EARLY CHILDHOOD MUSIC AND MATHEMATICAL ACHIEVEMENT - COUNTING THE SHARPS AND FLATS OF EMPIRICAL RESEARCH

NOEL GEOGHEGAN
University of Western Sydney, Macarthur

This study explores how music might provide an effective aid to higher achievement in mathematical development. An experimental group of 35 preschool children was chosen from children enroled in a community music program. A comparison group consisting of 39 preschool children with limited musical background was employed as a contrast group. By testing both groups on early number concepts, initial results indicated that the experimental musical group performed better than the non-musical comparison group. However, post-hoc analysis indicated that musical experiences to be found in the home, and other pre-existing differences, were more likely to contribute to the experimental group's higher mathematical achievement than the music program treatment.

Research investigating the development of number concepts and processes in early childhood has been influenced largely by the constructivist view of learning (Steffe, 1990; Wright, 1992). However, although references to constructivist approaches are pervasive, practical descriptions of such approaches have not been readily accessible (Clements & Battista, 1990; Brophy, 1986). In consonance with the constructivist paradigm, early childhood education portrays children as active thinkers, who construct sense and meaning out of personal practical experiences (Wood, Cobb, & Yackel, 1989). 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). This ideology in education underpins the global, integrated nature of educational experiences in early childhood.

MUSIC AND MATHEMATICS

Efforts to integrate mathematics with music, are rare indeed (Kleiman, 1991). As teaching in early childhood focuses more and more on process-oriented, holistic, and collaborative approaches to learning, integration of mathematics and music could find an educational climate in which to flourish. Research is indicating that in addition to developing concepts in music, children are being introduced to concepts which are the foundation for other subject areas including mathematics (Bridges, 1980; Covell, 1984; Gregory, 1988; Kalmar, 1989a).

In the learning of mathematics, the ability to solve problems is considered one of the most important skills for children to develop. In early childhood, because "real life problem solving is really creative problem solving in that it requires a wide range of creative, conceptual and logical thinking abilities" (Feldhusen and Treffinger, 1984, p. 1), creativity and problem solving combine into a single concept. Music provides a wealth of opportunities for children to solve problems with creative thinking in mathematical contexts. 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. A search of the literature indicates there has been little analysis of music and its effects on achievement in mathematical development in early childhood.

RELATED RESEARCH

Research has implied 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 (Kalmar, 1989b; Bridges, 1980; Hoermann and Herbert, 1979). Other research (Gregory, 1988; Neufeld, 1986) has shown that children who were involved in musical instructional programs demonstrated significant gains in achievement in mathematics.

METHOD

Overview

The study reported in this paper was designed to investigate the effects of a musical program on the mathematical achievement of young children who were about to commence their first year at primary school. The study compares the understandings of early number concepts of a group of children involved in a structured music program with those understandings of a group of children who have no musical training and limited musical background. The mathematical concepts tested were (1) concepts of relative magnitude, (2) counting skills, (3) calculational skills, (4) knowledge of conventions, and (5) number facts.

Subjects

A sample of preschool children in Bathurst was selected using a parent questionnaire. An experimental group of 39 children and a comparison group of 40 children were selected, delimited on the following criteria: (1) age, (2) socio-economic status, and (3) parental input. As the study aimed to contrast the mathematical development of musical children against non-musical children, all the comparison group subjects had limited musical background, and all the experimental group subjects were actively involved in the Central West Music Centre preschool music program. At the time of testing, 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

This study did not use random assignment. A static-group comparison design was used. This involved two groups: one received the experimental music treatment and both groups were posttested. The posttest scores of the two groups were then compared.

Experimental Treatment

Subjects in the experimental group participated in a year long music program at the Central West Music Centre. The experimental treatment was an 'in-house' music program based on Kodaly techniques and sequenced to teach concepts of pitch, dynamics, duration, timbre and form; as well as skills such as moving, playing, listening, singing and organising sound.

