Effect of using songs to teach junior secondary mathematics

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Abstract

Singing songs is part of human everyday lifestyle, they can easily be recalled and thereafter affect other aspects of human life. The study examined the effect of songs application in teaching junior secondary mathematics. The junior secondary level being the intermediate and upper basic level of education where learners are prepared for the serious academic rigour of the post-basic or senior secondary level in Nigeria require the introduction of more learner-centred, learner-friendly and activity-based methods. Teaching Mathematics with use of songs will be one of such methods. The study employed the pre- test, post-test, quasi experimental design. Using purposive sampling technique, one hundred and twenty (120) junior secondary students from two public secondary schools were selected for the sample. Three hypotheses were formulated and tested. Two instruments, procedural and main instrument, were used. The data collected were analyzed using analysis of covariance (ANCOVA). The result of the study revealed that there was a significant effect of songs on the academic achievement of students in Mathematics and it was recommended that teachers should be encouraged to adopt songs composed during teaching since their use sustains students' interest and retention.

Keywords: songs, junior secondary mathematics, gender

Introduction

Mathematics is central to all science subjects and a major life skill of numeracy. It is a compulsory and core subject both at the primary and secondary school levels. It is a major requirement for admission into most courses or programmes at the tertiary level of education in Nigeria. Mathematics has been a challenging subject at both the primary and secondary levels of education in Nigeria. Program for International Student Assessment (PISA) 2018 report of a study conducted by Organisation for Economic Co-operation and Development (OECD) stated that about half a million 15-year-old students world over participated in a test that measured their proficiency in reading, mathematics and science. The findings showed that from the 56 countries where participants were sampled, 4 countries were above the OECD average benchmark in mathematics, 29 countries on the average, while 23 countries performed below the OECD average. This is an indication that students' performance in mathematics is below average globally and much is desired in this regard. "These numbers show that all countries still have some way to go towards reaching the global goals for quality education, as defined in the UN Sustainable Development Goal for education, by 2030" (PISA, 2018).

 Many boring methods used to teach the subject have contributed to the challenge witnessed by learners at these levels. Thus, there is the need for a change in the methodology employed in teaching the subject to learners at the basic level of education. One of these ways is the use of songs which has been proven to be effective with other less mental tasking subjects like languages, health science, religious studies, etc. (Lems, 1996; Medina, 2002). On the other hand, there are some researches that show the efficiency of using songs for teaching mathematics (An & Tillman, 2015; Courey et al., 2012; Edelson & Johnson, 2003; Lawani, 2016). An et al. (2016) speak of three possibilities of applying music for teaching mathematics: (1) mathematics as a tool during music creation; (2) music as a catalyst for mathematical cognition; and (3) music as a pedagogical approach to mathematics. The second and third approach are interesting for the current study. Peaceful classical music used as lessons' background was found to be correlated with better mathematical achievement compared to no such background. Besides, mathematics students who also took music lessons demonstrated better mathematical achievements than those students who did not take music classes. "Pedagogy utilising music-themed mathematics lessons has helped students to better understand mathematics concepts and reduce mathematics anxiety" (An et al., 2016, p. 22).

According to Laato et al. (2019), although much emphasis is laid on teaching mathematics in primary schools of Namibia, the results are not too inspiring. Their study investigated "how the rich music oriented indigenous culture of Namibia can be leveraged to assist in math education by teaching math via music" (p. 1). The combined learning of mathematics and songs was found to be successful in both motivating students to learn mathematics and removing the stress of doing hard mental work. Eventually, students' grades in mathematics increased. The application of songs by 7-8-year old students was also found effective by An and Tillman (2015), Bach Vinyets (2013) found it useful for primary school children (aged 7-12), Courey et al. (2012) for third-grade students.

These researchers are of the belief that using songs to teach mathematical concepts would be beneficial to both teachers and learners (especially at the age 7-11), as the method would help douse the usual tension and anxiety that usually characterize mathematics lessons. While mathematics teacher finds this pedagogy handy in explaining topics in mathematics effortlessly, learners would find the musical medium to the learning of mathematical concepts the play-way, thereby making the teaching and learning experience more interesting and worth the while.

