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ABSTRACT

Assuming that young children's involvement in music programs provides a conceptual foundation for subjects such as mathematics, this study examined the impact of music education on mathematics achievement in preschool children. A pseudo-experimental design was used in which 35 preschool children involved in a music program treatment were compared at school entry to 39 preschool children without musical experience. All children were from families with similar socioeconomic levels. The music program was based on Kodaly techniques, sequenced to teach concepts of pitch, dynamics, duration, timbre, and form, as well as skills in moving, listening, singing, and organizing sounds. Children participated in one 1-hour session per week for 10 months. They were compared on the Test of Early Mathematics Ability-2 (TEMA-2). Initial results indicated that the music group had higher TEMA-2 mean scores than children without musical experience. However, musical experience in the home and other pre-existing differences may have contributed to group differences. The experimental group was further divided into two groups, children with home music, and children with no music at home. There were no differences in mathematics achievement between the comparison group and the experimental group without music at home. However, the experimental group with music at home scored higher in mathematics achievement than the experimental group without music at home. Two home music activities were related to mathematics achievement: listening to their own music collection, and listening to a family member sing to them. (Contains 25 references.) (KDFB)

POSSIBLE EFFECTS OF EARLY CHILDHOOD MUSIC ON MATHEMATICAL ACHIEVEMENT

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ABSTRACT

Many writers claim that early childhood music education is valuable in developing skills not only in the emotional, social and physical domains but also in cognitive domains such as mathematics. However, there is very little research to back up this claim. This paper reports on a study which explored how music might provide an effective aid to higher achievement in mathematical development in early childhood. The study used a pseudo-experimental design to contrast a group of 35 preschool children involved in a music program treatment against a group of 39 preschool children with limited or no musical experience. Children were compared on a measure of early number concepts. Initial results indicated that the music group achieved higher mathematical achievement. However post-hoc analysis revealed that children in the music group with musical experiences in the home exhibited higher average mathematical achievement than children without such experiences. Further analysis sought to reveal what aspects of home musical experiences might contribute towards higher mathematical achievement.

INTRODUCTION

The importance of early childhood as a period of critical intellectual growth and a critical time for perceiving and formulating ideas about the world, has been, for the most part and for too long, vastly underestimated (Katz, 1988; Gifford, 1992). Indeed, Elkind (1986) contends that in a society which prides itself on its openness to research and on its respect for 'expert' opinion, parents, educators, administrators, and legislators have been blatantly ignoring the consensus of experts about how young children learn and how best to teach them. Whilst the research is providing affirmation of the educational import of the early years of child development, acceptance and implementation of the implications are slow to be forthcoming. Katz (1988:4) remonstrates that 'there is an abundance of research on intellectual and social development and learning that is rich with implications for the kind of teaching and curriculum that should be provided for young children. Unfortunately, our practices are way behind what we know'. Ironically, with the new knowledge about the way young children learn, an anomaly is emerging. It appears that we currently know more about how children learn than we do about how to apply this knowledge.

MUSIC IN EARLY CHILDHOOD EDUCATION

Music is considered to be a powerful means for developing the young child's emotional, social, physical and cognitive growth. The potential of music as an instructional technique was emphasised in a position paper by the Music Educators' National Committee on Instruction (1977:59). The position paper stated:

> *Some persons are convinced that music can serve as a methodological tool in teaching children academic skills such as reading, language arts and mathematics; that the study of music can help to make the learning process itself*

more effective and appealing; and that music can contribute to the emotional and social development of the child.

Widmer (1970:33) regarded musical experiences in early childhood as 'fertile ground' in which young children's concepts can be formed, clarified and extended, and wherein multisensory impressions, motor manipulation, problem solving, creating and questioning are developed.

Music is widely acknowledged as being a great source of enjoyment in young children's lives, as well as a wonderful vehicle for expression and enrichment. It is ironic and unfortunate that music tends to be regarded as a somewhat peripheral subject; a pleasant addition to the curriculum, and considered perhaps not all that important (Moore, 1992). Andress (1980:3) contends that because learning processes inherent in musical activities reflect basic human needs, music should not be thought of as peripheral to the curriculum but instead as 'basic to all learning'. For example, research by Hoermann and Herbert (1979) and Neufeld (1986) has shown that from involvement in music programs, in addition to learning about music, young children develop concepts that are the foundations for other subject areas such as mathematics.

MATHEMATICS IN EARLY CHILDHOOD EDUCATION

Covell (1984) notes that in society, music is a public passion, a wild enthusiasm, a source of widespread joy and excited anticipation in a way which there is not the slightest parallel in mathematics. And yet, Young (1984:8) describes the two subject areas as existing in a consummate friendship wherein mathematics is the 'favourite sister of music'.

