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Mathematics in Indian Music: Examining Children's Learning Process

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Abstract

There are many mathematical concepts found in music. Music is integrated into Indian culture. It is a common practice among children in India to engage in music lessons from a young age. The purpose of this study was to investigate the impact of Indian music on the cognitive development of children to understand or reinforce mathematics. Data was collected from three schools in Kolkata, India, through interviews, observations, and survey questionnaires. Six different music classes from three music schools were observed at different times. Observations were documented through pictures, video recordings, running records, and anecdotal records. To supplement these documentations, a field journal was kept at all times. The study was qualitative in nature, and all data were analyzed thematically. The findings suggested the importance of Indian music in children's cognitive development and how Indian music helped in learning mathematics. Both teachers and parents felt that music builds concentration among children and also helps children with disabilities.

Keywords: Mathematics, Indian music, children, children's Learning Process, children's cognitive development, teachers, parents, school, curriculum

Introduction

Learning mathematics could be a challenge for many children. Children may find it difficult to understand abstract concepts and, as a result, may lose interest in mathematics. The students may become unmotivated to learn mathematics due to a lack of understanding or have different learning needs. Although India has strong mathematical traditions, India is dealing with problems of widespread poverty and universalizing education. Yet, despite difficulties, India has managed to produce eminent mathematicians. However, a large number of children either fail or drop out of elementary school because they cannot take the pressure of the curriculum. (Ramanujam & Subramaniam, 2012). There are no concrete objects, games, or manipulatives in the mathematics classroom, and teachers most often do not recognize the importance of such materials in the processes of math learning. Curricular reform involves layered negotiation to change mindsets about how children learn and how that may be assessed. (Rampal & Subramanian, 2012). Nevertheless, the association of mathematics and music with cognition has

persisted across time and culture. Mathematics and music have a close relationship (Guha & Chakrabarty, 2015). There are a lot of mathematical concepts found in music. Music is part and parcel of Indian culture. It is a common practice among children in India to start learning vocal, dance, or instrumental lessons from a young age. This study aimed to investigate the impact of Indian music on children's cognitive development, especially in learning mathematics.

Elementary Mathematical Knowledge and Skills of Young Children

Children who are 2-7 years old belong to Piaget's (1929) Pre-operational stage. Children think at a symbolic level during this stage and usually do not use cognitive operations.

According to the National Council of Teachers of Mathematics (NCTM), the five Content Standards are as follows: Appendix A has the Content standards from NCTM.

- Number & Operations.
- Algebra.
- Geometry.
- Measurement.
- Data Analysis & Probability.

In general, as for mathematical knowledge and skill, children by age 5 to 6 can link a number of objects to the numeral. They can also group objects into sets, and they are able to count by ones to determine the number of objects in each set. Children develop the concept of more than and less than. Children would also be able to count forward and backward. Moreover, children will also be able to read a number and mark a number on a number line. They would also be able to compare and order numbers. Children would be able to add or subtract double-digit numbers, add or subtract ten to or from a number, and find missing numbers in an equation.

Furthermore, children would be able to understand symbols (e.g., '+' means addition). In addition, children would develop estimation skills and skip counting, which is a prelude to learning multiplication. Most of the children also learn to use tallies, read an analog clock, identify and count coins, and use the symbolic

representation of numbers. They would be able to understand the concept of "odd" and "even" numbers as well. However, age 7 is a critical time as children may start their way to the operational stage, according to Piaget (1929). However, not all children develop the same way. Most of the above mathematical concepts could be taught to children through music. Then children could find the difficult and abstract mathematical concepts interesting. The students may become motivated to learn mathematics.

