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An Investigation of the Impact of Non-Band Music on Six Graders' Mathematics Achievement

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This study seeks to explore the impact of non-band music on the academic achievement of 6th grade students. The conceptual framework bolstering this study is comprised of Maslow's Hierarchy of Needs, self-determination theory, multiple intelligence theory and brain research. This causal comparative study seeks to answer one research question; is there a difference between the academic achievements of 6th grade mathematics students based on non-band music participation status? The study was conducted using scores from the 2013-2014 administration of the Northwest Education Association's Measures of Academic Progress assessment. After removing cases for students who participated in band, remaining cases were sorted into two groups; scores for students who participated in non-band music and scores for students who did not. Group means were compared using a Mann Whitney U. The results from the Mann-Whitney U showed that the mean score for the group of students who participated in non-band music was higher.

Key words**:** non-band music, mathematics learning, engagement, motivation, academic achievement.

Music programs across the country are in danger, as resources are cut in order to allocate funding for reading and mathematics instruction (Henwood and Featherstone, 2013). However, this redistribution of funds has not translated into great gains for American children. In fact, when compared with students from other developed nations, students in the United States are not making progress (Wagner, 2008). This may be because the very programs that are being cut, are those that could increase achievement. For example, music may be a key factor in increasing mathematics achievement, and engagement, and this increased engagement may lead to higher levels of motivation (Spires, Lee, Turner and Johnson, 2008; Turner, Warzon, and Christensen, 2011). Zepke and Leach (2010) suggest that some ways to increase student engagement include: a) the creation of learning activities that are enriching and extend beyond the school environment; b) making sure that the culture of school institutions are welcoming to all students, regardless of background; and c) allowing students to grow their own social and cultural capital. The inclusion of music, as part of the middle school experience, not only affords students a way to connect and capitalize on cultural experiences, it may also inform the teaching and learning process, allowing students to increase their engagement in school (Zepke and Leach, 2010).

The engagement, motivation, and academic achievement cycle can be either positive or negative. For many students the cycle vacillates during the middle school years. However, for some students the cycle is either wholly positive or negative, and too many students in American schools are stuck in a negative rut. This article provides a synthesis of the literature surrounding the impact of music on mathematics achievement.

The intersection of music and mathematics is not a new area of study. However, the focus on non-band music participation as opposed to band serves to differentiate this research from that of others (Catterall, 2011; National Association for Music Education, 2007). This study focuses on non-band music participation in courses such as chorus, in order to explicate the impact of hearing and singing music, with our without the use of informal instruments. Additionally, the use of data from 6th grade, middle school students separates this study from those that focus on the impact of instrumental music participation at the high school level and those that study the impact of non-band music participation at the elementary school level (An, Ma, & Capraro, 2011; An & Tillman, 2015; Fauvel, Flood, & Wilson, 2006; Johnson & Edelson, 2003).

Conceptual Framework

The conceptual context for this study is bolstered by self-determination theory, multiple intelligence theory, and Maslow's Hierarchy of Needs. Together with brain research, these tenants provide a framework for hypothesis of the positive impact of non-band music participation on mathematics achievement (Allcock & Hulme, 2010; Deci & Ryan, 2008; Jang, 2008; Ryan & Deci, 2000). In addition, brain research, spearheaded by Covino (2002) supports the connection between participation in music and learning mathematics, and other higher-order thinking skills. The strong connection between music and mathematics achievement is supported by a conceptual framework bolstered by self-determination theory, multiple intelligence theory, and brain research (Covino, 2002; Deci & Ryan, 2008; Gardner, 1983; Maslow, 1948; Shaw, 2002). Further, music is beneficial in creating a positive engagement, motivation, and academic achievement cycle by increasing motivation (Dogan-Temur, 2007; Jang, 2008; Zepke & Leach, 2010). This study is important as it seeks to fill a gap in the literature represented by the lack of focused research on the impact of non-band music participation on mathematics achievement, at the middle-school level. Current research on the impact of music participation is largely centered on the study of instrumental music instruction at the high school level, and the use of music to teach isolated mathematics lessons about patterns and fractions at the elementary level (An, Ma, & Capraro, 2009; Fauvel, Flood, & Wilson, 2006; Johnson & Edelson, 2003).