Recent research investigating the development of early childhood mathematics has been influenced largely by the constructivist view of learning developed from von Glasersfeld's work (Steffe, 1990). In consonance with the constructivist view of learning, early childhood educators portray children as active thinkers, who construct sense and meaning out of personal practical experiences. Making sense is the purpose of education; to encourage children to look for similarities, oppositions and connectedness in the sensory inputs they are receiving (Dienes, 1987). However, although references to constructivist approaches are pervasive, practical descriptions of such approaches have not been readily accessible (Clements & Battista, 1990).

Approaches to teaching mathematics in early childhood are focusing more and more on holistic and integrated processes in learning. It is apparent though that integration of mathematics with other subjects is often disregarded because of the traditional mathematics obsession with workbooks, drills, formalised teaching methods and tests. The neglect of mathematics in the movement toward interdisciplinary and integrated approaches to teaching stems in part from misconceptions about mathematics that pervade our educational systems and society. Mathematics has traditionally been taught in isolation from other subjects and is too often perceived as a discrete discipline, a separate body of knowledge, irrelevant to every-day life, and mostly devoid of creativity or aesthetics. Consequently mathematics is often eventually rejected by many students. Because of such rejection mathematics education is experiencing a call for major change around the world. Steffe (1992:1) maintains that mathematics might consist of 'one of the most urgent problems of education today'. The publication *Curriculum and Evaluation Standards for School Mathematics* by the National Council of Teachers of Mathematics (1989:1) conveys a similar message that 'all students need to learn more, and often different, mathematics and that instruction in mathematics must be significantly revised'.

Because music might offer a new dimension to the teaching and integration of mathematics, and because of music's dynamic effect on the lives of young children, there needs to be more consideration of how music might be used to effect positive mathematical development in young children.

MATHEMATICS IN EARLY CHILDHOOD MUSIC

Many people believe that the learning of mathematics and the learning of music are related but there is little evidence to make such convictions persuasive arguments. Efforts to integrate the teaching of mathematics with music are rare (Kleiman, 1991). Through developmentally appropriate early childhood musical experiences children can be exposed to many mathematical ideas. Presented below is a range of significant mathematical processes and examples of how they arise in musical experiences:

- Classification: e.g., classify sounds as either high or low
- Comparison: e.g., identify which song has more/fewer actions
- Seriation: e.g., identify sounds getting louder or softer
- One-to-one correspondence: e.g., clap, stamp or slap once for each beat in a song
- Rational Counting: e.g., associate one name tag for each action or item (e.g., claps in songs)
- Recognise and comprehend Cardinal Numerals: e.g., respond with appropriate number of actions according to numeral cards presented
- Problem solving: e.g., devise actions to match songs
- Patterning: e.g., explore motor patterning (e.g., using various body actions and movements to depict beat, rhythm, timbral, dynamic and melodic patterns).

It should be noted that patterning is implicit in many of the activities mentioned above in that it requires a combination of a wide range of multisensory experiences. Also, the use of general problem solving processes are required to achieve many of the outcomes listed above. In the learning of mathematics, the ability to solve problems is considered one of the most important skills for young children to develop (Wright, 1994). Problem solving in early childhood is really creative problem solving in that it requires a wide range of creative, conceptual and logical thinking abilities to combine in reaching a solution. Early childhood music thus provides contexts where creative, conceptual and logical thinking combine to present windows of opportunity for the development and reinforcement of early mathematical concepts. Research by Kalmar (1989) has reported that a group of children with extra music training provide more creative, original and complex ideas and a higher level of abstraction than those with the usual amount of music. These outcomes are considered highly desirable in today's students of mathematics.

SIGNIFICANCE OF THE STUDY

Despite the many supporters of music education, it is pointed out by Eisner (1992:593), that in education generally, 'the value of the arts in comparison to the sciences is set low'. He sees this comparative imbalance as detrimental to education, and contends that 'providing a decent place for the arts in our schools may be one of the most important first steps we can take to bring about genuine reform in education' (Eisner, 1992:595). Gardner (1985) feels that music involves the manipulation and understanding of objects, sounds, patterns, colours, forms, shapes - all of which have the potential to refer to, exemplify, or express most aspects of the learner's world mathematically.