Theoretical Framework and Related Review of Literature

Both theory and research support and mandate the inclusion of music in early education (Gardner, 1991; Snyder, 1997; Patel, 2008; Chandler, 2008; Huron, 2008; Rajan, 2016). The theory of multiple intelligences developed by Howard Gardner (1983) has significantly influenced education because he professed that children have different kinds of intelligences and learn in different ways. Gardner (1997) explained that music could be helpful in cognitive processes, especially among young people. Supporting this theory, Indians for a long time believed that each child has different strengths and that children learn in different ways. That is why parents of young children enroll their children in music, sports, or other extra-curricular activities to identify their strength and nurture it. It thus becomes important for teachers to learn different ways other than traditional ways to teach the children. Teaching mathematics through music could be one of the ways to motivate students. If children like music, then music could be one way to motivate or reinforce mathematical concepts. In that way, children could find interest in learning mathematics.

When asked about the arts and education, brain researcher Eric Jensen (2005) stated that "music is part of all of us, and it's critical to us as learners to develop pattern-making." In addition, Jensen believes that math skills are stronger in students with a music background. Further, Synder's (1997) research contributes significant knowledge about music and brain development. She mentioned that only if children are exposed to music in their early years, then those areas in the brain get stimulated and would create strong connections with other parts of the brain. Additionally, some of the music centers lie in the brain's middle section that connects to emotions. Music that evokes emotional responses opens the gate to higher-level thinking and stimulates critical thinking (Snyder, 1997). Edelson & Johnson (2012) quoted D'Arcangelo (1998, p. 25), who stated: "The connections between music

and mathematics are ever-present." Children have the potential to be more engaged when listening to steady beats than when listening to verbal-only instructions (Costa-Giomi, 1999). The author further stated that listening to a steady beat pattern during mathematical activities in early childhood classrooms could promote more focus. According to Rauscher (1993), rhythm is, after all, "the subdivision of a beat." It is about ratios and proportions, the relationship between a part and a whole. Rauscher (1993) further mentioned that children's test scores improved due to learning music.

Background of Indian Music with Mathematics

Ancient Indian civilization offered contributions in mathematics and music from the Vedic times around 1500 BCE. Music schools in India base their music curriculum on historical classical music. Indian music and mathematics originated from the Vedas, a holy scripture. There exists a close relationship between Indian music and mathematics (Authors, 2015). Srimani & Paimala (2011) stated how *Ragas* in Indian classical music have found their roots in the Vedic period, which was based on a scientific foundation, and contributed for thousands of years. *"Ragas*" translates to beauty or color and are formed by different permutations and combinations of notes. Notes, or "*swaras*," are formed by combining fundamental frequencies and their overtones. Authors (2015) found that Indian Classical music impacted mathematics learning among children and that parents and teachers encouraged children to learn music in-order to reinforce mathematical concepts.

Although the above studies indicated a positive relationship with mathematics, there is a dearth of literature on Indian music and its perceived influence on mathematics learning. This study aimed to investigate the impact of Indian music on children's cognitive development, especially in mathematics. The research question of this study was to examine the convergence of mathematics with Indian music and how children acquire skills in mathematics by learning Indian music.

Methodology

Participants

The participants consisted of 50 students who were 6 years old from three music schools in Kolkata, India. Around 40% were boys, and 60% were girls. The children were learning music from a very young. The classes were randomly selected from

the music schools in India. The students were observed in their music classes. Twelve students were randomly selected from the three schools for a short interview. All observations and interviews took place in front of their teachers or parents to ensure ethical consideration on the part of the researcher since the children were very young. Data were also collected through in-depth interviews with the Guru, a senior teacher, and eight other music teachers from three different music schools. The Guru and the teachers were interviewed so that the researcher could learn more about Indian music and how Indian music helps children in cognitive development and especially in learning mathematics. The children were observed during the music classes to examine how they were learning music and their interaction with music teachers and peers. Some children were interviewed to examine their feelings about music and mathematics. Eighty-two parents from three different music schools were randomly grouped and asked interview questions in depth. The parents were interviewed to discover their views about their children's learning of music and to what extent they believed that it helped them in their children's cognitive development, especially in learning mathematics.

Research Sites

The music schools were located in Kolkata, India. These music schools were quite well-known among the people living in the city. Parents choose these music schools by their name and also convenience. In these schools, the common method of teaching music has deep roots in Indian classical music as well as light music. Children start learning music in these schools from a very young age and move up a grade level yearly with the examination.

