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Differences in mathematics scores between students who receive traditional Montessori instruction and students who receive music enriched Montessori instruction.

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DIFFERENCES IN MATHEMATICS SCORES BETWEEN STUDENTS WHO RECEIVE TRADITIONAL MONTESSORI INSTRUCTION AND STUDENTS WHO RECEIVE MUSIC ENRICHED MONTESSORI INSTRUCTION

by

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ABSTRACT

While a growing body of research reveals the beneficial effects of music on education performance the value of music in educating the young child is not being recognized, particularly in the area of Montessori education. This study was an experimental design using a two-group post-test comparison. A sample of 200 Montessori students aged 3 to 5-years-old were selected and randomly placed in one of two groups. The experimental treatment was an "in-house" music enriched Montessori program and children participated in 3 half-hour sessions weekly, for 6 months. This program was designed from appropriate early childhood educational pedagogies and was sequenced in order to teach concepts of pitch, dynamics, duration, timbre, and form. The instrument used to measure mathematical achievement was the Test of Early Mathematics Ability-3 to determine if the independent variable, music instruction had any effect on students' mathematics test scores, the dependent variable. The results showed that subjects who received music enriched Montessori instruction had significantly higher mathematics scores. When compared by age group, 3 year-old students had higher scores than either the 4 or 5 year-old children.

Dedicated to the memory of my father,

Christopher James Duffy

(1927-1997)

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CHAPTER I

INTRODUCTION

A. General Statement of the Problem

Montessori educators and parents are pondering the kind of education our children need to become responsible and productive members of a global society. In order to create the kind of futuristic thinking necessary to cope with our ever-changing world, Pitman (1998) suggests that higher order thinking processes deserve attention now and an arts-rich curriculum can provide a vehicle for creative problem solving and motivation. Sadly, the value of music in educating the young child is not being recognized, and despite the amount of literature available regarding the effect of music instruction on academic achievement, little has been written on different Montessori music pedagogies and their effectiveness.

The potential to learn is never greater than at the moment of birth and what children learn in the first 5 years of life forms the foundation for all subsequent educational development (Olsho, 1984). Olsho believes that early experiences are crucial to the developing architecture of the young brain and research indicates that music plays an important role in the brain development of a child. Because neural connections are responsible for all types of intelligence, a child's brain develops to its full potential only with exposure to the necessary enriching experiences in early childhood. Young children need to develop the foundation for their listening and singing music vocabulary, just as they develop the foundation of their listening and speaking language vocabularies long before entering school. A child's loss of opportunity during this time cannot be corrected

and unfortunately no amount of compensatory education at a later time will be able to completely offset this handicap (Gordon, 2003).

Recognizing that schooling should enhance the development of creative and responsible citizens, it is necessary to consider how such development takes place, and provide rich opportunities for learning for all students (Landsberg, 1997; Eisler, 2000). The arts are most effective when they are connected with the rest of the school curriculum and when students are allowed to explore topics from both an artistic and academic perspective. Through connection with other participants the arts become a central part of the learning experience, drawing upon the content of other disciplines and adding depth and quality to the learning process. There is a growing body of more evidence to suggest every day that music education has a beneficial ripple effect through the rest of a child's academic and social life, and that music should not be any more optional than English or mathematics (Haroutounian, 2002).

A review of the extant literature suggests that a) learning through the arts can benefit the 'whole' child such as having a positive impact on reading, mathematics, writing, self-esteem, and brain development; b) academic achievement scores are significantly higher for those students studying music; c) attending a Montessori program from the approximate ages of 3 to 11 predicts significantly higher mathematics and science standardized test scores in high school (Gartner & Kerzner-Lipsky, 2002); and d) Montessori produces a more academically accomplished child (Clifford & Takacs, 1991). What then, is the potential for the child when Montessori includes a music- enriched curriculum?

As Montessori faces the challenges of the future with an opportunity and responsibility to change, early childhood music education continues to grow during a never-ending search to improve. As we face the challenges of the future, this is truly the time to explore how research and practice reflects the wider world of early childhood education. Montessori children are achieving higher percentile scores on mathematics tests than non Montessori children (Clifford & Takacs, 1991), and Montessori children receiving music-enriched Montessori instruction are achieving higher percentile scores on mathematics tests than those receiving traditional Montessori instruction (Harris, 2005). One can only imagine the possibilities across the curriculum, for those children receiving music-enriched Montessori instruction. The present study clearly shows that it is time to develop a new model for Montessori music education that will demonstrate the value of an arts-based comprehensive approach and serve as a practical blueprint for all the Montessori classrooms globally.

B. Significance of the Study

It is believed that early experiences are crucial to the developing architecture of the young brain and research indicates that music plays an important role in the brain development of a child (Gordon 2003). Montessori programs (18 months to 5 years) have grown considerably over the past decades and with growth have come concerns about outcomes, especially academic ones. This study offers quantitative evidence that could help Montessori and early childhood educators recognize the value of music enriched instruction for the young child and implementing the instructional designs used in this study could lead to higher levels of student achievement in mathematics. This is significant because they improve students' mathematics scores and a grasp of

proportional mathematics and fractions is a prerequisite to mathematics at higher levels, and children who do not master these areas of mathematics cannot understand more advanced mathematical concepts that are critical to higher order thinking.

The decision to support music cannot be made without knowing music's effect on academic achievement and its contribution to a student's education. As the quantity, quality, and availability of empirical studies increases, Montessori schools will be able to make a stronger connection between their design decisions and the evidence of 'what works.'

C. Definition of Terms

Casa: Casa consists of Montessori children between the ages of 3 to 5 years who remain with the same Montessori teacher for a 3-year time frame. Older children help teach those younger to perfect their own skills while younger children learn by observing the behaviour and interest modeled by older students (Montessori, 1964).

Montessori: The philosophy and curriculum of the Montessori method is based on the work and writings of the Italian physician Maria Montessori. The Montessori method of preschool education is unique in its ability to educate the child from birth (Hainstock, 1997). It attempts to develop the child's senses, academic skills, practical life skills, and character and is one of the world's oldest early childhood curriculum models. The teachers carefully prepare program settings, filling them with Montessori didactic materials, which are designed to encourage children to learn on their own (Havis 1997).

Montessori built on the work of Itard and Sequin to develop a child-centered approach to education that became known as the Montessori method. She brought to early childhood education the belief that each child develops from within as an

individual; and that a child must be free to select and use materials with a minimum of adult interference for as long as desired. Montessori designed didactic materials to build the foundation for reading, writing, and arithmetic. She encouraged the use of child-sized materials, furniture, tables and chairs. Montessori advocated a change in the role of the teacher from a shaper of behaviour to an observer of child directed activities in an unhurried environment that was suited to the needs of the child. Elements of the Montessori method and adaptations of Montessori materials are used widely today in early childhood programs throughout the world. Montessori provided insight into and respect for the ways in which young children learn (Montessori, 1964).

Music-enriched Montessori Instruction: In the early years when the foundation of musical knowledge is laid, it is important that the young child receive music sessions weekly. The length of the class period is not as important as the frequency - two or three 20 to 30 minute weekly sessions with Casa age children is more valuable than one 40-minute session (Choksy, 1999). This newly developed music-enriched Montessori instruction (Harris, 2004) is administered by an experienced Montessori teacher who is also an early childhood music specialist. It provides a child-centered musical environment to facilitate development in all curriculum areas, while enabling the child to learn fundamental music skills (Harris, 2005).

Creative movement develops individual expressiveness and coordination, while music skills are refined using group activities and hands-on Montessori materials. Composing integrates aural and written skills and gives children a sense of ownership. Lastly, rhythm ensemble develops coordination, beat, inner hearing, and nurtures self-confidence and communication skills. It builds a solid foundation of understanding and

enjoyment of music while allowing the child to explore and develop his or her own strengths in a variety of musical areas (Gordon, 2003).

Traditional Montessori Curriculum without Music-enriched Montessori Instruction: The traditional Montessori curriculum is based on a 3-year program and concentrates on the Practical Life, Sensorial, Language, Mathematics, and Cultural (including music) areas of development. The Montessori bells and tone bars are used as a sensorial based exploration which leads to the writing and reading of music (Miller, 1999). Music instruction is left to the discretion of the classroom teacher whose musical knowledge and confidence level may be limited, thus hindering the effectiveness of the instruction. Little development has been made in the areas of the curriculum specific to music.

Music Terms

Accent: *a stress, such as an increase in dynamic level* (Slonimsky, 1998). When children have learned to tap and step to the beat accurately, it is then possible to introduce the concept of stressed or accented beats. Swaying to the accent of the music assists children in internalizing the beat. In the beginning, the teacher simply moves to the accent and the children imitate. Over time, the children begin to internalize the accent and experiment with movement by taking long slow steps on the beat while playing the song 'Giant Steps' (Richards, 1977, 1978).

Audiation: *audiation takes place when one hears and comprehends music silently, the sound of the music no longer being or never having been physically present* (Gordon, 2003) the ability to hear the song without vocalizing it is cultivated over time. First the song is heard, then sung, then sung while adding hand gestures. Once the song

and beat are firmly established fewer words are used as the song is performed, by using hand gestures only in time to an inner beat. The song 'Open Shut Them' is an excellent tool for this exercise (Harris 2004). The actions enable children to maintain a collective steady beat together while continuing to develop inner hearing.

Basic Concepts: basic concepts upon which the music-enriched Montessori instruction was based, are listed here from simplest and easiest to the most complex and difficult. They relate directly to what research has shown about the order in which young children acquire musical skills, loud-soft, fast-slow, timbre, long-short, beat, accent (duple meters), simple vs. compound duple meter, phrase, form, and melody (Choksy, 1999). These concepts are demonstrated to the children through singing and moving as 'fun' or 'play.'

Beat: *the division or unit of musical time in a measure* (Slonimsky, 1998) - Stepping evenly to a beat requires considerable skill for young children. It should be approached gradually after many months of confidently clapping a beat and then begin in a controlled situation with the children are sitting on the floor. The teacher may begin by patting the beat on her lap while the children imitate her with large motions. With repeated practice most children will begin to tap the beat to familiar songs without assistance from the teacher. Specific response to beat is a learned skill that requires time and practice (Montgomery 2002). When first having children consciously attempt to step to the beat, it is beneficial to use familiar songs at the child's natural walking tempo as children's legs are shorter and their natural stepping tempo is faster than that of the adult. Development of gross-motor skills (through such movements as swaying, marching, jumping, hopping, skating, or tapping one's foot) and fine-motor skills (through finger or

hand movements accompanying singing or listening to music) provides an additional dimension to musical expression.

Form: *in music, any concept or organization governing order, character, meter, and key of composition* (Slonimsky, 1998) - Form is an extension of phrasing and should only be introduced after the children can identify phrasing with ease. Different musical forms can be identified by using matching symbols such as a triangle to represent the A section of the music, while using a solid circle to represent the B section of the music. An appropriate activity is the children clapping their hands to the rhythmic beat of section 'A' followed by creatively moving with scarves during the 'B' section (Greene, 1995).

An extension of this exercise is mapping, where the children trace and draw the song's form. Mapping is multi-sensory as it connects listening, singing, seeing, moving, and touching into one unifying activity. It is the expression of the whole of the song as experienced (Richards, 1978).

Instruments of the Orchestra: in this study instruments were systematically introduced through exemplar recordings. Prokofiev's *Peter and the Wolf* (1991), a musical tale for children, provides an exciting auditory and visual introduction to the four instrumental families of the orchestra. Music vocabulary is introduced and used later in children's writing (Collett, 1992).

