consent form. About half of the twenty volunteers indicated that they have had some form of music instruction.

The researcher administered the Advanced Measures of Music Audiation to the 20 participants. The tests were hand scored by the researcher following the directions in the manual. The adjusted total raw scores were used in the correlation. Next, the researcher obtained the subjects' ACT mathematics adjusted scores from the students' school records. After the scores for each subject were paired, the names of the subjects were destroyed to ensure confidentiality. Then, the data were analyzed.

Data Analysis

The scores were analyzed by the Pearson Product Moment Correlation Coefficient (r) to determine the degree of relationship between the two variables (Crowl, 1993). This is the most appropriate measure of correlation. The Pearson (r) takes into account all scores in both distributions and is the most stable correlation measure (Gay, 1987).

CHAPTER IV

Results and Discussion

<u>Results</u>

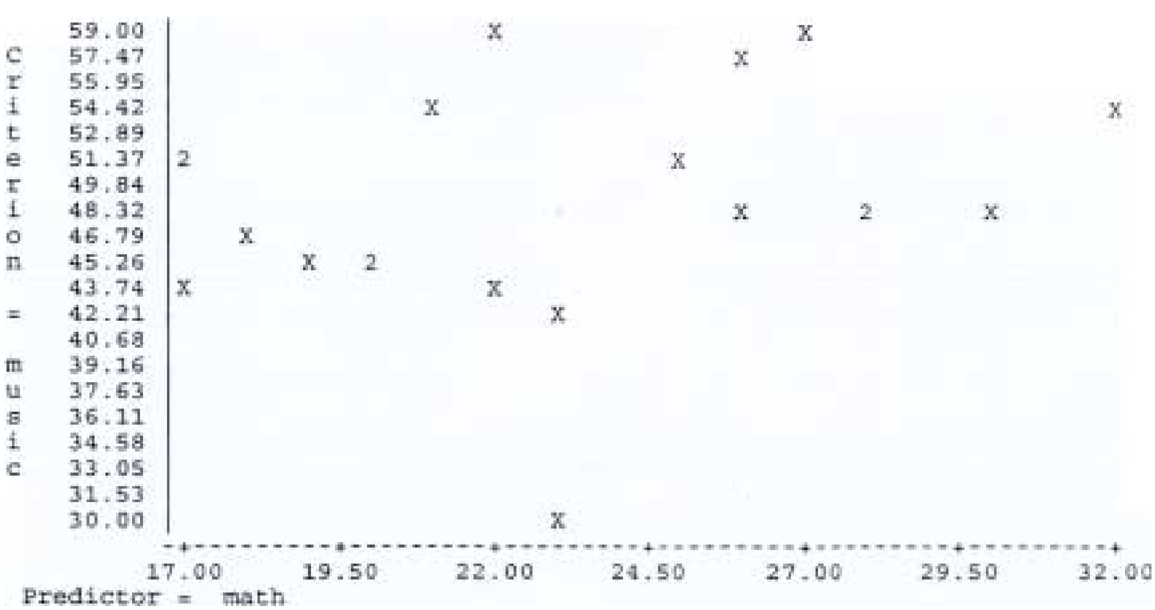
The null hypothesis was that there **is** no statistically significant correlation between musical aptitude scores and mathematical achievement scores for high school seniors. The null hypothesis was accepted at .05, **for r =** ,277. The means and standard deviations of the mathematics values and music values are given in Table 1.

Table 1: Means and Standard Deviations

	N	Mean	SD
math	20	23.050	4.421
music	20	48.950	6.637

Table 2 shows a scatterplot of the mathematics and music values for each of the 20 subjects. (Raw date **is** included in Appendix C.) **The** values **of** **music** aptitude and mathematical achievement are **positively** comlated, **but** not at a statistically **significant level.**

Table 2: Scatterplot of Math and Music Scores



Discussion

Even though the results of this study are not statistically significant, further investigation is needed to determine the relationship between mathematics and music. As indicated in the review of the literature, there is a level of similarity, but just how much and to what extent is still in question. Nevertheless, the instruction in arts as a whole, which includes music, has proven to have a positive influence on many students' educational development.