Method

Data were obtained in three ways: through interviews, open-ended survey questionnaires, and observations; all took place in the music schools. All interviews were tape-recorded and transcribed later. Six different music classes from the three music schools were observed at different times. Observations were documented through pictures, video recordings, running records, and anecdotal records. To supplement these documentations, a field journal was kept at all times. The study is qualitative in nature. Data collected were analyzed qualitatively because, basically, the investigation was undefined at the beginning and emerged as the study progressed.

Findings

Guru's Interview (The Senior and Master Teacher)

After analyzing the data for themes, two main categories emerged from the conversation with the Guru. First, respect for the historical significance of music and then its connection to mathematics. The Guru stated that music helps an individual to make a connection with oneself. The body, mind, and consciousness are the three components of human beings into which music is integrated. He explained that Indian music is curvilinear with respect to tune. The Guru also said that *taal* (rhythm) originated from the human heartbeat. Since a normal human heartbeat is 72 per minute, he says to set the *taal* at 72 beats per minute. *Taal* or rhythm is cyclical in nature because in any type of *taal*, after the last beat comes the very first beat, and the cycle continues just like the pattern of day and night continues. He also mentioned that the distribution and measure of time come from the concept of rhythm. For example, the intervals of minutes are equidistant, so the intervals of rhythm measurements are also equidistant. The Guru believed that all children develop cognitively when they learn music. He said that music helps children with concentration and creativity. He mentioned that music helps in all subject areas, including mathematics, and music goes beyond mathematics. He further stated that it takes at least six months to examine any development after enrolling in a music class. He also emphasized that children need to start at a very young age.

In another school, the master teacher explained the mathematics in music. He said *Merukhand* is an improvisational style in Hindustani classical music. It is a permutation of a fixed set of swaras or notes (*Meru*, which means spine), and it is broken up in various ways (*khand*, which means fragment) while retaining the proper emphasis on various notes as required by the raga. In *merukhand*, 3 or 4-note patterns are selected, and all the possible combinations and patterns are rendered with practice. *The Merukhand* technique works well in enhancing the creativity of a singer and in improving the vocalization of notes as well. He stated the purpose of the musical exercise was to show how different designs could be produced musically without repeating any design. It is mainly to show the permutation and combination of different notes. In practicing *merukhand*, students develop a great deal of concentration when creating the design without repetition,

and that too at a fast pace. To illustrate the *merukhand* style, he selected a 4-notes pattern initially:

Sa Re Ga Ma (Indian music notes)

Do Re Mi Fa (Corresponding Western music notes)

1 2 3 4

Then he created all the possible patterns, taking only these notes, without repeating any swaras (notes):

Sa Re Ga Ma, Re Sa Ga Ma, Ga Re Sa Ma, Ma Ga Re Sa,

1 2 3 4, 2 1 3 4, 3 2 1 4, 4 3 2 1

Sa Re Ma Ga, Re Ga Sa Ma, Ga Re Ma Sa, Ma Ga Sa Re,

1 2 3 4, 2 3 1 4, 3 2 4 1, 4 3 1 2

Sa Ga Re Ma, Re Sa Ma Ga, Ga Sa Re Ma, Ma Re Ga Sa,

1 3 2 4, 2 1 4 3, 3 1 2 4, 4 2 3 1

Sa Ga Ma Re, Re Ga Ma Sa, Ga Sa Ma Re, Ma Re Sa Ga,

1 3 4 2, 2 3 4 1, 3 1 4 2, 4 2 1 3

Sa Ma Re Ga, Re Ma Ga Sa, Ga Ma Sa Re, Ma Sa Re Ga,

1 4 2 3, 2 4 3 1, 3 4 1 2, 4 1 2 3

Sa Ma Ga Re, Re Ma Sa Ga, Ga Ma Re Sa, Ma Sa Ga Re = 24 patterns.