A similar musical introduction is Benjamin Britten's *The Young Persons Guide to the Orchestra* (Ardley, 1995), where the theme is clearly played by first one orchestral family and then another. Whenever possible instruments should be introduced through live performances and beginning school band and orchestra students often make the best demonstrators (Bayley, 2000). In preparation for the first symphony concert, good quality

performance recordings, such as 'You are my Sunshine' from the CD '100 familiar folk songs' performed on a variety of instruments, accompanied by pictures, or videotapes, may be substituted (Gordon 1995).

A further extension to this exercise is the making of musical instruments. Shakers, drums, bells and other percussion instruments are easily constructed within the classroom by the children and can be used for rhythm exploration and theatre activities (Harris, 2005).

Phrase: *a short figure or passage complete in itself and unbroken in continuity* (Slonimsky, 1998) - A musical phrase is similar to a sentence in language, usually four to eight bars in length followed by a natural breathing place. To demonstrate using the song 'It's a Small World,' the children would change direction after each break, or phrase in the song. The children can also be instructed to make an arc-shaped motion with their right arm, from left to right, as this is the actual musical symbol for a phrase. Montessori teachers must, of course, show the arc from right to left if the children are to mirror it and perform from left to right – the direction of reading.

Music Centre: While introducing music books to the music center and the child's attention can be drawn to music notation. A visitor can be invited to talk about the books to the children and to play an instrument or sing. It is also encouraged to provide a wide range of exemplar music recordings and children's book about composers such as *Lives of the Musicians: Good times, Bad Times; and What the Neighbours Thought* both by K. Krull & Hewitt, (1993) and *Peter and the Wolf* (Lemieux, 1991).

Rhythm: *the measured movement of similar tone groups* (Slonimsky, 1998). Children can sing short (4-beat) motives from songs, using the words long and short, or

clapping the rhythm to 'Happy Birthday to You.' An extension of this activity is the Montessori music note value classified cards.

Simple versus Compound Duple Meter: *each beat is divisible by two for simple time and by three for compound duple meter* (Wilson, 1976) - While moving to the accent of the music, the children are asked if the song is a stepping song (those in 2/4 time), or a skipping song (those in 6/8 time)? 'Hot Cross Buns,' 'Hey, Hey Look at Me,' are examples of duple time while 'The Mulberry Bush' and 'Oats, Peas, Beans' are examples of 6/8 songs (Choksy, 1999).

Silence Game: children sit quietly and concentrate on the silence. They can watch the second hand on a clock, close their eyes, or do whatever ismeans necessary to aid in maintaining quiet. This is an opportunity for children to develop concentration, focus, and listening skills while remaining as calm as possible.

Song: Song and voice are the most accessible and natural of all instruments. A melody is defined as a succession of sounds that achieve a distinctive musical shape (Wilson, 1976). Children's songs should lie within one octave above middle 'C' which is the comfortable singing range of the child (Phillips, 1992), and include songs for singing, moving, playing, and listening. Over time, this repertoire of songs is developed providing an excellent source of music to work with. Choksy (1986) stated that children's voices are not physiologically ready to handle difficult melodies and recommend songs that fit a six- or seven-note range. 'Here we are Together,' 'Hot Cross Buns,' 'Open Shut Them,' 'Twinkle, Twinkle Little Star,' and 'I'm Thinking of Someone,' should be included in the teaching repertoire (Harris, 2004).

Tempo: the speed at which rhythm patterns are performed (Gordon, 2003) - 'We're Going to Kentucky,' and 'I Hear the Mill Wheel' (Musik Garten, 1999) are well known and loved quick-moving game songs ideal for focusing children's attention on tempo. The words fast, faster, stop, now slower, and slower assist in developing a musical vocabulary. Children aged 4 and 5-years-old are able to identify the speed of the music as tempo. The words 'faster temp' and 'slower tempo' should be repeated often with this musical activity.

Timbre: the quality of tone and colour (Slonimsky, 1998) - Children recognize voices and other sounds around them from a very early age. Sitting in a circle with eyes closed, each of the children can take a turn saying their name while the other children listen carefully. The quality that makes voices easily recognizable is timbre. Playing the game 'Button and the Key' encourages careful listening skills as children over time learn to disguise their sounds (Richards, 1978). Instruments can also be used to distinguish timbre – whether it is metal or wood (Choksy, 1986). Eventually the children, while blindfolded, should be able to name the instrument being struck. The Montessori sound cylinders introduced as difference sounds offers a further exercise in differentiation.

Volumne: *changes in loudness in a piece of music (*Wilkepedia, 2005) the first musical phenomenon to generate a response from children is decibel or dynamic level – the loudness or softness of music (Olsho, 1984). This can be demonstrated by singing a song such as 'Hush Little Baby' softly to the children, without comment, as something for them to listen to. After it has been heard a number of times, the children are invited to join in and sing. They can then be asked to describe how the song makes them feel 'sleepy,' 'quiet,' 'soft'? This 'soft' song should now be compared with a song of

different character – one the children have been singing in a much louder voice such as 'Jump Down Turn Around Pick a Bail of Cotton,' or 'Puncinella,' (Richards, 1985) while the teacher describes the song ensuring the correct terminology is used ('loud' and 'soft').

World Music: Music from around the world can assist in reaffirming cultural diversity, norms, and values. Through music, students learn the rich dimensions of their own cultural heritage. They also discover the musical heritage of other cultures that assists in finding common grounds and minimizing national boundaries and language differences (Miller & Coen, 1994). When introducing music from other cultures, the best strategy is to select children's songs that children will be able to sing easily (Campbell & Kassner, 1995). A further exercise is to develop a multicultural perspective of music by looking at the cultures represented by the community. Cultural trends can be found through expression of songs, dances, images, and stories (Miller & Coen, 1994). The Montessori classified cards, that categorize instruments by region, can also be used to further enhance a musical knowledge of all cultures.

CHAPTER II

REVIEW OF THE LITERATURE

A. Introduction

In the history of education in North America, more children are receiving more music lessons in more schools than ever before. There are many curricula to choose from with Orff, Jaques-Dalcroze, Kodaly, Suzuki, Education Through Music, Kindermusik, Music Learning Theory, and Music for Young Children being the most widely used. Many of these methods originated in Europe and have been successfully adapted for use in North America.

Looking back over the history of music in North America very little music education existed prior to the 1800s. During the years 1950 through 1980 art education was considered as aesthetic education (Reimer, 1980) and conducting research on the non-arts effect of arts education was not acceptable. Mann in 1827 was the first legislator to respond to the call for public responsibility for schools (Choksy 1986) and thus began the long road to educational reform. Along the way music was implemented as part of the regular curriculum thanks to the efforts of Lowell Mason. Mason's impact on music education intensified after coming in contact with the pedagogical principles of Pestalozzi, a Swiss education reformer. Pestalozzi rejected the school practices of memorization and recitation that were then commonly used, and substituted for them observation, experimentation, and reasoning. This was the first to attempt to link the educational process to the natural development of the child (Choksy 1986).
Based upon Mason's- Pestalozzian method music spread throughout the public school system and by 1900 it was well established. A need to replace the endless

exercises and concentration on technical proficiency began to grow and music for enjoyment was born. Music as a discipline, with skill and concept content suffered (Choksy, 1986). Throughout the twentieth century the arts enjoyed prominence during times of progressive reform while being regarded as an extra during the 'back-to-basics' movements (Oreck, 2002).

In the mid-1970s, Eisner (1994) began calling for the evaluation of the impact of music programs and discovered positive effects on other aspects of living and learning. Reported benefits of the arts included the development of the imagination (Greene, 1995); greater motivation to learn increased student creativity, lower dropout rates and increased social skills (Catterall, 1998). Researchers also reported that students involved in music exhibited higher academic achievement over students who were not involved in music (Catterall, 1998; Catterall, Chapleau, & Iwanga, 1999). The arts were particularly important for experiencing the joy of creating, developing attention to detail, and learning ways of expressing thoughts, knowledge, and feelings beyond words (Eisner, 1994). Eisner also suggested there were distinct contributions of the arts to learning, which may contribute to any achievement gains, exhibited in other participants, possibly because of transfer (Burton, Horowitz, & Abeles, 1999), or possibly because of overall increased engagement in school. Vaughn (2000) suggested that there were specific cognitive links between some of the arts disciplines and other participants, such as the proposed link between music and mathematics), or it could be that music offered a way for students to become more motivated to learn.

The research evidence clearly identifies the benefits of learning through the arts (Dewey, 1934; Gardner, 1973). A 3-year study by Upitis and Smithrim(2001) of Queen's

University, Ontario included the effect of learning through the arts on language and mathematics performance. Using standardized tests, they compared the achievement of 467 students in Grade Six from schools participating in learning through the arts with 281 Grade Six students from two schools. The researchers Smithrin & Upitis (2001) found that learning through the arts students scored higher in computation and estimation and that the differences were statistically significant. In this study the term engagement was used to describe the involvement of the sensorimotor or physical, emotional, cognitive, and social dimensions. Students, parents, teachers, artists, and principals from the learning through the arts schools all indicated through interviews and surveys that the arts seemed to engage children in learning.

A current school restructuring program called Roots & Wings at John Hopkins University and funded by the New American Schools Development Corporation (NASDC) is revolutionizing elementary education in an attempt to create the schools of the 21st century. In addition to standard curriculum, Roots & Wings provided daily opportunities for students to work on building higher-order skills to creatively solve problems, understand their own learning processes, and connect knowledge from different disciplines (Slavin, Madden, Dolan & Wasik, 1996). The goal was to engage students in activities that enabled them to apply everything they learned so that they could learn the usefulness and interconnectedness of all knowledge (Burton, Horowitz, & Abels, 1999).

The extant literature available regarding the effect of music instruction on academic achievement, the relationship between mathematics and music; and the effect of a Montessori education on academic achievement reveals four recurrent themes: 1) the

effect of music on brain functions, 2) music students and academic growth, 3) the relationship between music and mathematics, and 4) Montessori students and academic growth.

The Effect of Music on Brain Functions

The role music plays in the education of the child is the focus of much discussion in education today, and this environment influences the child who grows up surrounded by music. Research by Olsho (1984) showed that during the early months and years of life, the child's brain expanded at a pace that was never matched in later years and early experiences were believed to be crucial to the developing architecture of the young brain.

Research results showed that babies studied at 2 to 4 days of age who had been exposed to a melody repeatedly while their mothers were pregnant exhibited changes in heart rate and movements when the same melody was presented after birth. Also, fetuses of 29 to 37 weeks gestation age showed specific behavioural responses to tunes played earlier in pregnancy. In both experiments, behavioural responses were specific to the tune to which they had been exposed. These results indicated that the learning and remembering of a melody occurred not only before birth but actually before or at the beginning of the third trimester (Hepper, 1991). Classical music, played at a rhythm of 60 beats per minute, which is equivalent to that of a resting human heart, encouraged creative and intellectual development for the unborn child (Verny, 1981). Further studies showed that even very young children learned music, especially if they were engaged and involved in active participation (Upitis & Smithrin, 2001). Research by Hodges (2000) demonstrated that the first 3 years in a child's life was the time when music was used to stimulate the development of nerve connections between brain cells necessary for optimal

cognitive development. Attentive parents recognized that the earliest signs of musical aptitude was at the age of 2, when children began to capture portions of songs and moved in response to music (Davidson & Colley, 1986). Learning occurred through movement and quick emotional associations, until a major leap took place in brain growth in the elementary years. This further supported the notion that young children inherently expressed themselves and music, through movement-tactile and kinesthetic experiences (Hargreaves, 1994).