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However, songs as an effective tool for teaching, has not been encouraged and has not been given a place in the teaching and learning of mathematics and this has not brought about significant effects on student's performance in mathematics. Thus, the goal of this study is to examine the effect of the usage of songs in teaching Junior Secondary 1 mathematics with moderating effect of gender been also investigated. While the issue has been underestimated in general, there are no empirical studies in Nigeria on it. The current study is trying to fill in this gap. As the researchers wanted to develop some recommendations on the application of songs for teaching mathematics, they needed to know whether all students, both males and females, would benefit from the treatment.

Hypotheses

1.   There is no significant effect of songs on the academic achievement of students in mathematics.
2.   There is no significant effect of gender on students' academic achievement in mathematics via songs.
3.   There is no significant interaction effect of songs and gender on students' academic achievement in mathematics.

Literature review

Music is the art of producing pleasing or expressive combinations of tones, especially with melody, rhythm, and usually harmony (Merriam-Webster Dictionary, 2019). The word 'music' comes from the Greek word [mousika], which means "art of music". In ancient Greece, music included the goddesses of music, poetry, art, and dance. Educational music can be described as a genre of music in which songs, lyrics, or other musical components are used as a method of teaching and/or learning. Music is a cultural language. It gives our culture characteristics and perfect material to work on intercultural competence.

A song is a short piece of music with words that are sung (Merriam-Webster Dictionary, 2019). Songs are everyday human activities and they are easy to memorize, because the melody helps the listener to remember their contents. Consequently, singing is an easy technique for memorizing something.

Cohen (1961) showed that integrated teaching of mathematics and music was applied as early as in the Pythagorean school of Greek antiquity (the quadrivium included arithmetic, geometry, music, and astrology) and remained important until the Renaissance. Cohen points out three aspects in which mathematics and music are similar: they are systems of symbols that do not necessarily point to anything – only to themselves, in other words, mathematics and music are self-referential; they are both creative, they created by building from a set of predetermined presumptions, or axioms.

The English man taught numbers to African population using recitations such as one-two buckle my shoe, three-four knock at the door, five-six pickup sticks, seven-eight lay them straight, nine-ten a big fat hen. Through such recitation, a child could dance to the rhymes and retention was aided, but the contextualization of learning did not take place, the language of the immediate environment was not used, so children did not contextualize what they had been taught. Learning at school and in the environment were not linked together, this made learning to be completely disintegrated from the people's way of life, as a result of Babs Fafunwa (1974), one of the most famous African educators, and his followers started looking for the ways how to contextualize learning and bring about the integration of home and the school, so they started using *African* songs like: Eni bi eni; Eji bi eji; Eta n ta gba; Erin woroko . . . That helped the child to understand and retain the materials better, thereby improving their performance. Through the usage of songs learners enlarged their knowledge of the culture reflected in those songs. Application of songs in the ethnic traditions of the African continent for teaching mathematics enable educators to make learning this subject more motivating and efficient.

Songs are a very strong and powerful medium of communication. Songs, in all their forms, have been a part of human life and living for as long as man has existed. Human beings have made use of songs every day, while relaxing and socializing in bars, while in the shower, or just listening for pleasure to the car radio while commuting to work, etc. Using songs for learning has both affective and cognitive effect on the student. Therefore, songs have become an essential part of human experiences. Bach Vinyets (2013) affirmed that songs are a good resource for teaching and learning. Most educated adults in Nigeria can probably still remember having learnt the multiplication table with a specific musical tune. Research showed that mathematics and music are related in the human brain, right from early in a man's life (Burack, 2005). When songs are incorporated into mathematics lessons, it keeps learning mathematics natural and comfortable at any level. Glastra et al. (2004) affirmed that mathematics instruction integrated with music can effectively increase student's intrinsic motivation. Special songs are written to make the teaching and learning of mathematics memorable. The use of songs in a classroom environment is an advantage to teachers.