1 4 3 2, 2 4 1 3, 3 4 2 1, 4 1 3 2

Furthermore, “Pa Dha Ni Sa” (5 6 7 8) (corresponding western music notes are “So La Ti Do”),

Then the “Re Ga Ma Pa” (2 3 4 5) note series also makes 24 possible improvisational patterns. Therefore, we can make numerous swar-patterns only from four notes. He further stated that specific notes of the ragas could also be

practiced, and it keeps the brain engaged in creating phrases. Similarly, with pentatonic ragas, we can make more combinations.

Observation of Students in the Music Class

The two themes that emerged from the observation are how music helped with focus and how mathematics concepts could be learned through music. The teacher asked the children to close their eyes and visualize their school. This was reinforced by having the students recall details about their school and then use that conversation to transition into how music can be visual. The teacher then transitioned from senses and music to incorporating mathematics with music. *Taal*, or rhythm, was explained by having students add numbers to get to the number 11 (for example: 6+5, 5+6, 4+7, 7+4, 3+8, 8+3, 2+9, 9+2, 1+10, 10+1). By doing this exercise, the students were able to understand how the 11 beats of the song could be broken down and distributed while keeping the rhythm of the song. Teachers built on this further by having students increase the song's speed, so they were singing it twice as fast, understanding that 11x2=22. Mathematics was thoroughly incorporated throughout the music lesson. The teachers were teaching the relationship between Mathematics and Indian Classical Music. Following are some of the mathematics skills that the children learned from different music classes.

Counting is one of the mathematics concepts, and children were learning counting through music. Children were associating one-to-one correspondence with Indian musical notes and also learned place value that each note has a distinct position in a musical tone. As each note gets higher, the number also increases. Following is an example of one-to-one correspondence and place value.

One-to-One Correspondence

1	2	3	4	5	6	7	
Sa	Re	Ga	Ma	Pa	Dha	Ni	
Do	Re	Me	Fa	So	La	Ti	(Western music counterparts)

The children learned that there are 7 notes in a set. Each note has a signature sound that one has to understand and recognize in music. When you include flats (komol) and sharps (tivra), a total of 5, along with the previous 7 notes, makes 12 notes altogether.

Then the teacher showed sets of numbers how to sing three in a set, as:

Sa Re Ga, Re Ga Ma, Ga Ma Pa, …

1 2 3, 2 3 4, 3 4 5, …

Do Re Me, Re Me Fa, Me Fa So, …

Four in a set, as:

Sa Re Ga Ma, Re Ga Ma Pa, Ga Ma Pa Dha…

1 2 3 4, 2 3 4 5, 3 4 5 6, …

Do Re Me Fa, Re Me Fa So, Me Fa So La, …

Next is Learning Skip Counting

Sa Ga, Re Ma, Ga Pa, Ma Dha, Pa Ni,…

1 3, 2 4, 3 5, 4 6, 5 7

Do Me, Re Fa, Me So, Fa La, So Ti

This Was Followed by Backward Counting

(The Higher Note Sa is Italicized)

Sa Ni Dha Pa Ma Ga Re Sa.

8 7 6 5 4 3 2 1

Do Ti La So Fa Me Re Do

Children Also Learned Backward Skip Counting

Skipping one note, as:

Sa Dha, Ni Pa, Dha Ma ….

8 6, 7 5, 6 4, ….

Do La, Ti So, La Fa, …

Next, the Children Learned Connecting and Representing

Using various physical models and representations, connecting number words and numerals to the quantities they represent is a mathematics concept. In music, sound and words are connected; for example, *Sa* has a distinct sound. When some notes are combined to make a tune, musicians integrate words to make it more pleasant to hear.

In another class, the children learned **mathematics operations** (addition, subtraction, multiplication, and division) with musical notes.