The Measure of Achievement

The instrument chosen for this study was the TEMA-2: Test of Early Mathematics Ability-2 developed by Ginsburg and Baroody (1990).

RESULTS

Table 1 shows the means and standard deviations of the mathematics score by the experimental group and the comparison group, and level of significance of the difference in the means.

Group	Mean	SD	*t*
Experimental Group	19.9714	5.721	0.016
Comparison Group	16.6410	5.829	

Table 1

Means and standard deviations for experimental group and comparison group on the TEMA-2 test.

As can be noted from the results the mean score was higher for the experimental group (mean=19.9) than for the comparison group (mean=16.6) with a significant difference between groups ($p<0.05$).

Post-hoc Analysis

The results indicated that the experimental group performed better than the comparison group. However, it was apparent that musical experiences other than the experimental music treatment (in particular music experiences in the home), as well as other pre-existing differences between groups, may have contributed to group differences. Post-hoc analysis was done to re-categorise the experimental group into two subgroups: Subgroup 1 ('No Homus' - those with limited home musical experiences), and Subgroup 2 ('Homus' - those involved in musical experiences at home). The subjects with limited music background experiences (Comparison group and 'No Homus' group) were then compared on the relationship of mathematical scores using a *t*-test. Similarly, the subjects who had done the music program ('No Homus' group and 'Homus' group) were compared on the relationship of mathematical scores using a *t*-test.

Results of Post-hoc Analysis

Table 2 shows the means and standard deviations of the 'No Homus' and comparison groups, and level of significance.

Group	Mean	SD	*t*
Experimental Group (No Homus)	17.3125	5.082	0.689
Comparison Group	16.6410	5.829	

Table 2

Means and standard deviations for the 'No Homus' experimental group and comparison group on the TEMA-2 test.

As can be noted from the results in Table 2 the mean score was higher for the 'No Homus' experimental group (mean=17.3) than for the comparison group (mean=16.6) but was not significant.

Table 3 shows the means and standard deviations of the 'Homus' experimental group and the 'No Homus' experimental group on the relationship of mathematical scores, and level of significance. As can be noted from the results in Table 3 the mean score was higher for the 'Homus' experimental group (mean=22.2) than for the 'No Homus' experimental group (mean=17.3) and with a significant difference between groups ($p<0.025$).

Group	Mean	SD	*t*
Experimental Group (Homus)	22.2105	5.360	0.009
Experimental Group (No Homus)	17.3125	5.082	

Table 3

Means and standard deviations for the 'Homus' experimental group and the 'No Homus' experimental group on the TEMA-2 test.

The results provided in Tables 2 and 3 were an indication that the difference in mathematical achievement might be connected to the musical background experiences rather than the music program. To ascertain what aspects of home background might be significant in contributing to higher mathematical scores, responses to questions on the questionnaire were subjected to a series of *t*-tests. Three questions focusing on home musical background provided substantial results (see Table 4). The three questions were: (1) Does (the child) listen to his/her own music collection very often? (2) Does (the child) learn music? (3) Does anyone in the family sing to (the child)? The mean maths scores, standard deviations and *t* according to the way in which parents answered the above three questions from the questionnaire are shown in Table 4.

Question	Response	Mean Score	SD	*t*
Listens to own music collection?	Yes	19.6	5.71	0.014
	No	16.2	5.84	
Learns music?	Yes	19.9	5.72	0.016
	No	16.6	5.82	
Any family member sing to child?	Yes	20.0	6.42	0.030
	No	16.9	5.38	

Table 4
Responses, means and standard deviations for questions in relation to scores on the TEMA-2 test.

SUMMARY

Initial findings in this study indicated that the experimental music group showed a significant difference in mathematics achievement compared to the non-musical comparison group. However, post-hoc analysis indicates that a structured music program alone is less likely to contribute to higher achievement in early number concepts than musical experiences generated from the home environment or other pre-existing differences. Accordingly, further research utilising random assignment is required in order to control for pre-existing differences.

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