Many early childhood educators are looking for better ways to integrate developmentally appropriate learning experiences, and to improve the teaching of mathematics. As an alternative to the traditional approaches, music can be considered in the teaching of mathematics. Such an approach to teaching mathematics aims to build upon the natural enjoyment children derive from involvement in musical experiences. The arts have been an important aspect of early childhood education for many decades (Wright, 1991). The inclusion of an appropriate music program as an essential and vital component of early childhood education could offer an effective variation to mathematical instructional methodologies, and present opportunities to explore mathematics in dynamic, productive and enjoyable ways. Current reform in early childhood education advocates that the arts have more to offer through cross-disciplinary and integrated practices than through

segregated subject-orientated programs. The integration of music and mathematics is reflective of cross-disciplinary teaching methodology.

OVERVIEW

The study reported in this paper investigated the effects of a music program on the mathematical achievement of children who were about to commence their first year at school. The study compared the understandings of early number concepts of a group of preschool children who had participated in a year-long formal music program with the understandings of a group of preschool children who had no musical training and limited or no home music background. The study sought to explore whether there is a relationship between musical concepts of pitch, dynamics, duration, timbre and form and skills of moving, playing, listening, singing and organising sound with improved performance in mathematics concepts of relative magnitude, counting and calculation skills, knowledge of conventions and number facts.

METHOD

Subjects

A sample of preschool children from the Bathurst region was selected for the study. All subjects were selected by (1) age - all children were 4-5 years old and commencing primary school the following year; (2) socio-economic status - all children came from families with an income equivalent to a teacher with at least five years teaching experience; and (3) parental input - all children had parents who were active in ensuring their child's education was not left to happenstance by actively involving the child in educational experiences such as organised sport and reading to their child. Both the experimental group (N=39) and comparison group (N=40) were selected from children enrolled in the Central West Music Centre preschool program, however the comparison group had limited or no musical background. At the time of testing in the final months of the year the experimental group consisted of 35 children (4 children dropped out of the music program) and the comparison group consisted of 39 children as 1 child left the community.

Procedure

A static-group comparison design was used, as random assignment was not possible. Two groups were involved: an experimental group and a comparison group. The experimental group received a treatment of nearly 10 months tuition in music and then both groups were post tested. The post tested scores of the two groups were then compared. The experimental treatment was an 'in-house' music 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 organising sound. Children participated in one session each week which lasted approximately one hour. In order to select the comparison group a questionnaire for parents was administered over the telephone to find subjects that could be delimited by the criteria of age, SES and parental input and no musical background. The comparison group received no musical treatment during this period. The instrument used to measure mathematical achievement was the Test of Early Mathematics Ability-2 (TEMA-2) 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.

RESULTS

The results indicated that the experimental group (mean = 20.0) scored higher than the comparison group (mean = 16.6) on the TEMA-2. Using a two-sample *t*-test, the difference was found to be significant ($p<0.02$).

Post hoc analysis

The initial results indicated that the experimental group had performed better than the comparison group. However, it was evident that musical experiences in the home, as well as other pre-existing differences may have contributed to group differences. By administering the questionnaire to the parents of the children in the experimental group, an attempt was made to separate the experimental music treatment influence from the home music factor. This allowed for the experimental group to be re-categorised into two subgroups: Subgroup 1 (No Home Music group - those children with limited or no home music background as in the comparison group) and Subgroup 2 (Home Music group - those involved in musical experiences in the home). Subgroup 1 (No Home Music group) consisted of 19 children and Subgroup 2 (Home Music group) consisted of 16 children. The two groups with limited or no music background at home (i.e., the comparison group and Subgroup 1) were then compared to ascertain the effects of the experimental music treatment. Similarly, the two groups who had done the music program (i.e., Subgroup 1 and Subgroup 2) were tested to ascertain the effects of a home music background. Using two-sample *t*-tests, it was found that the performances of the comparison group (mean = 16.6) and Subgroup 1 (mean =17.3) were not significantly different. However the mean score for Subgroup 2 (mean = 22.2) when compared with the mean score for Subgroup 1 (mean = 17.3) was significantly higher ($p<0.01$). These results were an indication that the difference in mathematical achievement might be connected to the children's home music background rather than the music program itself.

Further analysis was conducted to ascertain what aspects of home music background might be significant in contributing to higher mathematical scores. The relation of mathematics scores to questionnaire responses was investigated in the total sample of children. The only questions which were significantly related to home musical experiences ($p <0.05$) were: *Does your child listen to his/her own music collection very often?* and *Does anyone in the family sing to or with the child?*

In this sample of children, the two musical activities of listening to their own music collection (not simply having one) and listening to a family member sing to them, were related to mathematics achievement.

DISCUSSION

This study has sought to examine the links between music and mathematics in early childhood. Initial indications were that there was a difference in mathematical achievement of a group of children who were involved in a music program compared a group of children who had not been involved in the music program and had a limited musical background. However post-hoc analysis indicated that a structured music program alone is less likely to contribute to higher achievement in early number concepts than the music program together with musical experiences generated in the home environment.