Songs allow learners to acquire information naturally and present information as parts and wholes. They are an effective, almost magical medium for learning and retaining information. According to McCollum (2019), they activate three different centers of the brain at the same time; language, hearing and rhythmic control. By inducing emotions, they also create a heightened condition of awareness and mental acuity. A song gives students a chance to reduce the information into parts yet work with it as a whole. It does spark recall. It also motivates students to write and makes the classroom experience fun. Songs have proven to be gummy in students' minds – the easily stick – and they are not forgotten easily like other forms of information such as ordinary speech. Medina (2002) thinks that the major advantage of employing songs and music is the pleasurable experience that both brings to learners along with the comfortable atmosphere they create in the class. The more comfortable the students are, the more receptive they are to learning in the class.

Concerning the requirements to the songs applied in education, Lems (1996) said that it is imperative that the songs to be used in teaching should contain words that are easily comprehensible; to provide adequate oral practice in classes, it is crucial to use songs with enough chorus or repetitions. The selected songs should be common, relatively known to the learners outside the lessons, and well-written, from a native speaker's point of view. The age and level of the learner with the aim of teaching a subject should also be taken into consideration. When introducing songs to a junior class, they should involve a few new words; should not be longer than 16 lines, with a lot of repetition. Songs for students of the intermediate level should "contain manageable load of vocabulary, limited total text length and should not be heavily embedded" (Lems 1996, p. 2).

Lash (2004) reviewed that teaching mathematics through songs offers opportunities to support students whose most developed intelligence strengths are not necessarily within logical-mathematical domains. Edelson and Johnson (2003) found out that songs enrich the learning atmosphere in mathematics classes for children because such activities have a high degree of pleasant passion; they promote the fun in learning, and allow the learners to be active participants.

Bach Vinyets (2013) said that the major benefit of using songs in classrooms is that learners enjoy the relaxed atmosphere in the class. He added that music creates an endearing and comforting way to acquire process, songs have the ability to change the listener's mood because they excite, promote motivation like video games or images, among others do. Linder et al. (2011) found that children who did not have musical experiences during their mathematics classes had trouble recalling any of the mathematical concepts that were discussed in the classes. They also discovered that daily learning knowledge, such as listening to music, is especially germane in supporting the development of mathematical concepts in children from infancy to the age of 5. Courey et al. (2012) concluded that integration of music and mathematics can be beneficial to the students' learning, and that finding other connections between the two disciplines in the classroom may both improve students' mathematics performance. An and Tillman (2015) observed that the intervention of music-mathematics integrated lessons yielded a statistically significant improvement in the music group students' mathematical abilities.

Methodology

The study utilized a pre-test, post-test control group quasi-experimental design. The population comprised of all first year students' in public junior secondary school in Ijebu-Ode Local Government Area of Ogun state, Nigeria. The sample for the study comprised of one hundred and twenty Junior Secondary School I students (aged 9-11) from two public junior secondary schools in Ijebu-Ode Local Government Area of Ogun state. Songs were used to teach students of this age category because they have the peculiarities of hobby development, in Piaget (1977) stages of cognitive development learners within these age brackets are categorized as organizers. They can use mnemonics or memory triggers and learn well with hands-on activities to aid learning. Learners at concrete operational age (7-11) are able to think logically, but their thinking is rather concrete than abstract, that is why many of them face challenges while learning mathematics. At the same time, it is exactly at this age that basic mathematical concepts are formed – if the critical time is lost, student can later have problems of learning not only mathematics, but also other science subjects.

The purposive sampling technique was used for the selection of the two schools that took part in the study. And the conditions for the purposive sampling are that: they must be a public and co-educational school; the topics to be treated in the study have not been taught in the school; the school has produced candidates for public examination like JSSCE; readiness and wiliness of the co-operating teachers to participate in the study. In each school, intact classes of JSS1 were used. Songs used for teaching were purposely composed by the researchers. Research assistants were trained to assist in the conduct of the research. Research assistants were graduate teachers who had put in not less than five years in the teaching profession.