Bennett Reimer is a music education professor who is interested in the purposes and effects of music education. Reimer has thought much about Rauscher's study on the "Mozart effect." and the implications. Spatial-temporal reasoning is thought to be foundational for success in higher mathematics and proportional reasoning. Rauscher, among others, have concluded that instruction in and/or listening to music can enhance a person's spatial-temporal reasoning. Reimer (1999) implies that much more research needs to be done. He also wonders about reversibility; whether direct training in spatial-temporal reasoning would positively affect musical responses. But Reimer does not want to focus too much on the instruction of music for the sake of improving spatial-temporal reasoning. Music should be taught in schools because of its own worth, not just because of its positive effects on mathematics, science, and reasoning. All the "hype" of a possible "Mozart effect" may be devaluing other reasons and implications for music. For example, many cultural and spiritual events are centered around music. However, it has been shown that integrating the arts in schools can have a great impact on learning in other areas. Integrating the arts correctly will also teach students to have an appreciation of the arts for their own sake.

Besides achieving academically at rates higher than expected in mathematics and science, Oddleifson (1994) found that students were respecting their peers and treating them well, were motivated to learn, and enjoyed coming to school, working hard, and succeeding. Also, the relationship between teachers and students improved. These students belonged to an arts-integrated school. Eric Oddleifson is the chairman of the Center of Arts in the Basic Curriculum (CABC). Research conducted by CABC concludes that these schools are the most promising way to improve American education. Arts-integrated schools embrace education in and through the arts. They recognize diverse learning styles and multiple intelligences. Teachers, administrators, parents, and students value arts for their own sake; as a cognition. These schools devote a meaningful part of the day to teaching the arts to everyone. Curriculum material is set up around themes and units in which the arts illuminate other subjects. CABC hopes the trend of arts-integrated schools catches on because of the positive effects they have.

Although these effects have been publicized for some time, the Department of Education devotes less than .1% of their $30 billion budget to arts education (Oddleifson, 1994). In order to increase that amount, more evidence linking the arts to “traditional” academics and the remarkable outcomes the arts have, needs to be presented. It would be worthy to conduct further studies and research (like this study on the correlation of music aptitude and mathematical achievement) to find the much needed evidence.

<u>Recommendations for Further Study</u>

Although not statistically significant, this study was only conducted in one school and was limited to students who had already taken the ACT. It would be of value to extend the study to include more subjects and a more diverse population.

There are many testing instruments on the market that measure mathematical achievement and musical aptitude. The two tests in this study were chosen because they were available and affordable to the researcher. The Advanced Measures of Music Audiation was a short test, thus easily administered. Although it is a reliable test, other instruments that are more specialized and complex in testing music aptitude may hold more validity. Furthermore, the ACT Assessment measures a variety of mathematical abilities. Since research has shown that the specific area of spatial-temporal reasoning improves with music instruction, a specific mathematics test in that area may be valuable.

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APPENDIX A

The Advanced Measures of Music Audiation Answer Sheet

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APPENDIX B

CONSENT FORM

I understand that my participation in this study is strictly voluntary and I may discontinue my participation at any time without any prejudice. I understand that the purpose of this study is to investigate the correlation of math scores (from the ACT) and music aptitude scores for high school seniors. I further understand that any information about me that is collected during this study will be held in the strictest confidence and will not be part of my permanent record. I understand that at the conclusion of this study all records which identify individual participants will be destroyed.

Signature of Client:___________________________________date:_________Age:_____

Signature of Guardian:________________________________date:__________________

NOTE: Questions or concerns about participation in the research or subsequent complaints should be addressed first to the researcher or research advisor and second to Dr. Ted Knous, Chair, UW-Stout Institutional Review Board for the Protection of Human Subjects in Research, 11 HH, UW-Stout, Menomonie, WI, 54751, phone (715) 232-1126.

APPENDIX C

Raw Data

Value	Math	Music
1	17	52
2	17	52
3	17	44
4	18	47
5	19	45
6	20	46
7	20	46
8	21	55
9	22	59
10	22	44
11	23	42
12	23	30
13	25	52
14	26	58
15	26	48
16	27	59
17	28	49
18	28	48
19	30	48
20	32	55