

# **The Effect of Music-Enriched Instruction on the Mathematics Scores of Pre-School Children**

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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.

The value of music in educating the young child is not being recognized, particularly in the area of mathematics. 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 the effect on students' math scores. If research of students in the school system indicates that learning through the arts can benefit the 'whole' child [21]; that math achievement scores are significantly higher for those students studying music [17]; and if Montessori education produces a more academically accomplished child [3]; then what is the potential for the child when Montessori includes an enriched music curriculum?

## **Education Today and Tomorrow**

At the outset of the 21<sup>st</sup> Century many educators and parents are considering the kind of education young people need to become responsible and productive members of a global society. Major changes globally are making it increasingly more difficult to prepare the student to be the responsible citizen of the future with the life skills to live and work in a global world. Recognizing that schooling should enhance the development of creative and responsible citizens, we need to consider how such development takes place, and provide rich opportunities for learning for all students

## **Music and Brain Development**

The role music plays in the education of the child is the focus of much discussion in education today. The baby at play is sculpting a brain that will be used for the rest of his or her life [16]. Research results would seem to indicate that the learning and remembering of a melody can occur

not only before birth but actually before or at the beginning of the third trimester [6] The first 3 years in a child's life is a time when music can be used to stimulate the development of nerve connections between brain cells necessary for optimal cognitive development [12]

### **Music and Math**

Researchers have found time and again an apparent link between the arts (music most commonly) having a positive impact on – reading, math, writing, self-esteem, and brain development. Rauscher & Shaw (1997), while studying higher brain function, found a connection to the brain linking music lessons to improved spatial-temporal reasoning abilities of four to six year olds. While music is viewed as a separate intelligence, there is a high correlation between mathematics and music and it is more than a coincidence that math and music are noted for their crossover talents. Music involves ratios, regularity, and patterns, all of which parallel mathematical concepts [14]. For example, the musical scale is similar to a neat logarithmic progression of frequencies. There are also similar connections between patterns of notes and patterns of numbers [4]. Students who developed the rhythms for the songs, 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 [4].

Music enables students to learn multiplication tables and math formulas more easily; rhythm students learn the concept of fractions more easily; students who were taught using rhythm notation scored 100% higher on fractions tests, and a child may use the ability for logical thinking that was developed in the music class to solve problems quite unrelated to music [13]. The core question being: “is the ability to learn ‘anything’ enhanced when music, rhythm and movement are added and the child is engaged”

### **Engagement and Learning through the Arts**

Engagement means that children are wholly involved, physically, emotionally, intellectually, and socially. Work in the arts requires that children learn how to pay attention to relationships and so many of the decisions that are made in life are decisions that cannot be made by appealing to formula, recipes, or algorithms. The arts promote that kind of perception and engender that sort of thinking. The tools the workforce of tomorrow will need are creative thinking, problem solving, risk-taking, teamwork and communication, and are precisely the skills the arts teach [15]. If we do not encourage students to master these skills through quality arts instruction today, how can we ever expect them to succeed in their highly competitive business careers tomorrow?

### **Life without Music**

A study of five hundred thousand students in forty-five countries has shown that the United States is below average in mathematics [8]. A study titled “Musical training improves a child's ability in spatial-temporal reasoning, which is important in mathematics and science education” suggests 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 math and science concepts must be explored and exploited. Dr. Jean Houston of the Foundation for Mind Research says that children without access to an arts program are actually damaging their brain. They are not being engaged to non-verbal modalities that help them to learn skills like reading, writing, and math [18].

## Montessori Music Research

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 [5]. Assuming that young children's involvement in music programs provides a conceptual foundation for subjects such as mathematics, a study examining the difference in math achievement scores between Montessori students who received traditional Montessori instruction and students who received music-enriched Montessori instruction predicts positive results [9]. A sample of 250 Casa students (ages 3-5) within the jurisdiction of a Montessori School board located in Southwestern Ontario was selected for the study. The researcher, an experienced Montessori teacher and music specialist, used the Test of Early Mathematics Ability 3 (TEMA-3) assessment for this study [7.a]. This instrument measures mathematical achievement 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). All schools were established Montessori programs that met recognized affiliation standards. The children in the study, aged 3-5 years, were divided into two groups, experimental and control. The experimental treatment was a 6-month 'in-house' music-enriched Montessori program designed from appropriate early childhood educational perspectives and based on Kodaly techniques. The program was sequenced to teach concepts of pitch, dynamics, duration, timbre and form as well as skills in moving, playing, listening, singing and organizing sound. Children participated in 3 half-hour sessions weekly. The comparison group received traditional Montessori instruction during this period. Children in both groups were post-tested on the TEMA – 3.