Two instruments were used: procedural instruments were used for teaching and main instruments for data collection. The procedural instrument was used to instruct participant in the experimental and control groups respectively. They are designed as control for school-teacher effect and are expected to increase internal validity of the experiment. The procedural instrument consisted of the activities, behaviours and specific instructions guiding the teachers instructing the experimental and the control groups. The topics taught were: measurements of angles, properties of a complete rotation, straight line angles, right angle, acute angle, obtuse angles, complimentary angles, supplementary angles and intersecting lines and angle at a point. The main instrument, Mathematics Achievement Test (MAT), was developed by the researcher to measure the level of students' mathematics skills and competence. The validity of the instrument was established by the researchers among whom are a professor and associate professor of Mathematics education. The MAT was also pilot-tested on a group of similar respondents who were not participants in this study using the test-retest method. A reliability coefficient of 0.89 was obtained.

It was a fifty items multiple-choice test with four options that measure knowledge, understanding and application of the content taught. The number of items picked for each topic was proportional to the number of the sub-concepts and ideas that was covered in the topic. In order to score the Mathematics Achievement Test (MAT) each correct response was awarded a score of one (1) while a wrong response was awarded zero (0). The total score obtainable in the MAT was 50. The same instrument was used for pre-test and post-test but the theme fonts and order of arrangement for post-test was changed. The maximum scores obtainable in MAT was 50 and the minimum score was 0.

The study lasted for six weeks. The first and the last week was used for the pre-test and post-test respectively. The main treatment lasted for four weeks. While the control group had no special treatment as they were taught in the conventional style, the experimental group were taught the mathematical concepts with songs (see appendix) which was the treatment. The songs, as the intervention, were used as means of explaining the mathematical concepts taught in the topics. They were also designed to aid memorization and assimilation of concept taught. For instance:

Step1: The teacher presents to the student the meaning of angle and also presents the types of angles using the acronym ARAOR (Acute, Right angle, Obtuse and Reflex angle).

Step 2: Regular explanations of the concept are given with demonstrations and the application of instructional aids.

Step 3: Then the songs are introduced (see in the appendix). The teacher sings the song several times, so that students memorize the lyrics and rhythm.

Step 4: Students sing as a choir, sing by roll and then selected students sing individually.

Step 5: Exercises on the concept taught are then given to further foreground the topic taught.

Step 6: As homework, in groups, students are asked to compose minimum two-line songs on complimentary and supplementary angles, to demonstrate their understanding of the terms.

Pre-test was given to determine whether any statistically significant difference exists among the groups at the beginning of the study. ANCOVA was used to analyze the data.

Results

Hypothesis One

There is no significant effect of songs on the academic achievements of students in mathematics.

Table 1. Tests of between-subjects effects of song treatment and gender on academic achievement of students in mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8258.721[a]	4	2064.680	71.233	.000	.712
Intercept	1195.052	1	1195.052	41.230	.000	.264
Pre	3694.338	1	3694.338	127.458	.000	.526
Treatments	2224.411	1	2224.411	76.744	.000	.400
Gender	1.046	1	1.046	.036	. 850	.000
treatments * gender	20.710	1	20.710	.714	.400	.006
Error	3333.246	115	28.985			
Total	82548.000	120				
Corrected Total	11591.967	119				

a. R Squared =' .712 (Adjusted R Squared = .702)

Null hypothesis was denied. Table 1 above revealed a significant effect of songs on students' academic achievement in Mathematics ($F_{1, 115}$= 76.744; p <0.05; η^2= .40).

Table 2. Estimates of control and experimental treatment

Treatments	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experimental control	27.934[a] 18.684[a]	.643 .816	26.660 17.068	29.207 20.300

a. Covariates appearing in the model are evaluated at the following values: pre = 18.1667.

The results in Table 2 revealed that the students in the conventional method of teaching (the control group) had a mean score of 18 .684 and standard error of .816, while those in the experimental group had a mean score of 27.934 and a standard error of .643. Further analysis determined whether the difference in mean scores is statistically significant (see Table 3).

Table 3. Univariate test of the effects of songs and conventional teaching on students' achievement in mathematics

	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Contrast Error	2224.411 3333.246	1 115	2224.411 28.985	76.744	.000	.400

The F tests the effect of songs. This test is based on the linearly independent Pairwise comparisons among the estimated marginal means.