Addition

Sa Sa Re + Sa Sa Re Ga

1 1 2 + 1 1 2 3

Do Do Re + Do Do Re Me

Re Re Ga + Re Re Ga Ma

2 2 3 + 2 2 3 4

Re Re Me + Re Re Me Fa

Subtraction

Sa Ga Re Sa, Pa Ni Dha Pa

Sa (omit Re) Pa (omit Dha)

1 (omit 2) 3 2 1 5 (omit 6) 7 6 5

Do (omit Re) Me Re Do So (omit La) Ti La So

Ga Sa Ni Pa

3 1 7 5

Me Do Ti So

Multiplication

Sa Sa Re Re Ga Ga

1 1 2 2 3 3

Do Do Re Re Me Me

Sa Sa Sa Re Re Re Ga Ga Ga

1 1 1 2 2 2 3 3 3

Do Do Do Re Re Re Me Me Me

Sa Sa Sa Sa, Re Re Re Re Ga Ga Ga Ga

1 1 1 1 2 2 2 2 3 3 3 3

Do Do Do Do Re Re Re Re Me Me Me Me

Division

Sa Re Ga Ma Pa Dha Ni *Sa*

1 2 3 4 5 6 7 8. Now 8/2 = 4

Sa Ga Pa Ni or

Re Ma Dha *Sa*

Do Me So Ti

Re Fa La *Do*

Fractions

Understand and represent commonly used fractions, such as 1/4, 1/3, and 1/2.

In music, fractions can be represented in various ways. For example, using two notes (double) in one beat, three notes (triple) in one beat, or four notes (quadruple) in one beat. This is vocally possible with speed.

In one beat, one can combine to sing two notes, learning ½ or three notes, learning 1/3 or four notes, learning ¼.

Beats:	1	2	3
Notes:	Sa Re	Ga Ma	Pa Dha
	Do Re	Me Fa	So La
	Sa Re Re	Ga Ma Ma	Pa Dha Dha
	Do Re Re	Me Fa Fa	So La La
	Sa Re Re Re	Ga Ma Ma Ma	Pa Dha Dha Dha
	Do Re Re Re	Me Fa Fa Fa	So La La La

In algebra, understanding patterns, relations, and functions are mathematical concepts that all students should learn from pre-K through grade 2. Children should learn to sort, classify, and order objects by size, number, and other properties.

In music, based on different ragas, notes are sorted, classified, and one has to follow an order. The notes are combined and permuted according to the characteristics of each raga.

At another time, the children learned **algebra**, mainly patterns as follows.

The pattern is a repetition of the same design. For example, with musical notes, a pattern could be as follows:

Sa Re Ga, Re Ga Ma, Ga Ma Pa, …

1 2 3, 2 3 4, 3 4 5, …

Do Re Me, Re Me Fa, Me Fa So….

When a pattern in tune has been formed, one has to continue the pattern and then translate it into words to represent the raga.

Another instance was generating repeating and growing patterns:

In music, patterns are formed to grow in the design. One has to visualize the sound generated and express it through tunes to create the mood.

For example,

Sa Re Ga, Re Ga Ma, Ga Ma Pa…the notes are ascending as well as repeating and growing.

1 2 3, 2 3 4, 3 4 5

Do Re Me, Re Me Fa, Me Fa So….

Examples of different patterns were shown to the learner. For example,

Sa Ga Re Sa, Sa Re Ga Ma; Re Ma Ga Re, Re Ga Ma Pa,…

1 3 2 1, 1 2 3 4, 2 4 3 2, 2 3 4 5,….

Do Me Re Do, Do Re Ga Fa, Re Fa Me Re, Re Me Fa So….

Mathematical concepts of **estimation, measurement, and time** were demonstrated in another class. In Indian classical music, a rhythm is played with a percussion instrument (*tabla*). The *tabla* plays in a cyclic order: the rhythm. The rhythm could be anywhere from 5 measures to 21 measures. For example, in a 16-measure rhythm, the learner has to estimate the time required to complete in order to match the 16-measure of t*abla*. In the course of estimation, the vocalist has to beautify the raga according to the notes required in each raga. Further, 24 hours in a clock has been divided into quarters. Specific raga has to be sung in specific quarters.