The power of music helped the brain to develop, integrated the two hemispheres, and played a crucial role in the neurological development of the child. Hickerson (1983) compared the performance on the left and right hemisphere processing tasks of kindergarten students in three different instructional approaches: Montessori, Open Activity-Centered, and Traditional-Conventional. There was no statistically significant difference between the groups, but females from all three approaches scored consistently higher on left-brain tasks than did males. Males from all three approaches scored consistently higher on right brain tasks. The only significant difference was found in the Montessori class where experimental groups from all three approaches scored consistently higher on right brain tasks than did control groups from the Montessori classes. A study by Whitwell (1977) dealt with the left brain/right brain issue, in which talking about music used the left side of the brain, while creatively producing music utilized the right side of the brain.

Music greatly assisted sense-making of patterns when the development of right brain activities, such as creativity, artistic expression, and musical intelligence heightened around 4-years-old (Finnerty, 1999). This process was essential in developing lifelong

thinking skills, and led to enhancing natural development of communication, expression, and cognition (Weinberger, 1998).

Research by Rauscher and Shaw (1998) emphasized the causal relationship between early music training and the development of the neural circuitry that governs spatial intelligence. Their studies indicated that music training generated the neural connections used for abstract reasoning, including those necessary for understanding mathematical concepts.

Music was also being used in the treatment of Attention-Deficit Hyperactivity Disorder (ADHD). Music therapists often work with preschool children, and Jackson (2003) conducted a survey to ascertain the music therapy methods being used for children with an ADHD diagnosis, how effective this treatment was perceived to be, and the role that music therapy treatment played in relation to other forms of treatment. The results of the survey indicated that music therapists often utilized a number of music therapy methods in the treatment of children with ADHD.

Shuter-Dyson and Gabriel, (1981) identified that students as young as 5-years-old were able to sing a song, match pitch, adhere to the melodic compositional structure of the song, and clap to a steady pulse at 6-years-old. Children who demonstrated these abilities before the age of 5-years-old showed signs of musical aptitude (Davidson & Colley, 1986) and studies found that students who were recognized as showing early signs of musical aptitude had begun private music instruction by 5-years-old (Howe & Sloboda, 1994). In addition, a child learned to play piano and developed areas in the brain similar to those in the same area used for reading and mathematical skills (Kosik, 1999). The more musical experiences children were exposed to before they entered school, the

more deeply this stage of neural coding assisted them throughout their lives (Campbell, 1997). Research supported the theory that music had a positive effect on the development of the brain and the earlier in life, the young child was exposed to music, the sooner this effect began to take place.

Roehmann & Wilson (1988) found that Houston of the Foundation for Mind Research said that children without access to an arts program were actually damaging their brain. They were not being engaged to non-verbal modalities that helped them learn skills like reading, writing, and mathematics.

Music Students and Academic Growth

The literature suggested that music education was vital to individual development; that the competencies learned in one art form were in some sense generic and transferable to other participants (Brademas, 1995); and student participation in music activities had a positive effect on many things from academic achievement to self-discipline (Morrison, 1994).

A 3-year follow-up study on Learning Through the Arts suggested that music reinforced concepts that were essential to academic achievement and also helped to develop critical thinking skills (Upitis & Smithrin 2001). Research by Rauscher and Shaw (1998) revealed the value of music study and its positive relationship to test scores, grades, and academic achievement. Educators used music instruction to enhance academic achievement and mental discipline (Upitis & Smithrin, 2001) and evidence existed to suggest that focused listening to music facilitated learning to read, probably by increasing children's awareness of speech sounds, which was important in learning to 'sound out' words (Butzlaff, 2000). Music, specifically song, was one of the best training

grounds for babies learning to recognize the tones that added up to spoken language. The study 'Project Zero' at Harvard University, under the co-direction of Howard Gardner, reported that while very young children could reproduce specific pitches with considerable accuracy, intervals and melodic fragments develop much later. By 3 years of age children appeared to have a sense of the rhythmic structure of songs and reproduced fragments of songs. By 4 years of age, they attempted to reproduce whole songs, although usually without stability of key or tonality, and only at 5 or 6 years of age were specific intervals sung correctly (Gardner, 1973). Research by Schlaug (1999) suggested that all children should begin music instruction before 7-years-old to obtain optimal brain development.

The basis of the music-enriched Montessori instruction was singing where it was the teacher's role to introduce melodies that were matched to children's abilities (Harris, 2005). Repetition of easy tunes strengthened children's singing voices. By keeping the music simple, children were able to focus their attention on pitch, melody, and rhythm, and progress became more accurate with the passing of time (Gordon, 2003). The most effective method of teaching melody was teacher modeling. The songs were chosen with simple repetitive segments, repeatedly sung in its entirety in child appropriate pitch range, with a pleasant singing voice. Often children sang 'out of tune' because the beginning note was not firmly established in their minds. Before singing, the teacher held the pitch while the children attempted to match it. Considerable time and attention was given to the first note. When all of the children were able to match a pitch in unison, singing began (Richards 1977).

Using music to train and prepare the ear was also important during the early grades, when children started to transpose sounds into letters. While learning to read, music enhanced the student's ability to perform the skills necessary for reading, listening, anticipating, forecasting, memory training, recall skills, concentration techniques and speed-reading. A reading program in New York dramatically improved reading achievement scores by including music and art in the curriculum (New York City Board of Education, 1980).

A study by Hurwitz, Wolff, Bortnick and Kokas (1975) asked whether music training improved reading performance in first grade children. The experimental group received Kodaly training which used folk songs and emphasized melodic and rhythmic elements. The control group consisted of children who were matched in age, IQ, and socioeconomic status at the beginning of the study and who received no special treatment. The music instruction was extensive, 5 days a week for 40 minutes each day, for 7 months. Students were tested on reading ability at the start of the school year and then re-tested at the end of the year. After training the music group exhibited significantly higher reading scores than the control group. Continued music training was beneficial and after an additional year of Kodaly training, the experimental group was still superior to the control group. These findings supported the view that music education facilitated the ability to read.

Research also suggested that music therapy was beneficial in teaching both social and academic skills to young children. A study by Register (2004) examined the effects of a music therapy program on teaching reading skills and also compared on- and off-task behaviour of students during video versus music conditions. This study confirmed that

music increased the on-task behaviour of students and supported the need for further investigation regarding the benefits of enrichment programs, particularly programs that incorporated music activities.

Whitwell contended that creative participation in music improved self-image, self-awareness and created positive attitudes about oneself as documented in Learning Through the Arts, which was commissioned by *Texas Music Educators Association* (Whitwell, 1997). It was also found that music students out-performed non-music students on achievement tests in reading and mathematics in a study of medical school applicants, 66% of music students who applied to medical school were admitted, the highest percentage of all groups, while students who studied music scored higher on both the verbal and mathematics portions of the SAT than non-music students (College Entrance Examination Board as reported in Symphony, Sep-Oct 1996).

Further research suggested that music should assume a place in the regular school curriculum as it showed a positive effect on academic achievement. "Music and the arts were vital to the development and expanse of the human intellect, which in turn resulted in superior academic and career performance" (Oddleifson as cited in Kelstrom, 1998). A child may use the ability for logical thinking that was developed in the music class to solve problems quite unrelated to music, and it became clear that music had a profound influence upon the academic life of a child and deserved equal status within the curriculum (Sloboda, 2001).

The studies cited here presented a compelling argument in favour of the implementation of long-term developmental music programs for all students, not just those students with an obvious aptitude and interest.

The Relationship between Music and Mathematics

A study of 500,000 students in 45 countries showed that the United States was below average in mathematics and a study titled 'Musical training improves a child's ability in spatial-temporal reasoning, which is important in mathematics and science education' (Grandin, Peterson & Shaw, 1998) suggested that music education be present in schools, preferably starting in preschool, to develop "hardware" for spatial temporal reasoning in the child's brain. The absolute crucial role of spatial temporal reasoning in learning difficult mathematics and science concepts must be explored and exploited.

Learning Through the Arts was initiated in 1994 by the Royal Conservatory of Music and is about teaching core academics through arts-based activities that engage the child (Catterall, 1998). Engagement means that children are wholly involved, physically, emotionally, intellectually, and socially. Hoffman, (2003) described an LTTA class for Parents magazine as-

"For example, the class is gathered at one end of the gym and the children are walking around in a tight little clump beating time to a deliberate drumbeat. Suddenly the beat quickens and the children begin to spread out across the gym. What are they studying? Energy transfer! The students are water molecules being heated up by a uranium bundle in a nuclear power plant. (When water is heated, each molecule moves more quickly and further apart from the others, - a change in movement which was signaled by the drum). Later in the lesson the children shuffle along the floor, representing electrons moving along power lines. Then they pretend to be atoms joining together and breaking apart, and chant a rap about the pros and cons of various energy sources – all of this while engaging in musical accompaniment."

Interviews and surveys with students, parents, teachers, artists, and principals from LTTA schools all indicated that arts seem to engage children in learning (Upitis & Smithrim, 2001). Artsvision (American leader in innovative education projects) recommended the Arts as a means of engaging the student and teaching across the curriculum.

A New York City program called LEAP (Learning through an Expanded Arts Program) used art and music to teach academic skills. Simple mathematical concepts such as odd and even, counting, addition, multiplication, sets and fractions were integrated throughout the musically enriched lessons (Dean 1992).

As students developed the rhythms for their songs, they began to think in multiples of four. They realized that if they had sixteen beats of music, they then had four sets of four beats. Students also grasped the concept of odd and even as the groups were subdivided into smaller units for particular steps or musical rounds (Dean, 1992).

There were similar brain processes at work in developing a strong sense of musical pitch, and the understanding and use of numbers. Pitches in a musical scale and numbers increased from step to step and from lower to higher. The representations were different but they required a similar way of understanding and using information (Gardiner, Fox, Knowles, & Jeffrey, 1996). Music taught and reinforced basic mathematical concepts that were otherwise difficult to grasp for some students (Geoghegan & Mitchelmore, 1996).

There is no doubt that beating drums and acting as molecules in the gym is much more fun than sitting in class, but does it really improve student achievement? The research team Rauscher & Shaw (1997), exploring the link between music and

intelligence reported that music training – specifically piano instruction – was far superior to computer instruction in dramatically enhancing children's abstract reasoning skills necessary for learning mathematics and science. The new findings were the result of a 2-year experiment, with preschoolers. This team set out to compare the effects of musical and non-musical training on intellectual development. The experiment involved seventy-eight 3 to 4-year-old children of normal intelligence from three preschools in Southern California. Of this group 34 received private piano lessons, 20 received private computer instruction, 10 received singing lessons and 14 in a control group received no special lessons. None had prior music lessons or computer training. Those children who received piano/keyboard training performed 34% higher on tests measuring spatial-temporal ability than the others. What Rauscher and Shaw emphasized was the causal relationship between early music training and the development of the neural circuitry that governs spatial intelligence. Rauscher, Shaw, Levine, Wright, Dennis & Newcomb (1997), while studying higher brain function, found a connection to the brain linking musical and spatial skills. Children who took music lessons scored up to 35% higher on spatial tasks; and music lessons improved the spatial-temporal reasoning abilities of 4 to 6-year-olds.