Self-Determination Theory

The theory of self-determination is multi-faceted. According to Deci & Ryan (2008), self-determination theory "addresses such basic issues as personality development, self-regulation, universal psychological needs, life goals and aspirations, energy and vitality, non-conscious processes, [and] the relations of culture to motivation" (p.182). Self-determination theory is integral, in understanding the engagement, motivation, academic achievement cycle. This theory supports the postulate that the process of increasing self-determination is two-fold, as environmental and social supports promote student motivated, positive behaviors and engagement in learning (Deci, Vallerand, Pelletier, & Ryan, 1991).

School based educators and educational policy makers have an expressed interest in ensuring that all students have the motivation necessary, to drive high levels of academic achievement (Baker, 2012). However, ensuring that motivation is present for all, is an arduous task. This is because, creating an environment where every student feels supported means that the environment must be differentiated, taking into account the intelligences, learning strengths, and culture of each and every child (Gay, 2010). Research shows that the self-determination of a student is linked to his or her feeling respected as a learner (Allcock & Hulme, 2010; Jang, 2008). Hence, it is important to study the impact of teaching and learning in a manner proven to activate learners preferred learning styles, as this type of education is necessary in order to garner increases in student engagement, motivation, and academic achievement (Allcock & Hulme, 2010; Jang, 2008; Johnson & Edelson, 2003).

Multiple Intelligence Theory

In order to help students feel supported, the individual learning styles of students should be an integral part of the planning and implementation process for teaching and other educational personnel (Caruthers, 2009; Deci & Ryan, 2008). This means that curricular activities can and will vary as every learner should be seen as an individual. As such, the background, learning tendencies, and unique areas of intelligence must be considered. Gardner (1983) notes that one of the many ways teachers can think about groups of students, in order to provide better instruction is to identify and then teach to and through different intelligences. The theory of multiple intelligences is a powerful one, because it posits that all students are intelligent, and part of teaching is tapping into identified intelligences amongst different learners. These differing intelligences include linguistic, musical, logical, mathematical, spatial, bodily-kinesthetic, interpersonal, intrapersonal, existential, and naturalistic (An, Ma, & Capraro, 2009; Gardner, 1983).

Gardner's (1983) Theory of Multiple Intelligence supports the idea that participation in non-band music is valuable, and that it may have a positive impact on the mathematics achievement of 6th grade students. Gardner (1996) describes intelligence as "the ability to solve problems, or to fashion products, that are valued in one or more cultural or community settings" (p. 7). This idea is directly related to Deci and Ryan's (2008) theory of self-determination and Maslow's (1963) Hierarchy of Needs. It also suggest that intelligence, and therefore education, transcends reading, mathematics, and that which is measured by a standard Intelligence Quotient (IQ) test. Just as the IQ test is a tool for measuring two modes of intelligence, many school systems teach to a limited number of intelligences. Consequently, many students are not learning (Wagner, 2010).

Gardner's (1983) inclusion of musical intelligence, as a viable category of intellect, has been used as a basis for the study of music's impact on mathematics. At the elementary school level De Vries (2010) and Hallam (2010) examined the impact of music education on academic performance. Further, the teaching and learning of certain mathematical concepts has been examined at the high school level (Cox & Stephens, 2006; Fitzpatrick, 2006; Kinney, 2008; Major, 2013). Through these studies and others, attention to multiple intelligences has been shown to boost student motivation, leading to increased engagement, and therefore positively impacting student achievement (Jang, 2008; Johnson & Edelson, 2003).