Data Representation

The teacher explained that when the learner visualizes the notes in mind, the learner creates a visual image in his or her mind. Depending on the notes, whether ascending or descending, the notes could be plotted on a piece of paper, and a line graph could easily be drawn, representing the notes.

For example,

Ma Fa

Ga Me

Re Re

Sa Do

Children Also Learned About Frequency and Probability

In Indian classical music, specific raga has specific notes that are most frequently used (badi swar) and second most frequently used (sambadi swar). The learner has to remember those while singing the raga. The other notes have an equal chance of being used (probability); however, all notes needed are specific to each raga.

In the Observed Class, Children Also Learned About Permutation and Combination

The teacher mentioned that the learners must think about different strategies to beautify a raga. As stated before, the learner must combine different notes to create an intricate design in a specific raga.

The children were engrossed in the music. None of the children fidgeted or wanted to go and play. They were all concentrating on the music class. They were aware of the music class's routine and practiced all the above notes.

Survey and In-Depth Interviews

In this study, twelve randomly selected students were asked about their preferences in mathematics and music. While 40% of children confirmed that they liked doing mathematics, only 60% confirmed that they scored well in mathematics. Nevertheless, all the students demonstrated an improvement in their mathematics scores since they started learning music, as per the parents' interview. During the interview with the children, the children all said that they liked music. One child stated, "I like to sing because it sounds nice." Another child said, "I like to sing with my friends." Some of the children mentioned that music makes them happy.

From the parents' interview, three themes emerged: the effect of music on their children's cognitive development, how learning Indian Classical music had an effect on their children's mathematics scores, and how parents' views affect their children's mathematics learning if their child has to discontinue music lesson for some reason.

One hundred percent of the parents stated that all the children loved music very much. The parents mentioned that mathematics requires students' complete attention, but music can reduce fatigue from studying hard. One of the parents stated that music improved the child's attitude to learning and concentration.

Another parent mentioned that her child had ADD, but he recovered from it by learning music. A third parent persuaded his child to rehearse his music before he studied to help him succeed with his studies and focus more, as the music seemed to have a calming effect on the children. A fourth parent pointed out that the organization of music helped her child organize her schoolwork better. The parents mentioned they started noticing changes in their children as early as three months, more evident after six months.

About two-thirds of the parents noticed that as their children increased their study of music, their mathematics scores increased. One of the parents mentioned that his child has learned to overcome simple mistakes in mathematics. One parent even made the connection that his child was able to learn sequences in mathematics from the rhythm of the music. Overall, the parents believed that music was imperative to their child's success in mathematics, and discontinuing music programs was not an option.

Discussion and Conclusion

This study aimed to investigate the impact of Indian music on children's cognitive development, especially in learning mathematics. The study indicated the impact of Indian music on the cognitive development of children, especially in learning mathematics. The kind of rigorous practice with musical notes undoubtedly impacted the minds of young learners.

The interview with the Guru was profound and created lasting impressions on how Indian music has a strong connection to mathematics. Further, similar to the study by Rauscher (1993), this study showed that in Indian music, rhythm is broken down into beats, and measurement of time, which is similar to the theory that the element of rhythm links musical and spatial processes. This study also echoes Parsons et al. (1999) that the element of rhythm links musical and spatial processes. Therefore, music is strongly related to mathematics through a variety of skills and processes used to link learning in all areas.

Music is an integral part of child development, and its power should not be undermined; as indicated by Gardener's (1983) Theory of Multiple Intelligence, music helps in cognitive development among children and Snyder's (1997) research that music has a direct route to thinking. Therefore, if music helps to

reinforce mathematics concepts, then there should be every reason to integrate music into early childhood and childhood curricula.

From this article, teachers can acknowledge how mathematics and music are so closely connected. Further, research has stated that test scores in mathematics increased for students who studied music. The parents in this study indicated the same. The idea of listening to music or rhythm while learning led to a higher engagement in mathematics. The knowledge about *merukhand* from an early age gives children a strong foundation in permutation and mathematics in general. Another highlighted idea is how music teachers incorporated mathematics lessons with the children, helping them to add different numbers to get to 11 – mimicking the 11 beats of the song, then later singing the song faster. This means the students had to understand the concept of double. Children were definitely learning in the music class with the alignment of different mathematics concepts with music.