Perhaps listening to specific music enhances spatial-temporal reasoning. The well-known Mozart effect study, which was conducted, by Rauscher, Shaw and Ky (1995) found that students performed better on spatial tasks from the Standford –Binet Intelligence test after listening to 10 minutes of Mozart's Sonata for Two Pianos in D major. A similar study was conducted by Morton, Kershner & Siegel from the University

It is more than a coincidence that mathematics and music were noted for their crossover talents. For example, the musical scale was similar to a neat logarithmic progression of frequencies. There were also similar connections between patterns of notes and patterns of numbers. Music involved ratios, regularity, and patterns, all of which paralleled mathematical concepts and while music was viewed as a separate intelligence, there was a high correlation between mathematics and music. Reading music required an understanding of ratios and proportions. Arithmetic progressions in music corresponded to geometric progressions in mathematics; that is, the relation between the two was logarithmic (Marsh, 1999). Case studies were conducted to assess the academic success of school music students (Milley et al., 1983; Mickela, 1990; McCarthy, 1992). The rhythm students learned the concept of fractions more easily and those students who were taught using rhythm notation scored 100% higher on fractions tests. The 67 individual case studies showed that students' achievement in mathematics improved when arts were included in the curriculum. It was also believed that studying music enabled students to learn multiplication tables and mathematics formulas more easily (Mickela as cited in Kelstrom, 1998). These findings indicated that music uniquely enhanced higher brain functions required for mathematics, chess, science, and engineering. Because neural connections were responsible for all types of intelligence, a child's brain developed to its full potential only with exposure to the necessary enriching experiences in early childhood (Hargreaves & Davis, 2000).

Montessori Students and Academic Growth

The Montessori method was conceived as an indirect approach to learning, presenting a comprehensive view of the child (Davenport, 1987). Montessori regarded

the classroom as a laboratory for observing children and testing and retesting ideas and aids to their growth. She approached education as a scientist and pursued her ideas with an open mind, always with strong respect for the child as an individual. The method was designed to develop the whole personality of the child at a natural rate of progress, and thus free the potential for self-development within a prepared environment. The Montessori curriculum did not place restraints on the student's ability and provided manual and physical activity through use of concrete and abstract experiences to help gain mastery of oneself and environment. The materials allowed the child to explore the world through various senses; developed confidence and competence while working from simple to the more complex (Havis, as cited in Hainstock 1997). Montessori embedded music in her approach with a variety of stimuli such as listening, singing, playing, body expression and above all by creating special sets of materials (Miller, 1999). These materials the Bells and Tone bars, were designed with the collaboration of Signorina Macheroni a music specialist and are more elementary age appropriate.

After innovating a methodology for working with children with disabilities Montessori started her Casa Dei Bambini in 1907 in Italy. In the 1950's American educator Nancy Rambush led a movement of renewal and Montessori education spread as an independent school movement. Montessori was influenced by the works of Rousseau, Pestalozzi, and Froebel and incorporated their ideologies into her own developing and expanding theories. She modified the sensory teaching materials of Itard and Seguin and produced the Montessori didactic materials (George 1964). Montessori's ultimate goal was the return of the child to a state of its true normal way of being which she named the 'normalized' child, with the qualities of spontaneous self-discipline, love of order and

constructive activity, attachment to reality and complete harmony with the entire environment. It was to this end that her vast array of materials was developed (Hainstock 1997).

Morgan's 1978 research on the effect of Montessori materials hypothesizes that certain aspects of the concept of number, as explained by Piagetian theory, could be accelerated by the Montessori mathematics experiences. A second hypothesis was that Montessori children would perform better on a preschool test of arithmetic skills and concepts than children in a traditional nursery school. The children from three Montessori and three traditional nursery schools were individually administered an Arithmetic Test. The results showed that the Montessori children were significantly superior in seriation and numeration tasks. However, without a description of the curriculum in the traditional schools, Morgan's results did not prove that the superior performance of the Montessori children was due to the Montessori curriculum alone (Boehnlein, 1998).

Montessori programs have grown considerably over the past decades and with growth came concerns about outcomes, especially academic ones. Many Montessori schools evidenced high achievement levels. Such results though impressive could be difficult to interpret for a variety of reasons, high socioeconomic backgrounds, parental influence etc. A study comparing the academic outcomes of two groups of students who graduated from high schools of the Milwaukee Public Schools during the years 1997-2001 indicated that one group had completed fifth grade in Montessori while the other group had not attended Montessori. The Montessori sample that consisted of 201 students, found that 5 to 7 years after the Montessori students had exited the Montessori

programs and enrolled in traditional public schools their mathematics scores were superior. Significant finding in this study supported the hypothesis that Montessori education had a positive long-term impact. In essence, attending a Montessori program from approximately 3 to 11-years-old predicted significantly higher mathematics and science standardized test scores in high school. In this context, the fact that the Montessori students had significantly higher Mathematics/Science scores suggests a substantive impact of their Montessori experience (Morgan, 1978).

In a study conducted by Clifford, & Takacs, (1991) graduates of the Montessori Head Start program at the Marotta Montessori School of Cleveland who had entered the Cleveland Public Schools (CPS) were studied in relation to their CPS peers. The comparisons showed the former Montessori students consistently fared better in mathematics. In addition to this work Boehnlein (1990) cited that low socio-economic status (SES) children benefited significantly from Montessori preschool. Other studies confirm these results. Dr. Tim Duax (1989) studied the 1987 and 1988 graduates of MacDowell School, a Milwaukee public school Montessori program spanning 4 to 11-years-old. Of these students, the standardized-test scores (Iowa Test of Basic Skills) of 84% of Mac Dowell graduates fell above the 50^{th} percentile, far above national norms. Nationally, 23% of students scored in the 'high achievement' range; of MacDowell graduates, 44.5% scored in that range. While 23% of their peers nationally scored in the 'low achievement' range, only 1.2% of MacDowell graduates scored in that range. Students in Montessori middle schools reported more positive motivation and experience than a matched sample of students from traditional middle schools (Rathunde & Csikszentmihalyi, 2003). Five Montessori schools from the United States participated in

the study encompassing all social class levels. Rathunde (2001) followed up with an article that put Montessori's rich understanding of the prepared environment in tandem with contemporary thought in both education and developmental psychology. These studies supported the view that Montessori education at both the preschool and elementary levels benefited the child academically (Boehnlein, 1998).

B. Research Question and Hypothesis: The following question will be examined for this study: Are there statistically significant differences in the mathematics achievement scores of Montessori students who receive traditional Montessori instruction and students who receive music-enriched Montessori instruction?

Null Hypothesis: There will be no statistically significant differences in mathematics achievement scores between students who receive traditional Montessori instruction and students who receive music-enriched Montessori instruction.

CHAPTER III

DESIGN AND METHODOLOGY

A. Participants

A sample of 200 Casa students within the jurisdiction of a Montessori School board located in Southwestern Ontario was selected for the study. The Montessori School was a licensed school; with an American Montessori International trained Directress and teachers. Casa students were between the ages of 3 and 5 years with gender being somewhat evenly distributed and all students were in the process of completing the total Montessori 3-year curriculum. The school was an established Montessori program that met recognized affiliation standards. Authenticity of a Montessori program specified minimum expectations in the following areas: 1) the teacher held a recognized Montessori diploma; 2) the classroom was fully equipped in all basic areas, and the curriculum areas were supplemented by handmade materials appropriate to the class; 3) the class consisted of mixed ages of children 3 to 6-years of age; 4) the school day was a minimum of two and one-half to three hours daily for 5 days per week for 9 months; 5) the classroom aide remained for the full term and functioned as an aide; and 6) the full Montessori curriculum was available to the child for extended, uninterrupted individual and small group work time (Boehnlein, 1998). All participants were randomly selected by age as defined in the table of random numbers (Gay & Airasian, 2000) and placed in one of two groups. The participants came from advantaged homes and were for the most part homogenous with respect to socio-economic status.

B. Instrumentation

The researcher, an experienced Montessori teacher; and music specialist, used the Test of Early Mathematics Ability 3 (TEMA-3) assessment for this study (Ginsburg & Baroody, 1998). This test is intended to provide useful information on the strengths and weaknesses of 3 to 8-year-olds mathematic ability and was individually administered to each child by the researcher, with a starting point determined by the child's age. The Mental Measurements Yearbook test reviews were complimentary of the test as a useful measure of children's mathematical knowledge and thinking; and the reviewers of the TEMA-3 approved of the addition of the Assessment probes and Instructional Activities. Coefficient alpha reliability estimates and standard errors are reported at each level. The median reliability estimate is .95 and the median standard error is 3. Reliability is estimated at .97 based on a sample of 46 children and corrected for restriction of range. This same sample was retested after two weeks and the correlation, corrected for restriction of range, was .93. In the present study the data that were collected from the assessment were the students' quantitative scores and was used as the dependent variable to determine if the independent variable, music instruction, had any effect on students' mathematics test scores. Test administrators and scorers were given the required training, materials and standard procedures used in testing and scoring to control for data collector bias and to ensure scoring reliability.

Foundational Theories from which this Treatment was Developed:

The music enriched Montessorimusic-enriched Montessori instruction used in this research incorporated the following approaches and philosophies that influence early

childhood music and movement in education today and are Casa age appropriate (3 to 6-year-olds).

Dalcroze, Emile Jacques (1865-1950): 'Dalcroze Eurythmics' which was named after the Swiss pedagogue Emile Jaques-Dalcroze, is an approach to music education based on the premise that rhythm is the primary element in music. and is named after the Swiss pedagogue Emile Jaques-Dalcroze. The method consists of 3 parts – Eurythmics, Solfege, and Improvisation and forms a totality of music that offers the opportunity to experience the wholeness and aliveness of the art (Bachmann, 1991).

Rhythm: The ears and the body are used as the natural instruments for the study of rhythmic movement. Dalcroze perceived that the aspects of music that make the most definite appeal to the senses were rhythm and movement. He was convinced that combining intense listening with body responses would generate and release a powerful musical force.

Solfege: This part of the method consists of thousands of graded and sequential exercises for the study of the theory and practice of scales, modes, intervals, melody, harmony, modulation, counterpoint, and vocal improvisation. Through these the student is offered guidelines for choosing phrasings, dynamics, accents and the other elements of musical expression. (Choksy, 1986)

Improvisation: The goal is to produce skillful ways of using movement materials (rhythm) and sound materials (pitch, scale, harmony) in imaginative, spontaneous, and personally expressive combinations to create music. (Choksy, 1986) Although improvisation is considered to be an important musical activity for preschoolers, few research studies have concentrated on the improvisations of the preschool child

(Reinhardt, 1990). Research by Moorhead and Pond (1978) detailed the general musical development of the child.

Inner Hearing: this is the ability to internalize feelings of movements and sounds. The principal objectives of Dalcroze instruction is to enable each student to develop the ability to express what is heard securely, effectively, and knowledgeably through movement before transferring those physical sensations into other forms of musical expression or other levels of musical knowledge (Choksy, 1999).

The Dalcroze Method involves the kinesthetic sense. It stimulates, develops and refines all the capacities used when engaged in music; the sense of hearing, sight and touch; faculties of knowing and reasoning; the ability to feel and to act on ones own feelings and provide first-hand aural and physical experience of music through rhythm and dynamic intensity (Bachmann, 1991). Coordinating these capacities is the kinesthetic sense, the feedback mechanism of the nervous system that conveys information between the mind and the body. The education of this sense to the purpose of music is at the heart of the Dalcroze work (Himes, 2004). The Dalcroze method primary goal is to integrate the Dalcroze principles to the rhythmic energy of life.