Maslow's Hierarchy of Needs

The needs of individuals are many, but according to Maslow (1948) there is an intrinsic manner for sorting and attending to needs. Maslow's (1948) theory, states that individuals attend to their needs starting with the most basic. For many students, especially those in middle school, learning does not top their list of needs. To add credence to this notion, Chapman (2013) posits that "middle school students who struggle with poverty or live in areas with safety concerns often struggle to have the basic levels sufficiently met and are therefore unable to progress to the self-actualization or self-transcendence levels" (p. 21). Because instruments cost money, and practices are often before and after school, many times the aforementioned students are not able to participate in band. However, this does not hold true, when it comes to non-band music, as students who have a low socioeconomic status participate in non-band music at a higher rate than those of higher socioeconomic status (Venter & Venter, 2010).

The inability to have basic needs met has an impact on the engagement, motivation, and academic achievement cycle. Chapman (2013) highlights Maslow's Hierarchy of Needs, and the fact that the theory explains "personal motivation and the need to have basic needs met before being able to progress to higher levels of motivation" (Maslow, 1948; Sadri & Bowen, 2011; p.20). This is an assertion that educational leaders and policy makers must understand, as they are charged with having the necessary programs in place to support the positive fulfillment of needs, allowing students, teachers, and other instructional personnel to assess which needs are not being met (Juliano & Sofield, 2011).

Brain Research

Brain research can be used as a bolster for those who posit that music may work to strengthen mathematics achievement, as there is significant scientific exploration of the connection between the two (Covino, 2003; Hallam, 2010; Helmrich, 2010; & Shaw, 2003). Johnson and Edelson (2003) assert that because music heightens temporal-spatial reasoning, it is useful in providing support for the learning of mathematics concepts like geometry and proportional reasoning. Further, Helmrich (2010) writes about the prefrontal cortex and parietal lobe of the brain, explaining that both music and mathematics engage these regions. The fact that music uses these parts of the brain, means that it can strengthen the areas, and is therefore helpful to adolescents and children who are attempting to comprehend mathematics. The work of Hallam (2010) supports that of Helmrich (2010) as it suggests that when people interact with music in an extensive and active manner, they may experience cortical reorganization; meaning that interaction with music may actually cause a functional change in how the brain receives, transmits, and processes both musical and mathematic information. The research of Helmrich (2010) and Hallam (2010) is particularly important when one ponders the question of what to do for the many students who struggle to grasp mathematics on a conceptual level.

Ellison (2001) asserts that as students learn, they are forming synaptic connections. “In this forming of synaptic connections, students, who are involved in music, form more synapses between brain cells. As these synapses develop, the capacity of the brain to retain information is increased” (Boyd, 2013 p. 34). Interaction with music may also prevent or curtail the process of synaptic pruning. Burriss and Strickland (2001) posit that people go through the first stage of synaptic pruning early in life, with some synapses dying by the age of three. It is thought that after the initial pruning, only about half of the synapses remaining will continue firing through adulthood, and that the brain will continue to prune them. Music may serve as a guide during times of synaptic pruning, helping to ensure that the correct synapses are eliminated, and the proper synapses remain active.

Brain research supports another connection between music and mathematics. Music also impacts the process of synaptogenesis (Burriss & Strickland, 2001). While the brain is always forming new connections, the period between the ages of 10 and 12 is a time of particularly strong growth. During this time there is a surge of synapse formation called synaptogenesis. This period of growth is followed by synaptic pruning, and after the two periods of synaptic change, the result is a brain where weak neural pathways are eliminated, pathways that are regularly used are strengthened (Helmrich, 2010).

Music and mathematics are both processed in the same parts of the brain. Both disciplines use the prefrontal cortex and parietal lobe. Hence, music can help to ensure that the synapses needed for critical thinking, and mathematics are not purged during times of synaptic pruning (Helmrich, 2010). The work of Covino (2002) is essential in understanding how music and math are linked through brain research. The Covino (2002) study found that when students engaged in choral or instrumental music, all major regions of the brain were stimulated. Further there was increased usage in the brain region linked to emotion and recall pathways.