The children in India, while learning music from music school, also gain knowledge and reinforcement in mathematics. Many young children loved singing, dancing, and listening to music. The implication from the study is music could be added to mathematics or lessons, and by integrating music, the subjects could be so much more enjoyable for the children. Teachers can also incorporate music with the 5 senses and can help children learn to count beats and understand the cyclical process of beats, like the rhythmic nature of the human heartbeat. Further, teachers can also help children in the improvisation of melody, keeping the rhythm constant.

Mathematics and music are strongly interconnected. Children can learn mathematics better through musical knowledge and understanding. This includes, but is not limited to, focusing on patterns of beats in music to comprehend mathematical patterns and scientific sequences. This is especially emphasized as the parents mentioned their children's increase in mathematics test scores. One of the outcomes of the study was the fact that students who learned music increased their concentration, as per the parents' comments from the interview. Parents also mentioned that their children's concentration increased as a result of music practice. One of the teachers mentioned that in practicing *merukhand*, students develop a great deal of concentration when creating the design without repetition. Thus, this research adds new knowledge to the field of early childhood education and also in teacher preparation and professional development. Teachers need to realize the strong connection between mathematics and music that would help students learn

complex, abstract concepts. Further, music helps children to be actively engaged, participate in groups, and build confidence.

The limitation of this study was that the data was collected only from three music schools in India. For future studies, it is important to enlarge the sample and explore other cultures. Further, it is important to note the qualitative character of the investigation and to prove the suggestions with future quantitative measures, comparing the improvement in the performance of math tests in children who practice music versus those who do not.

This research is significant because it suggests how Indian music has helped children develop or reinforce mathematics concepts, as evidenced by the parents' compliments and assessments of the teachers of children. The relationship of mathematics with music was ever present. This study brought a new light not only to the development of young children but also focused on the enjoyment of learning.

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Appendix A: Content Standards Prek-2

https://www.nctm.org

Understand numbers, ways of representing numbers, relationships among numbers, and number systems

Pre-K–2 Expectations: In pre-K through grade 2, each and every student should–

- count with understanding and recognize "how many" in sets of objects;
- use multiple models to develop initial understandings of place value and the base-ten number system;
- develop understanding of the relative position and magnitude of whole numbers and of ordinal and cardinal numbers and their connections;
- develop a sense of whole numbers and represent and use them in flexible ways, including relating, composing, and decomposing numbers;
- connect number words and numerals to the quantities they represent, using various physical models and representations;
- understand and represent commonly used fractions, such as 1/4, 1/3, and 1/2.

Understand patterns, relations, and functions

Pre-K–2 Expectations: In pre-K through grade 2, each and every student should–

- sort, classify, and order objects by size, number, and other properties;
- recognize, describe, and extend patterns such as sequences of sounds and shapes or simple numeric patterns and translate from one representation to another;
- analyze how both repeating and growing patterns are generated.

Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships

Pre-K–2 Expectations: In pre-K through grade 2, each and every student should–

- recognize, name, build, draw, compare, and sort two- and three-dimensional shapes;
- describe attributes and parts of two- and three-dimensional shapes;
- investigate and predict the results of putting together and taking apart two- and three-dimensional shapes.

Understand measurable attributes of objects and the units, systems, and processes of measurement

Pre-K–2 Expectations: In pre-K through grade 2, each and every student should–

- recognize the attributes of length, volume, weight, area, and time;
- compare and order objects according to these attributes;
- understand how to measure using nonstandard and standard units;
- select an appropriate unit and tool for the attribute being measured.

Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them

Pre-K–2 Expectations: In pre-K through grade 2, each and every student should–

- pose questions and gather data about themselves and their surroundings;
- sort and classify objects according to their attributes and organize data about the objects;
- represent data using concrete objects, pictures, and graphs.