Education through Music (Mary Helen Richards 1934-2001): The inception and development of ETM was strongly influenced by the philosophies of Zoltan Kodaly and child developmental theories of Piaget. The aesthetic foundation for musical thought is accomplished through participation in the 'song-experience-game in which children wait, participate, listen, think, move, time their response, learn to become interested in others, organize, strategize, predict, self-monitor and learn compassion and empathy. This is possible because each song-experience-game provides secure and enjoyable

situations in which to learn and think. As they keep insisting, "Let's do it again!" children themselves assure the repetition necessary for the development of their own intellect. The activity in the song-experience-game is imagination based and is very much like play as described by Piaget (1951) and yet is always accompanied by song. In the game he develops the ability to feel good about himself. The songs used in ETM have been handed down from generation to generation and are closely related to the English language and the art of communication in movement and in speech. The song-experience-game itself is an experience in participating in the music that motivates children to 'attend'. Once the children are familiar with the song through the game, they begin to identify the parts of the song and the relationship of the parts to the whole. This is centering in on the concrete aspects of song and Piaget's cognitive analytic processes of thought. The process developed in musical thought crosses disciplinary lines and seeks to solve problems that seem remote from the song-experience-game by using the tools discovered and invented there (Richards, 1978).

Children play, sing and experiment with high, low, and medium sounds. They sing songs and analyze and describe through movement and visual representation the melodic contours apparent in musical composition. Children can and should sing and can develop a repertoire of songs that helps to form the foundation of their lifelong musical education (Klinger, Campbell, Golsby, 1998). The children listen to, identify, perform and create the simultaneous sounds known as harmony. This is experienced through simple melodic ostinato patterns, partner songs, and simple two-part playing and singing. The exploration of differences in pitch, timbre, duration, intensity all result in form. Children explore form by identifying like and unlike phrases and sections, and by

identifying ABA form. The exploration of these elements and organizations of sound is done within social, aesthetic and historical contexts with a variety of world music materials.

The principal objectives of Education Through Music are to demonstrate the aesthetic experience of song and the concrete content of song; promote social development in the song; improve movement and perceptual skills; reinforce communication skills and language skills; and explore the music within the song – structure, phrasing, auditory perception and rhythm patterns.

When the song-experience-game is first presented to a group of children, it is presented in its wholeness and consists of the kind of experiences that the child is exposed to everywhere in his daily life. In the game these experiences are placed in a framework where they can be examined and practiced. Song-experience-games create real life situations for children. Their play of each song-experience-game and their repeated practice in symbolizing its song and language draw children in to learn effortlessly, time and again (Richards, 1978).

Kindermusik (1960 -): In 1960 a group of music educators in West Germany developed 'Musikalische Fruherzienhung', or music for young children. The program is designed to assist children experience the joy of learning music before beginning formal music instruction. In the 1970s due to growing popularity the program is translated and adapted for American children and renamed Kindermusik. In a Kindermusik class, educators lead a group of parents and their children through joyful activities, using music and movement. Parents learn more about their child's unique developmental process, and the shared learning experience creates a unique bond as the child associates learning with

fun, musical play. The Kindermusik curricula nurtures the 'whole child' beginning with the newborn through 7-years-old. With a mix of song and activity each curricula is designed to achieve multi-levels of age specific learning and developmental goals. Every lesson moves at the child's pace, pausing to engage his interests. Kindermusik's Foundation of Learning provides scientific explanations as to how Kindermusik enhances the natural growth systems of the young mind and body.

The Kindermusik objectives of instruction are that each student should develop the ability to express what is heard securely, effectively and knowledgeably through movement before transferring those physical sensations into other forms of musical expression. The Kindermusik method claims that movement and dance activities improve coordination and balance; one-on-one parent and child interaction nurtures self-esteem; music-making and music listening activities develop self-discipline, as well as critical and creative thinking skills (Kindermusik (2001) guidelines [Brochure]. The Kindermusik primary goal is to stimulate development in every part of a child's brain through music.

Kodaly, Zoltan (1882-1967) The Kodaly method of music instruction evolved in the Hungarian schools under the inspiration and guidance of Kodaly. The goals, philosophy and principles were Kodaly's, however the pedagogy was not. Solfa was invented in Italy and tonic solfa came from England; rhythm syllables were the invention of Cheve in France and many of the solfa techniques employed were taken from the work of Jaques-Dalcroze; hand-singing was adapted from John Curwen's approach in England (Choksy, 1974) and the teaching process was basically Pestalozzian (Choksy 1986). What was unique about Kodaly's method was the way in which these previously separate

techniques were combined into one unified approach. It is based upon a sequential system of sight singing that leads into the understanding of musical notation. Kodaly's basic aim is to teach children to read and write music through singing (Raebeck & Wheeler 1997).

The principal objectives of Kodaly musical training is that through singing every student should have the opportunity to become musically literate, in the sense of being able to see a score and imagine the sounds or to hear sounds and imagine the score, and to know and love his or her own folk music heritage and the great art music of the world (Choksy, 1979). The Kodaly Method involves using the instrument that is most accessible to everyone, the human voice. Singing forms the foundation for musical knowledge, artistic sensibility and social connection (Smee, 2004). The Kodaly primary goal is to produce universal musical literacy.

Music for Young Children (MYC) was created in 1980 by Education Specialist Frances Balodis. Her intent was a comprehensive beginning music program taught as a parent-child team in small groups, having fun together while learning keyboard, singing, rhythm ear training, sight reading, theory, history and composing (Nye, 1983). The program uses early childhood development techniques to provide music instruction in a positive and comprehensive way. The parent and child are taught as a team. Games and activities are used to reinforce the lesson's objectives using the child's visual, auditory and tactile senses (Arnoff, 1979). Keyboard, singing, rhythm, theory and composition are combined in each lesson to reinforce the teaching points of the lesson. Care is taken to provide gross motor and fine motor activities and the lesson is designed with the child's attention span and abilities in mind.

The principal objectives of MYC are to build a solid foundation of understanding and enjoyment of music; nurture team skills through keyboard playing and rhythm ensemble; develop individual expressiveness through movement; reinforce music reading and theory with group activities and colorful, hands-on materials; and integrate aural and written skills and give a sense of ownership. MYC accents the positive while refining the young child's listening, vocal, fine and gross motor skills. Musical concepts are taught at the child's learning level and emphasis is placed on accuracy of basic skills to provide a solid foundation for further musical growth (Balodis, 1995). The MYC's primary goal is to encourage children to develop the enjoyment of music and through work and play, spend much of their time involved in the activity of making music.

Music Learning Theory: Jump Right In (1995 -) this developmentally appropriate music series is based on A Music Learning Theory for Newborn and Young Children (Gordon, 2003) and years of practical and experimental research. It is designed to assist teachers, parents, and caregivers of newborn and young children in the development of basic music skills such as singing, rhythm chanting, and moving, with an emphasis on individual differences between children. Suggested activities guide the child through music developmental stages with corresponding tonal or rhythm patterns. Also, movement activities are encouraged to give children the opportunity to teach themselves how to coordinate their breathing with tonal, rhythm and movement responses (Gordon, Bolton, Reynolds, Taggart, Valero, 1998). All is accomplished through informal guidance that is based on and operates in consequence to the natural sequential activities and responses of the child.

Orff, Carl (1895-1982): Carl Orff's approach to music is based on the premise that feelings precede intellectual understanding (Raekeck & Wheeler, 1972). The child feels the sensations long before they are verbalized as ideas. When these inward sensations and feelings begin to form meanings for the child are then verbalized, it is now time to begin and write about them.

The principle objectives of the Orff teaching method are that all students should find ways to express themselves through music, both as individuals and as members of a musical community (the ensemble). The musical experience itself is the most important objective (Choksy, 1999).

The Orff Method lends itself to the "instructionally intelligent" music teacher as it encourages the use of a wide variety of media (speech, song, movement, body percussion, instruments, visual aids) through which music literacy may be taught to a wide variety of learners. (Goodkin, 2001). The Orff Method primary goal is to address every aspect of musical behavior: performing, creating, listening, and analyzing, through a variety of means (Frazee & Kreuter,1987).

Suzuki, Schinichi (1898-1998): Suzuki, born in Japan of a father who owned the largest violin factory in the world, taught himself to play violin by listening to recordings of classical music. Suzuki discovered a way to develop musical ability in young children in comparison to the way in which each child develops their native tongue. He believed that children could learn to play a musical instrument in the same way that they first learn language. He believed that a child's growth depended upon how he is raised and education begins from birth, with emphasis on a strong child-parent learning relationship.

Suzuki believed that from birth movement is the basis of all knowledge and intellectual performance (Wood, 2004).

Suzuki objectives are for students to find ways to express themselves through music, both as individuals and as members of a musical community; encourage the parents of each child to provide music in the earliest stages of life; his capacities as a scholar will rest upon the earlier development of the whole being; the child will first learn to listen and hear each note accurately; the relationship of the parent to the child in a learning situation should be warm; respect is the most important element in the relationship; and the musical experience and production of beautiful sound is the most important objective.

The Suzuki method builds upon the inherent nature of the child from birth and providing an ideal home environment with parental support and participation at each lesson. Music to be learned should always be played beforehand followed by repetition with praise. One's future fate, or ability in later life, is determined by training in infancy and childhood (Suzuki & Mills, 1997) The Suzuki method primary goal is to work together to build a new human race.

Music-enriched Montessori instruction: incorporates the above leading approaches and philosophies that influence early childhood music and movement in education today and is sequenced to teach concepts of pitch, dynamics, duration, timbre, and form. It accents the positive while refining the young child's listening, vocal, fine and gross motor skills. Musical concepts are taught at the child's learning level and emphasis is placed on accuracy of basic skills to provide a solid foundation for further musical growth The length of the class period is not as important as the frequency - two

or three 20 to 30 minute weekly sessions with Casa age children is more valuable than one 40-minute session (Choksy, 1999). This music-enriched Montessori instruction is administered by an experienced Montessori teacher who is also an early childhood music specialist. Creative movement develops individual expressiveness and coordination, while music skills are refined using group activities and hands-on Montessori materials. Composing integrates aural and written skills and gives children a sense of ownership. Lastly, rhythm ensemble develops coordination, beat, inner hearing, and nurtures self-confidence, and communication skills. It builds a solid foundation of understanding and enjoyment of music while allowing the child to explore and develop his or her own strengths in a variety of musical areas (Gordon, 2003). It provides a child-centered musical environment to facilitate development in all curriculum areas, while enabling the child to learn fundamental music skills (Harris, 2005).

Montessori programs would benefit from enhancing Montessori's philosophy with a quality music methodology, expanding on the present treatment of classroom music to include daily group 'music and movement' sessions (if possible), enhanced with weekly piano lessons to provide the child with every opportunity to develop his whole being. The introduction of modern technology has opened a window for music instruction, and the ramifications for the future are only beginning to be realized.

Keeping in mind that the goal in early childhood education is to cultivate the child's own natural desire to learn (Montessori, 1916) Maria Montessori would carefully "follow the child" and encourage other educators likewise. Being a visionary whose innovative ideas were so unconventional for her time (Montessori, 1948) she would perhaps embrace a music-enriched Montessori curriculum.