### Significance of the Study

Based on these findings 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 had higher scores than either the 4-year old, or 5-year old children. Suggested follow-up research - a longitudinal 3-year study following the progress of the 3-year-old students and testing them again at 4 years and 5 years to see what is the consistent positive effect of enriched music instruction on these students' math ability scores. Further significant findings indicated that the Montessori students performed in the high percentile range for mathematics based on the expected norms of the TEMA-3 testing tool [7]. Of the Montessori students in the experimental group (those receiving music-enriched Montessori instruction) 100% fell in the 90<sup>th</sup> -99<sup>th</sup> percentile range. These scores far exceed the expected norms of the TEMA-3.

These 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 [22]. This study offers quantitative results 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 [10]. As the quantity, quality, and availability of empirical studies increases, Montessori and Early Childhood educators will have the knowledge to make a stronger connection between their design decisions and the evidence of 'what works'. This is the time to explore how research and practice reflects the wider world of early childhood education.

The quality of early childhood education can have long-term effects on a child's attitude toward further education and educational achievement [1]. 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[2] 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 [19].

As we embrace the 21<sup>st</sup> century and face the challenges of the future with and opportunity and responsibility to change, research suggests that providing a quality arts education today will ensure optimal opportunity for our children to succeed in the highly competitive world of tomorrow

## References

- [1] Andersson, B. E. (1989). The importance of public day care for preschool children's later development. *Child Development, 69*, 857-866.
- [2] Belsky, J., & MacKinnon, C. (1994). Transition to school: Developmental trajectories and school experiences. *Early Education and Development, 5*, 106-119.
- [3] Clifford, A. J., & Takacs, C. (1991). *Marotta Montessori Schools of Cleveland follow-up study of urban center pupils*. Unpublished manuscript, Cleveland State University.
- [4] Dean, J. (1992). Teaching basic skills through art and music. *Phi Delta Kappan, 73*, 613-618.
- [5] Fiske, E. (1999). *Champions of change: the impact of the arts on learning*. Washington, DC: The Arts Education Partnership and the President's Committee on the Arts and Humanities.
- [6] Gardiner, M., Fox, A., Knowles, F., & Jeffrey, D. (1996). Learning improved by arts training. *Nature*.
- [7] Ginsburg, & Baroody. (1990). Test of early math ability 3<sup>rd</sup> ed. 2003. PRO-ED, Texas.
- [8] Grandin, T., Peterson, M. & Shaw, G. L. (1998). Spatial-temporal versus language-analytic reasoning. The role of music training. Arts Education Policy Review 99, 6 (July/August), 11-14.
- [9] Harris, M. A. (2005). Montessori Mozart Programme. *Montessori International Journal, (75)* 17.
- [10] Harris, M. A. (2005) *Differences in mathematics scores between students who receive traditional Montessori instruction and students who receive music-enriched Montessori instruction*. Unpublished manuscript, University of Windsor, ON.
- [11] Hepper, P. G. (1991). An examination of fetal learning before and after birth. *Irish Journal of Psychology, 12*, 95-107. Hodges, D. (2000). *Why are we musical? Support for an evolutionary theory on human musicality*. Paper presented at the 6<sup>th</sup> International Conference on Music Perception and Cognition, Keele, England.
- [12] Hodges, D. (2000). *Why are we musical? Support for an evolutionary theory on human musicality*. Paper presented at the 6<sup>th</sup> International Conference on Music Perception and Cognition, England.
- [13] Kelstrom, J. M. (1998). The untapped power of music: Its role in the curriculum and its effect on academic achievement. *NASSP Bulletin, 82*, 34-43.
- [14] Marsh, A. (1999). Can you hum your way to math genius? *Forbes, 16*, 176-180.
- [15] Milley, J., Buchen, I., Oderlund, A., & Mortatotti, J. (1983). *The arts: An essential ingredient in education*. CA: California Council of Fine Arts Deans.
- [16] Olsho, L. (1984). Infant frequency discrimination. *Infant Behavior and Development, 7*, 27-35. Paper presented at the The Learning and the Brain Conference, Boston, MA.
- [17] Rauscher, F., & Shaw, G. (1998). Key components of the Mozart effect. *Perceptual and Motor Skills, 86*, 835-841.
- [18] Roehmann, F. L., & Wilson, F. R. (1988). *The biology of music making: Proceedings of the 1984 Denver conference*. St. Louis, MO: MMB Music Inc.
- [19] Sylva, K. (1994). School influences on children's development. *Journal of Child Psychology and Psychiatry, 35*(1), 135-170.
- [21] Uptis, R., Smithrim, K., Patteson, A., & Meban, M. (2001). The effects of an enriched elementary arts education program on teacher development, artist practices, and student achievement *International Journal of Education and the Arts, 2*(8).
- [22] Vaughn, K. (2000). Music and mathematics: Modest support for the oft-claimed relationship. *The Journal of Aesthetic Education, 34*(3-4), 149-166.