The results in table 3 indicated a significant effect of songs on students' academic achievement in mathematics ($F_{1, 115}$= 76.744; p <0.05). Therefore, the postulated null hypothesis one was rejected. This means that there was a significant effect of songs on students' academic achievement in mathematics. The implication of this finding is that while the two treatments are effective in causing achievement improvement in mathematics, they differ in terms of the degree of their effectiveness. To determine the direction of the difference, pairwise comparison was carried out. The results are presented in Table 4.

Table 4. Pairwise comparison of treatments on participants' achievement pairwise comparisons

| (I) Treatments (J) Treatment	Mean Difference (I-J)	Std. Error	Sig-[b]	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Experimental control	9.249[*]	1.056	.000	7.158	11.341
control experimental	-9.249[*]	1.056	.000	-11.341	-7.158

Based on estimated marginal means
*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

Table 4 above revealed significant differences in the academic achievement improvement of students' exposed to control group and those exposed to experimental group *(MD* = -9.249; Std. error = l.056; *p*=0.05) between those exposed to songs and conventional teaching (MZ) = 9.249; Std. error = 1.056; p <0.05). This implies that the treatments differ significantly in terms of their effectiveness on academic achievement in mathematics. The result is illustrated in Figure 1.
Estimated Marginal Means of post
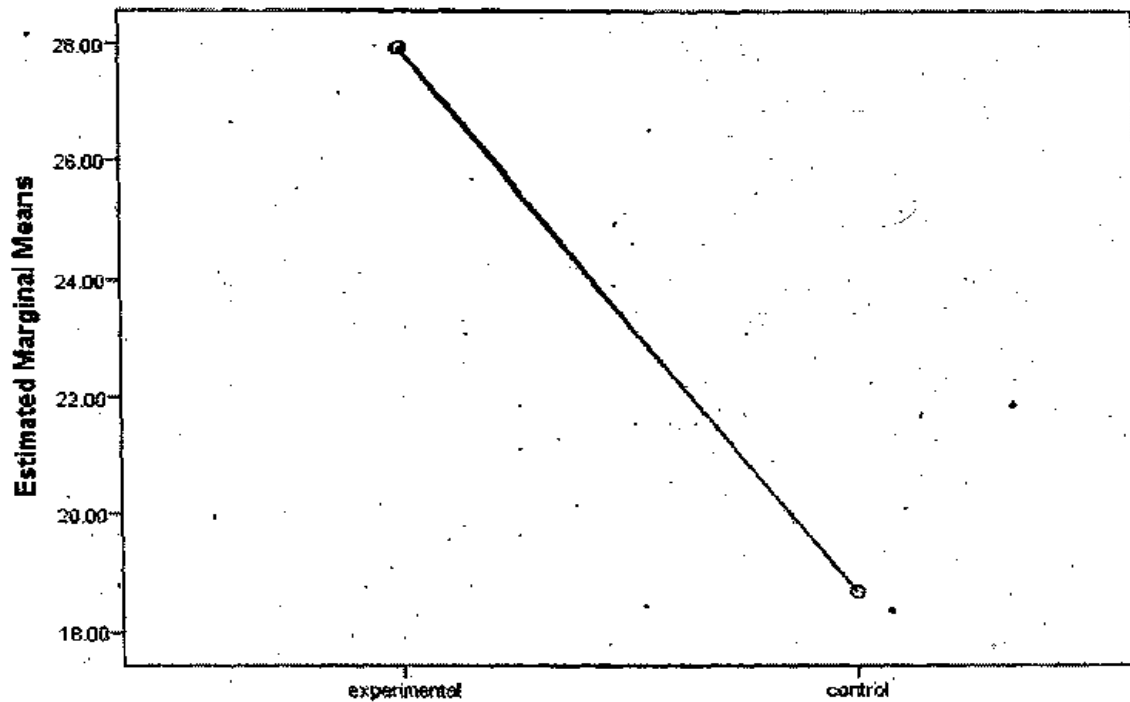
Treatments

Covariates appearing in the model are evaluated at the following values: pre-test = 18.1667

Figure 1: Estimated Marginal Means of Post-test

Figure1 indicated that participants in the control group had the lowest mean score (18.684) while those in the experimental group had the highest mean score (27.934). This implies that the treatment in the experimental group was the most effective from the point of view of increasing the academic achievement improvement in mathematics.