C. Design and Procedures

This was an experimental design using a two-group post-test comparison (Gay & Airasian, 2000). All children were from middle to upper middle class homes and were accepted to the study as they applied. A pre-test was not necessary due to the large sample size, the comparison being by age, and the participants were for the most part homogenous with respect to socio-economic status. The convenience sample was 200 children from a Montessori School in Ontario. Permission was sought and granted from the University of Windsor Research Ethics Board as well as the participating Montessori Board of Education by a Letter of Permission (see Appendix A). Permission was also sought and granted from the Directress of the participating Montessori school by means of a Letter of Information (see Appendix B). The participants were provided with the opportunity to participate in the study and were given a package that contained a Letter of Information (see Appendix C) that provided a thorough explanation of the study and a detailed Letter of Consent (see Appendix D). To be eligible to participate, participants had to return signed consent forms from their parents. The students were given one week to return the consent forms and all students returned the forms. Once the parental consent forms were returned the students were grouped according to age, comprising of 3, 4 and 5-year-olds. Using the Table of Random Numbers from the (Gay & Airasian, p.552-555) test each age grouping was randomly assigned to one of two groups – either the control group which experienced music-enriched Montessori instruction, or the experimental group which received traditional Montessori instruction. The final distribution between the two groups was a result of two students from the experimental group and eight students from the control group being re-assigned to an afternoon program in order to

accommodate student's school time scheduling needs. The experimental group received a treatment consisting of 3 half-hour weekly sessions in music instruction for 6 consecutive months and then both groups were post-tested. The experimental treatment was an "in-house" music-enriched Montessori program and was sequenced in order to teach concepts relating to pitch, dynamics, duration, timbre, and form as well as skills in moving, playing, listening, singing and organizing sound. The comparison control group received traditional Montessori instruction that is based on a 3-year program and concentrates on the Practical Life, Sensorial, Language, Mathematics, and Cultural (including music) areas of development and does not include a specific music curriculum.

The instrument used to measure mathematical achievement was the Test of Early Mathematics Ability-3 (TEMA-3) developed by Ginsburg and Baroody (1990). The test covered 1) concepts of relative magnitude, 2) counting skills, 3) calculation skills, 4) knowledge of conventions, and 5) number facts (reviewed by American Educational research Association, American Psychological Association, and National Council on Measurement in Education 1999). The post-test scores of both groups were then compared (see Tables 2 and 3). Comparisons of the groups' mathematics scores were analyzed.

D. Limitations of Design

Many Montessori schools evidence high achievement levels. Such results, though impressive, can be difficult to interpret for a variety of reasons. These schools may contain large proportions of children from high socioeconomic backgrounds who might be expected to show strong academic achievement regardless of type of schooling. It is also difficult to rule out the influence of parental motivation, in that Montessori schools

may attract families who are particularly committed to and involved in their children's education. Not administering a pretest was the decision of the researcher based on the large sample size; comparison by age, the participants, for the most part, being homogenous with respect to socio-economic status, the assumption all students were academically at an age appropriate similar level at the beginning of the study; and the fact that all children in the study attended Montessori school. The combination of random assignment and the presence of a control group provided a control for internal invalidity, and the absence of mortality did not prove to be a threat (Gay & Airasian, p.377).

CHAPTER IV

ANALYSIS OF THE DATA

The results of the data analysis that were used to address the research question that was developed for this study is presented in this chapter. The children in the study were divided into two groups; experimental and control. The experimental group received music enriched Montessori instruction consisting of 3 half-hour weekly sessions in music instruction for 6 consecutive months. The experimental treatment was an "in-house"' music enriched Montessori program designed from appropriate early childhood educational pedagogies. The control group received traditional Montessori instruction that is based on a 3-year program and concentrates on the Practical Life, Sensorial, Language, Mathematics, and Cultural (including music) areas of development. The children's ages were summarized using frequency distributions. To test the hypothesis, a 2 x 3 factorial analysis of variance was used to determine if a statistically significant difference exists between proficiency achievement of students receiving traditional Montessori instruction and those who received music-enriched Montessori instruction. The independent variables were group membership and age of the children (3, 4, and 5-year-olds). The dependent variable was raw scores on the TEMA-3. All decisions on the statistical significance of the findings were made using an alpha level of .05.

Children in both groups were posttested on the TEMA – 3. The children ranged in age from 3 to 5 years. Table 1 presents a cross tabulation of their ages by group membership.

Table 1

Cross tabulation: Age by Group Membership

	Group Membership					
	Experimental		Control		Total	
Age	Number	Percent	Number	Percent	Number	Percent
Three years	38	38.8	35	38.0	73	38.4
Four years	30	30.6	31	33.7	61	32.1
Five years	30	30.6	26	28.3	56	29.5
Total	98	100.0	92	100.0	190	100.0

The largest group of students (n=73, 38.4%) was the 3-year-olds. This number included 38 (38.8%) in the experimental group and 35 (38.0%) in the control group. Of the 61 (32.1%) 4-year-old children, 30 (30.6%) were in the experimental group and 31 (33.7%) were in the control group. Among the 56 (29.5%) 5-year-old children at the time of the study, 30 (30.6%) were in the experimental group and 26 (28.3%) were in the control group as indicated in the Age of Students by Group Membership (see Appendix E).

The research question developed for this study determined if there were possible differences in the mathematics achievement scores of Montessori students who received traditional Montessori instruction and students who received music-enriched Montessori instruction?

A 2 x 3 factorial analysis of variance was used to determine if a statistically significant difference existed between the experimental and control group on their raw

scores on the TEMA-3. The dependent variable in this analysis was scores on the TEMA-3, with group membership used as the independent variable. Table 2 presents results of this analysis.

Table 2

2 x 3 Analysis of Variance – TEMA – 3 Raw Scores by Group Membership

Source of Variance	Sum of Squares	DF	Mean Square	F	Sig
Group	29548.56	1	29548.56	526.31	<.001
Age	3345.63	2	1672.82	29.80	<.001
Group x Age	2057.05	2	1028.52	18.32	<.001
Error	10330.35	184	56.14		
Total	45281.59	189			

The main effect of group membership was statistically significant, indicating a difference in mathematics achievement between the experimental and control group, $F(1, 184) = 526.31$, $p < .001$. The result of this analysis of variance is presented on the Levene's Test of Equality of Error Variances (see Appendix F).

The second main effect, age, also produced statistically significant differences in mathematics achievement, $F(2, 184) = 29.80$, $p < .001$. The interaction between group and age was statistically significant, $F(2, 184) = 18.32$, $p < .001$.

Based on these findings, it appears that children differed relative to the type of Montessori instruction, music enriched or traditional, and age, 3, 4, or 5-years-old. The result of this analysis is presented in Post Hoc tests (see Appendix G).

To further examine these findings, descriptive statistics were obtained for each of the groups. Table 3 presents results of these analyses.

Table 3

Descriptive Statistics: TEMA – 3 Raw Scores by Group Membership

	Number	Mean	SD
Group			
Experimental	98	142.58	3.52
Control	92	118.30	12.52
Age			
Three	73	135.10	9.21
Four	61	130.49	15.59
Five	56	125.63	19.02
Group x Age			
Experimental x Three Years	38	143.02	2.49
Experimental x Four Years	30	140.00	2.26
Experimental x Five Years	30	140.60	4.70
Control x Three Years	35	126.49	5.14
Control x Four Years	31	117.42	11.04
Control x Five Years	26	108.35	13.80

The students in the experimental group (M = 142.58, SD = 3.52) had significantly higher mathematics achievement outcomes than students in the control group (M = 118.30, SD = 12.52). These findings are presented on a Profile Plot (see Appendix H). Based on this finding, it appears that students who received music-enriched

Montessori instruction had higher levels of mathematics achievement than students who received traditional Montessori instruction.

When compared by age group, 3-year-old students (M = 135.10, SD = 9.20) had higher scores than either the 4-year-old children (M = 130.49, SD = 15.59) or the 5-year-old children (M = 125.63, SD = 19.02). These findings indicate that 3-year-old students had higher mathematics achievement than children in the other two age groups as presented on the Estimated Marginal Means of math score (see Appendix I).

The mean scores for the interaction indicate that children in the experimental group at all three age levels had higher scores than children in the control group. These descriptive statistics results are presented in (Appendix J). Among children in the experimental group, the 3-year-old children (M = 143.02, SD = 2.49) had the highest scores, followed by 4-year-old children (M = 140.00, SD = 2.26) and 5-year-old children (M = 140.60, SD = 4.70). Similar findings were obtained among the control group children, with 3-year-old students (M = 126.49, SD = 5.14) having the highest scores. The 4-year-old children (M = 117.42, SD = 11.04) had higher scores than the 5-year-old students (M = 108.35). The result is presented on the Mathematical Achievement by Group (see Appendix K).

Based on these findings, the null hypothesis of no difference is rejected. It appears that participation in music-enriched Montessori instruction contributes to mathematics achievement at all three age levels, with the youngest age 3-year-olds having a higher score than the 4-year-olds, who had a higher score than the 5-year-olds. What then is the potential for the 'whole' child upon completion of the Montessori full 3-year term?

CHAPTER V

DISCUSSION

Private schools are enjoying something of a renaissance and the National Association for the Education of Young Children (NAEYC) predicts expansion of preschool programs with large numbers of young children benefiting and performing better in kindergarten (Bredkamp, 1987). According to National Center for Education Statistics data, 86% of private high school students applied to college, compared to 57% of public high school students, and reports from the College Board indicated that scores for private school students were well above the national average (CAPE). The American movement to nationalize preschool programs suggested fusing the NAEYC standards with the Montessori environment while using the resources from Head Start (Michel, 1997; Bredkamp, 1987).

The quality of early childhood education can have long-term effects on a child's attitude toward further education and educational achievement (Andersson, 1989). To guarantee quality in early childhood education, methods to evaluate, describe, visualize, and improve various pedagogical processes were made available (Sylva, 1994). Evidence indicated that once children's achievement patterns were established, there was a high degree of continuity from that point forward, and early attainment set boundaries on later attainment (Belsky & MacKinnon, 1994; Entwise, Alexander, Cadigan, & Pallas, 1986). Studies of high quality childcare indicated that such preschool experience was related to positive functioning in the early elementary grades (Andersson, 1989; Belsky &

MacKinnon, 1994) and an Arts-based education curriculum has been used in countries around the world for years with overwhelming academic success (Oddleifson, 1990).

Educators and administrators are often faced with budget cuts and financial stress (Phillips & Whitebrook, 1990). The future role of music and fine arts in schools depends on administrators, who will make music a part of the curriculum if they are aware of the financial, academic, and aesthetic merits of having a music program (Robitaille & O'Neal, 1981). The decision to support music cannot be made without knowing music's effect on academic achievement and its contribution to a student's education. The goal is to meet and exceed the challenge of giving young children the best possible preparation for the future and to do this a basic part of their learning experiences must be involvement with the arts (Fiske, 1999).

The Need for Future research: the primary responsibility of schools undertaking comprehensive school reform was creating programs that resulted in improved student achievement and one of the most important tasks in this process was choosing highly effective reform strategies, methods, and programs, that were grounded in scientifically based research (Boehnlein, 1998). Positive results in favor of Montessori are useless if the research does not adhere to accepted professional standards. In Boehnlein's 1987 review of the literature of a total of 84 studies on the Montessori method it was evident in some of the studies that the researcher was not a trained Montessorian and researchers who did not understand the integrated curriculum model in Montessori, missed valuable data or drew incorrect conclusions from their data. According to experienced Montessorians, it took at least 5 years to build a normalized and fully functional Montessori class where the mixed-ages functioned well as a community of learners. The

classroom environment needed to meet Montessori standards and the children needed the complete 3-year preschool program for the fullest aspects of the curriculum to be experienced (Boehnlein, 1988).

This study met the above criteria and raises the question: would even greater differences be seen between programs if the children receiving music-enriched Montessori instruction had a 3-year music education period? The students in the experimental group had significantly higher mathematics achievement outcomes than students in the control group and based on this finding, it appears that students who received music-enriched Montessori instruction had higher levels of mathematics achievement than students who received traditional Montessori instruction. These findings indicate that 3-year-old students had higher mathematics achievement than children in the other two age groups (see Appendix K).