The results of the study indicate that there are two areas of home musical experiences which contributed to higher mathematical achievement:

(1) children listening to their own music collection; and
(2) family members singing to or with the children.

From these outcomes two specific learning factors can be conjectured:

(1) *Listening* might be an important aspect of developing early childhood mathematical concepts; and

(2) the nurturing of a *positive self image (self esteem)* might be important in the learning of early childhood mathematical concepts.

Listening

Listening to music is considered both recreational and educational. Musical experiences in early childhood involve considerable listening. However, research has not clearly indicated to what degree listening is desirable in early learning experiences. The skill of listening effectively has been referred to in the literature as 'active listening'. However, it may also be considered as synonymous with 'active attentiveness'.

Research has not clarified to what extent incidental, focused or other levels of listening are significant in learning. Whilst there is a dearth of research on what happens when children listen to their own collection of music, or when someone sings to them, the study reported in this paper adds support to the importance of listening skills in the construction of mathematical knowledge. If children listen regularly to their own music collection, and listen when a parent sings to them, they arguably could be developing the skills of concentration and attentiveness; skills considered important for the learning of mathematics and relevant to the social constructivist paradigm (Cobb, Yackel & Wood, 1992).

Social constructivist theory implies that children are constructors of their own knowledge, and their experiences in problem solving investigations give rise to meaningful language connections; and that construction of mathematical knowledge is heavily influenced by social interactive processes embedded in group work and collaborative learning. It would seem apparent that the social constructivist paradigm hinges on learners being actively attentive (i.e., utilising effective listening skills during social interaction) and being able to respond to and assimilate the auditory stimuli from their surrounding environment. For children to learn the words and structures of music active attentiveness is required. When children are listening to a song or relating to the structure, concepts and/or conceptual associations in the musical experience, they could be developing their sense of form, pattern and other mathematical relationships through attentiveness and responsiveness to the experience. Because music is so much fun in early childhood children are positively drawn to the experiences and participate actively with focused attention and involvement rather than passive engagement. The integral nature and role of listening (i.e., effective listening rather than mere passive absorption) in the constructivist paradigm is worth pursuing further especially in an effort to reveal the importance of listening in terms of 'active attentiveness' in the learning of mathematics.

Self-esteem

Parents who engage in singing to their children regularly are more than likely to be relaxed, comforting, and reassuring as positive emotional and social role models. Consequently, such interactions could be embodiments of norms for positive self-concept. By focusing the singing interaction on the children, parents could be instilling a sense of self-worth in the children who could construe the songs sung by their parents as being sung just for them, their own songs, or their own special dedicated time to be in communion with their parents, or as a special time of giving and sharing. Parents singing to their children could be influential in developing a child's positive self-concept. 'A positive self-concept is valued as a desirable outcome and as a potential mediating influence leading to other desired outcomes such as academic achievement' (Marsh, Craven & Debus, 1991:377). This is in keeping with the social constructivist views on learning which associate 'positive' participation in experiences with the development of knowledge, skills and concepts (Cobb, 1995, personal conversation).

Parents who make the effort to buy their children a personal selection of musical recordings, encourage the children to listen to their own collection, participate in quality one-to-one experiences of singing to their children and share in their children's musical experiences, could be positively reinforcing their children's self-worth and personal confidence. That a child's self-esteem could have an effect on mathematical development is not a new idea and is in accord with the beliefs of many mathematics teachers who claim that fifty percent of mathematics understanding involves

'learning mathematics' and the other half involves motivation and self-esteem - getting children to take risks and feel confident in what they are doing.

Through more intensive and appropriately focused early childhood musical experiences which seek to enrich children's positive self-esteem parents and teachers could be affording children opportunities to assist with the progress of their children's mathematical achievement.

CONCLUSION

Hoermann & Herbert (1979:7) contend that 'the teaching of basic music concepts is comparable in many ways to the teaching of early concepts in mathematics'. This paper has sought to highlight how musical experiences might offer opportunities for young children to develop mathematical thinking. Early childhood musical experiences and early childhood mathematical experiences can be shown to reflect conjoint dimensions. Listening to a personal music collection and having family members sing to children are possible musical experiences in the home which might contribute to the foundations for mathematical achievement in early childhood. It is conjectured that 'active attentiveness' and 'self-esteem' nurtured through musical experiences with parents may have a bearing on higher mathematical achievement. Early music education may be only one of the many ways in which teachers and parents could develop 'active attentiveness' and 'self-esteem' in young children but it is surely a most effective one.

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