Hypothesis Two

There is no significant main effect of gender on students' academic achievement in mathematics.

Table 1 revealed no significant main effect of gender on the students' achievement scores in mathematics ($F_{1, 115}$= .036; p=.850). The result implied that the post-test mean achievement scores of male and female students exposed to the different instructional strategies are not significantly different. Therefore, the hypothesis is not rejected.

Hypothesis Three

There is no significant interaction effect of songs and gender on students' academic achievement in mathematics.

The results on table 1 revealed no significant interaction effect of songs and gender on students' academic achievement in mathematics ($F_{1, 115}$=.714; *p* =.400). Therefore, the hypothesis is not rejected.

Discussion of findings

The findings of the study revealed that there was significant main effect of songs on the academic achievement of students in mathematics. It was observed that all the two treatments are effective at causing achievement improvement in mathematics; they differ in terms of the strength of their effectiveness. Although the estimates of control and experimental treatment result in table 2 revealed that students' in experimental group had a mean score of 27.934 higher and a standard error of .643, than those in control group that had a mean score of 18.684 and standard error of .816 which means that the students taught with songs recorded a better mean score than those exposed to conventional teaching. Academic achievement can be influenced by many facts, Bach Vinyets (2013) affirmed that songs can be of great influence, they are good resource for teaching and learning. Medina (2002) confirmed that the major benefit of using songs is the plea-surable experience they bring to students and the calm mood they create in the class. The more comfortable the students are, the more receptive they are to learning. This finding proved the effectiveness of integrating songs into mathematics teaching over the conventional method holds true for Linder et al. (2011); Courey et al. (2012) and An and Tillman (2015) that all concluded that integration songs into

mathematics teaching will be of tremendous benefit to students' learning.

The result of the main effect of gender revealed no significant main effect of gender on the students' academic achievement in mathematics. The result implied that the post-test mean achievement scores of male and female students exposed to songs and conventional teaching are not significantly different; it means that male and female students did not differ significantly in their achievement to mathematics. This result was supported by Lawani et al. (2016) findings of no significant effect of treatment and gender in students' achievement in mathematics.

Further findings showed that there was no significant interaction effect of songs and gender on students' academic achievement in mathematics. Results of this study showed that integrating songs into mathematics teaching did not interact with gender in determining students' achievement in mathematics. This outcome implied that students' post-test mean achievement scores in mathematics after the usage of songs do not vary significantly between male and female students. Also as a single factor, gender did not contribute significantly to the difference in post-test mean scores of subjects, this implied that the effective use of songs was not associated with gender characteristics. Being a male or female does not determine achievement other factors could be responsible but not gender that is being a male or female does not make the students' a duller or flier which also corroborate nature and scientifically that there is no prove that male brain is superior to female. A female child is not inferior and they can perform as much as a male child.

RECOMMENDATIONS

Based on the findings, the following recommendations were made:

a. Teachers should be encouraged to adopt composed songs during teaching since its use sustains students' interest and retention is aided.

b. Government should equip schools with different equipment that can aid the use of songs in the classroom like the audio players, video players, projector, and so on in order to expose students to alternate ways of learning mathematics.

c. Mathematics teachers who have been trained on the use of songs should be encouraged to teach their colleagues in schools on how to adopt the method on how to use songs.

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Appendix. Some songs used for teaching mathematics

I am a line
We play to align
We both intersect which we most do,
And create an angle

Angles are distinct,
They come in numerous form
Also with distinct names
Including acute angle, right angle, obtuse angle
Ones that are attractive.
Anglers cannot angle, hence they cannot fish.

Nemo fish
And angels can't make you a wish or whistle...
Although angles are not angels, like circles and spheres,
They are useful when building, my love.
When bending your knees, angles are generated
That can be used for a variety of purposes.
Angles are all around us, and I believe I've discovered three angles
without which life would be circular.

Acute angles are less than 90^0 degrees in angle.
Obtuse angles exceed a 90°.
Sharp right angles measure a right angle at 90 degrees.
How do I know a reflex angle
What makes a reflex
Greater than 180^0
What makes a reflex
And lesser than 360^0
This is a reflex.