The findings are significant because a grasp of proportional mathematics and fractions is a prerequisite to mathematics at higher levels, and children who do not master these areas of mathematics cannot understand more advanced mathematics critical to high-tech fields. Moreover, music lessons involve a multiplicity of experiences that could generate improvement in a wide range of activities. This study offers quantitative results that could help Montessori and early childhood educators identify the value of music enriched instruction for the young child and implement the instructional designs used in this study to lead to higher levels of student achievement in mathematics. The studies cited here present a compelling argument in favor of the implementation of long-term developmental music programs for all students, not just those students with an obvious aptitude and interest (Hargreaves, 1994).

As the quantity, quality and availability of empirical studies increases, Montessori schools will be able to make a stronger connection between their design decisions and the evidence of 'what works.' The extensive research showing the improved academic achievement levels of children studying music, the positive long-term benefits of Montessori education on academic achievements levels of students, and this study showing the positive effect of music on Montessori students mathematics scores, raises the question what is the impact of music on the 'whole' child?

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UNIVERSITY OF
WINDSOR

APPENDIX A

MONTESSORI SCHOOL BOARD LETTER

(School name and address)

June 18, 2004

Dear (name),

I am seeking permission to conduct a research study as partial fulfillment of my Masters of Education degree in the Faculty of Education at the University of Windsor. I wish to use students of the Montessori School Board as participants for this study, entitled "A Comparison of the Difference in Mathematics Scores between Students who Attend Traditional Montessori and Students who Attend Music-Enriched Montessori." Please see the attached proposal for full details of the research study.

The study will involve approximately 200 students 3 to 4-year-olds. There will be no financial costs to the Montessori Board. Students will be given full information about the study and written parental consent will be obtained. Students and parents will have the right to refuse to participate and confidentiality will be guaranteed.

The results of this study, will contribute empirical evidence of the comparison of the difference in mathematics scores between students who attend traditional Montessori and students who attend music-enriched Montessori. The findings will provide students, teachers and parents with a link to effective adaptation.

I would greatly appreciate your approval for this study. If you wish to discuss this further, I can be contacted by e-mail (e-mail address).

Yours truly,

Maureen Harris

APPENDIX B

UNIVERSITY OF
WINDSOR

MONTESSORI SCHOOL LETTER

(School name and address)

June 18, 2004

Dear (name),

I am seeking permission to conduct a research study as partial fulfillment of my Masters of Education degree in the Faculty of Education at the University of Windsor. I wish to use students of the Montessori School Board as participants for this study, entitled "A Comparison of the Difference in Mathematics Scores between Students who Attend Traditional Montessori and Students who Attend Music-enriched Montessori". Please see the attached proposal for full details of the research study.

The study will involve approximately 200 students. There will be no financial costs to the Montessori Board. Students will be given full information about the study and written parental consent will be obtained. Students and parents will have the right to refuse to participate and confidentiality will be guaranteed.

The results of this study, will contribute empirical evidence of the comparison of the difference in mathematics scores between students who attend traditional Montessori and students who attend music-enriched Montessori. The findings will provide students, teachers and parents with a link to effective adaptation.

I would greatly appreciate your approval for this study. If you wish to discuss this further, I can be contacted by e-mail at (e-mail address).

Yours truly,
Maureen Harris

APPENDIX C

UNIVERSITY OF WINDSOR

PARENT INFORMATION LETTER

Title of Study: 'A comparison of the differences in mathematics scores between students who receive traditional Montessori instruction and students who receive music-enriched Montessori instruction

You are asked to consent to your child's participation in a research study conducted by Maureen Harris, from the Faculty of Education at the University of Windsor. These results will be contributed to a thesis research supported by the (name), Ontario.

If you have any questions or concerns about the research, please feel to contact (e-mail address).

This research project is to gather information to ascertain the benefits of music-enriched Montessori instruction on mathematics scores in a Montessori curriculum.

If you volunteer your child to participate in this study, we would ask you to do the following things

1. give permission for your child to participate in an in-classroom music-enriched Montessori instruction for one half-hour 3 times a week
2. give permission for your child's post-test assessment (mathematics) scores to be included in research for analysis
3. complete this consent form and return to the (name of researcher) , within one week.

The music-enriched Montessori instruction will take place at school, by the Montessori music specialist, for 3 half-hour lessons weekly and will feature singing, creative movement, rhythm ensembles, inner-hearing, basic musical concepts, and integrate aural and written skills. The goal is to build a solid musical foundation through the discovery of music. Music-enriched Montessori instruction will be offered to the remaining students during the months May and June.

Once the study is finalized you will have the opportunity to view the results on (web page).

[There are no anticipated risks, discomforts, or inconveniences. However, should you find that you no longer desire your child to participate for whatever reason, your child has the right to withdraw from the study at anytime.

The benefits your child will receive as a result of your participation in this study include:
Music-enriched Montessori instruction in class 3 half-hour lessons weekly.
This instruction develops singing, creative movement, rhythm ensembles, inner-hearing, basic musical concepts, and integrate aural and written skills.
The goal is to build a solid musical foundation through the discovery of music.

There will be no payment for participation in this study.

Participant confidentiality will be ensured as no names or identifying information will be taken. Data from this study may be used in future research.

You can choose whether your child should to be in this study or not. If you volunteer to be in this study, your child may withdraw at any time without consequences of any kind. The investigator may withdraw your child from this research if circumstances arise which warrant doing so.

All research findings will be available to parents on (web page).

You may withdraw your consent at any time and discontinue participation without penalty. This study has been reviewed and received ethics clearance through the University of Windsor Research Ethics Board. If you have questions regarding your rights as a research subject, contact:

Research Ethics Coordinator
University of Windsor
Windsor, Ontario
N9B 3P4

Telephone: 519-253-3000, ext. 3916
E-mail: lbunn@uwindsor.ca

APPENDIX D

PARENTAL CONSENT FORM

SIGNATURE OF RESEARCH SUBJECT/LEGAL REPRESENTATIVE

I understand the information provided for the study: 'A comparison of the differences in mathematics scores between students who receive traditional Montessori instruction and those who receive music-enriched Montessori instruction'as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Name of Subject

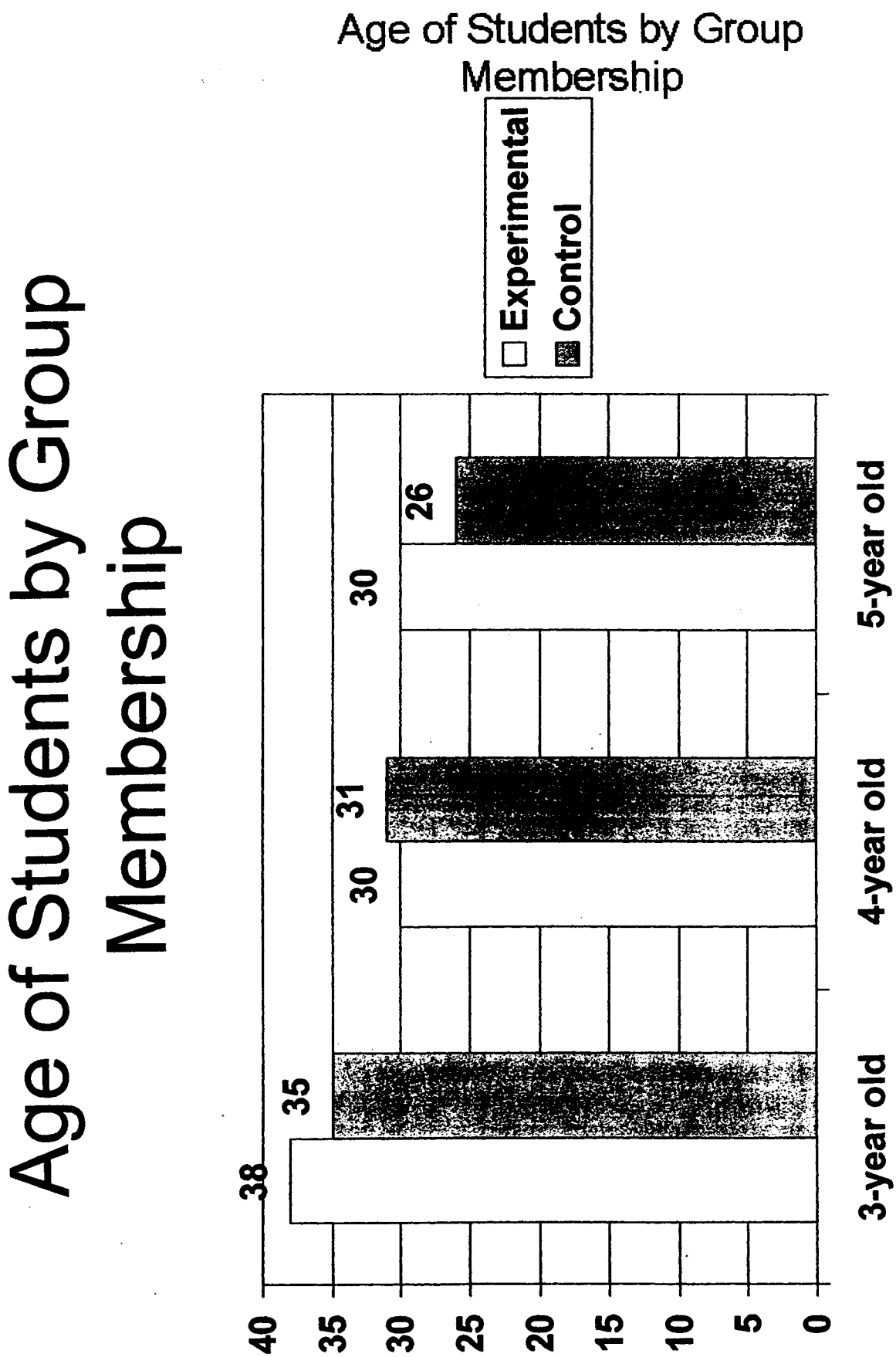
_____
Name of Parent/Guardian

_____ _____
Signature of Parent/Guardian Date

These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

APPDENDIX E



Age of Students by Group Membership

APPENDIX F

LEVENE'S TEST OF EQUALITY OF ERROR VARIANCES

Levene's Test of Equality of Error Variances[a]

Dependent Variable: math_score

F	df1	df2	Sig.
21.331	5	184	.000

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+group+age+group * age

APPENDIX G

POST HOC TEST

Post Hoc Tests

age

Multiple Comparisons

Dependent Variable: math_score
Scheffe

(I) age	(J) age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
3.00	4.00	4.6041*	1.29979	.002	1.3964	7.8117
	5.00	9.4709*	1.33103	.000	6.1862	12.7556
4.00	3.00	-4.6041*	1.29979	.002	-7.8117	-1.3964
	5.00	4.8668*	1.38670	.003	1.4447	8.2889
5.00	3.00	-9.4709*	1.33103	.000	-12.7556	-6.1862
	4.00	-4.8668*	1.38670	.003	-8.2889	-1.4447

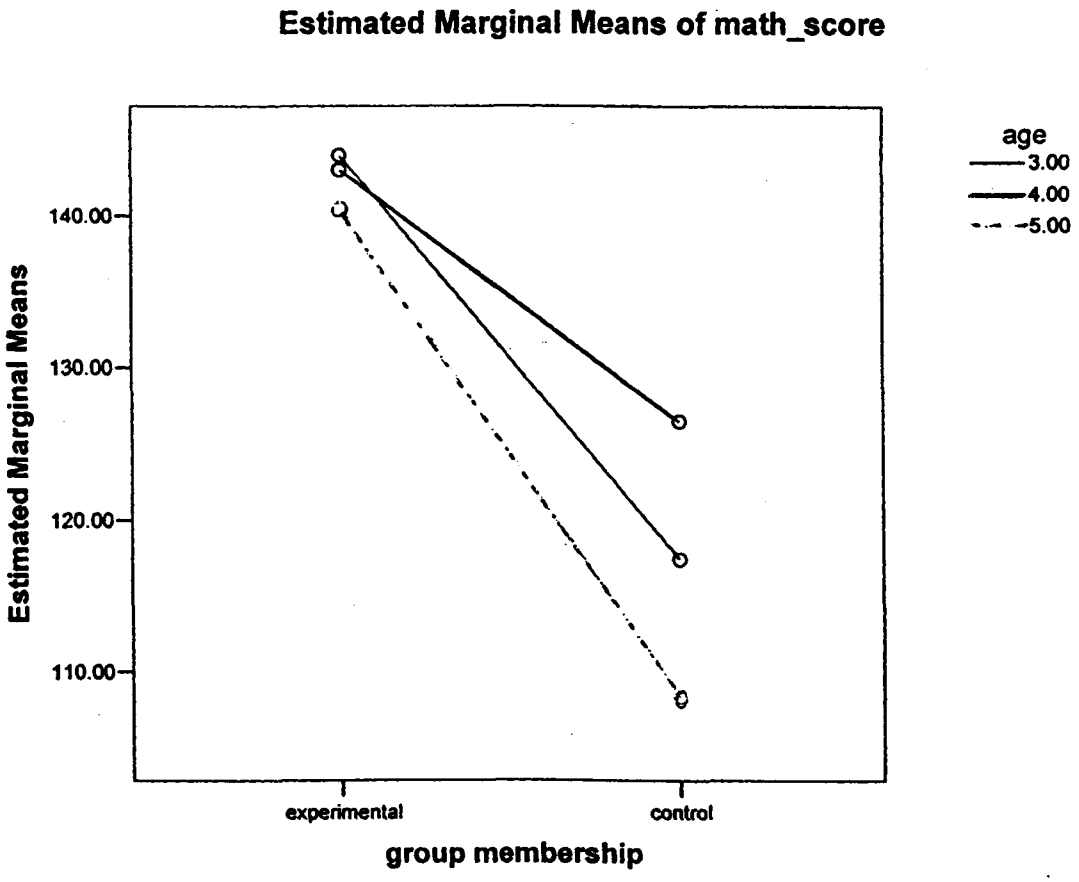
Based on observed means.

* The mean difference is significant at the .05 level.

APPENDIX H

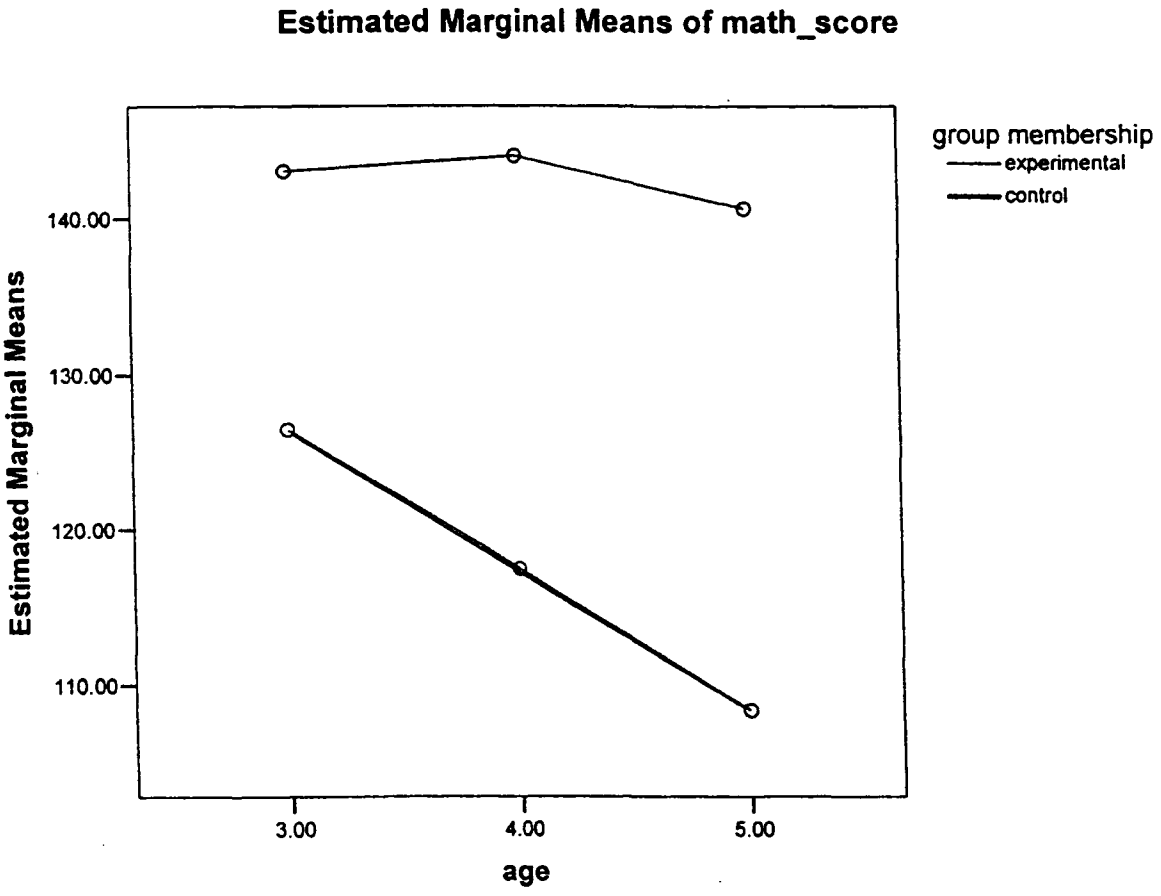
PROFILE PLOT

Profile Plots



APPENDIX I

ESTIMATED MARGINAL MEANS OF MATHEMATICAL SCORES



APPENDIX J

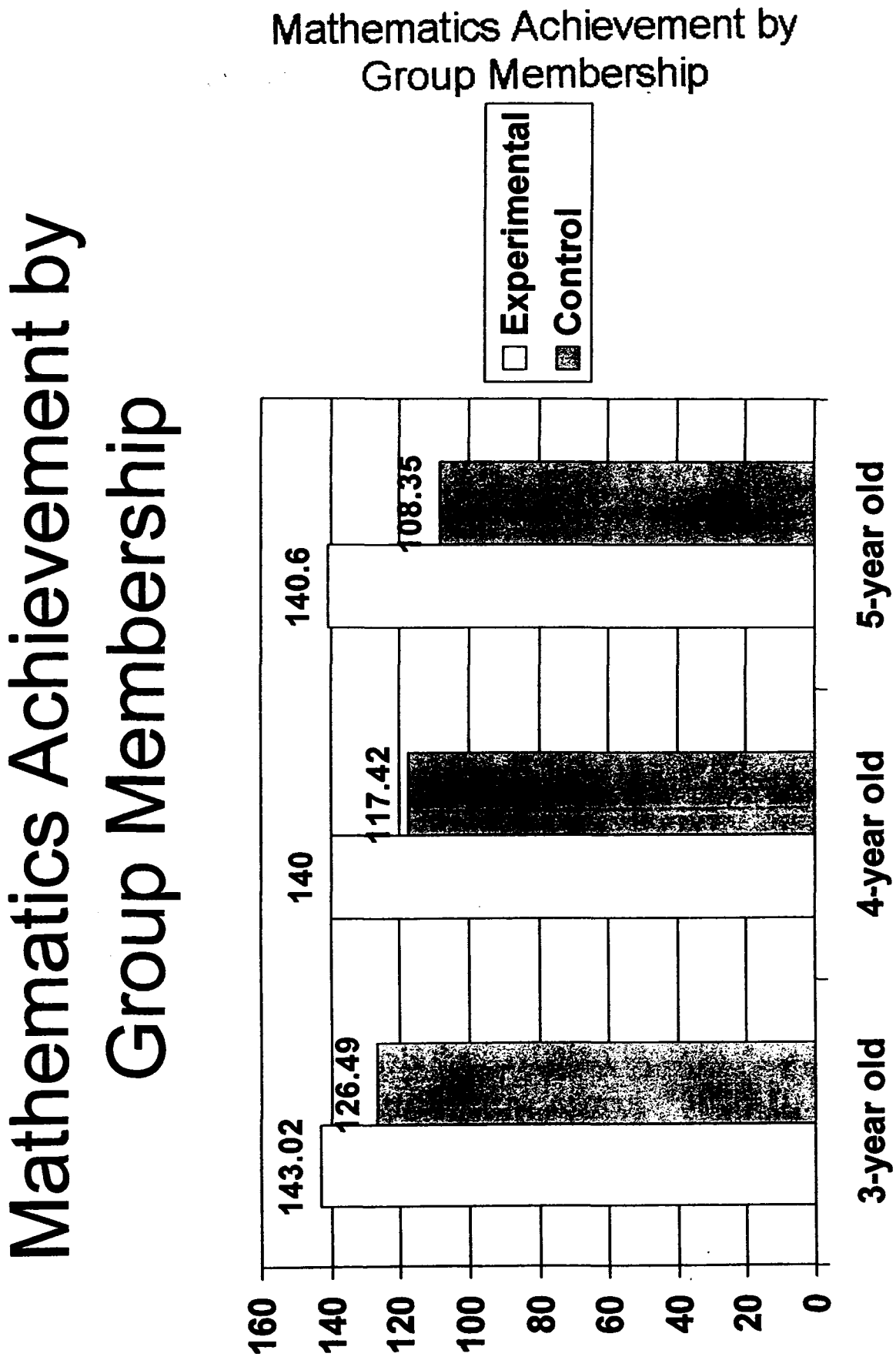
UNIVARIATE ANALYSIS OF VARIANCE

Descriptive Statistics

Dependent Variable: math_score

group group	age	Mean	Std. Deviation	N
1.00 experimental	3.00	143.0263	2.48767	38
	4.00	144.0000	2.25908	30
	5.00	140.6900	4.70216	30
	Total	142.5816	3.52290	98
2.00 control	3.00	126.4857	5.13564	35
	4.00	117.4194	11.04166	31
	5.00	108.3462	13.79548	26
	Total	118.3043	12.51701	92
Total	3.00	135.0959	9.21226	73
	4.00	130.4918	15.58698	61
	5.00	125.6250	19.01632	56
	Total	130.8263	15.15864	190

APPENDIX K



VITA AUCTORIS

November 14, 1956.....Born, Dublin, Ireland
ARCT, RCM, Ireland

1975-1979.....Piano & harmony instructor
Music School
Dublin, Ireland

1985.....O.R.M.T.A. piano instructor

1991.....B.Mus. Vocal, University of Windsor

1995.....Montessori Certification, NCME
National Centre for Montessori Education

1993-2003.....Teacher, Montessori School of Windsor
Ontario, Canada

2003.....Montessori Music Specialist

- The Children's House Montessori
- LaSalle Montessori School
- Montessori, Academy of Windsor
Ontario, Canada

2000.....Piano and Vocal Instructor
Academie Ste. Cecile

2004-2005.....Masters of Education
University of Windsor
Ontario, Canada

Early Childhood Music Certification
Michigan State University
Lansing U.S.A.