Music also has the ability to increase the brain's capacity to reason. This aids in the development of motor skills, memory, and movement (Covino, 2002; Shaw, 2002). The corpus callosum is the section of the brain that bridges the right and left hemispheres. Covino (2002) asserts that increased blood flow and development of this area, may be the cause of heightened levels of processing ability. This notion is supported by Cox and Stephens (2006) as their research also highlights a connection between students who participate in organized music, and those who have an enlarged corpus callosum region.

Methods

A causal comparative research design was used to collect and analyze quantitative data. This design was chosen because the interaction between the independent variable of participation in non-band music class, and the dependent variable of mathematics achievement had already occurred. Additionally, a non-experimental research design was used because experimentation was not desirable, as potential harm to students did not outweigh the implicit risks (Creswell, 2013; Gall, Gall, & Borg, 2007). For the purposes of this research, ex-post facto, archival data from the 2013-2014 administration of the NWEA mathematics MAP were used; hence, permission to conduct a study was garnered from the Central Virginia County where the students attend public school, rather than individual students and guardians.

Setting and Participants

The population for this study was identified by the researcher through the use of convenience sampling. The available sample proved sufficient, as it is recommended that substantive ex-post facto, causal comparative research have sample sizes of at least thirty per subgroup (Creswell, 2013). NWEA mathematics MAP scores for 765 of the 957 6^{th} grade students, in the central Virginia County where the data were collected, were used for the study. This represents approximately 60% of the total 6th grade population, as some student cases were omitted based on missing fall or spring mathematics MAP scores, mathematics course placement, and school placement.

The participants in the study attended grade 6 during the 2013-2014 school year, in a Central Virginia, public school district where there are three possible mathematics course placements for 6^{th} grade students; standard, advanced, and honors. Students who take standard level mathematics study the sixth grade material, as outlined by the Virginia Standards of Learning. Students who take advanced level mathematics study all sixth and some seventh grade material, while students in the honors level mathematics classes study all sixth, seventh, and eighth grade material; in order to enroll in Algebra in grade seven. For the purposes of this study, cases for honors-level mathematics students were excluded, as these students tend to have a high propensity for mathematics, and therefore the potential to skew achievement scores. The omission of this subgroup of students helps to control the extraneous variable of mathematics aptitude across the sample.

Students who were enrolled in the standard and advanced level 6^{th} grade, mathematics classes were further divided into three groups: a) students who were enrolled in one or more semesters of band, b) students who were enrolled in one or more semester of choral music class, and c) students who did not participate in music class. For the purposes of this study, cases for students who participated in band classes were excluded. The researcher omitted scores or this group of students because a nationwide analysis of research, conducted by Elpus (2013) suggests that students in band outperform their same grade peers, as a result of selection bias.

The ex-post facto data from the study were obtained from students in one Central Virginia County. Within the county, there are six middle schools. For the purposes of this study, the middle schools will be identified as: MSA, MSB, MSC, MSD, MSE, and MSF. Data for students who attended MSF were not included in the study, as students from this middle school do not have the option of taking band or non-band music, as the arts infused, charter school does not offer elective courses. In addition, cases for students who attended MSE were not included, in order to avoid a conflict of interest on the part of the researcher. Scores for all other 6^{th} graders were included in the study, without discrimination on the basis of gender, race, ethnicity, English proficiency, socio-economic status, or participation in Special Education or gifted programs.

Instrument

To assess mathematics achievement, the researcher used data collected using the Northwest Education Association’s (NWEA) Measures of Academic Progress (MAP) test. The nationally normed test is used to measure academic progress in the areas of mathematics, writing, reading, language and usage, and science (Cronin, Dhalin, Durant, & Xiang, 2010). The MAP test allows teachers and other education professionals to gather a wealth of information about student achievement, and is widely accepted as a valid and reliable measure of growth. The test can be used to measure and report of several subsets within the mathematics discipline including: a) number sense/ number systems b) estimation and computation c) algebra d) geometry e) measurement f) statistics and probability and g) problem solving, reasoning, and proofs (NWEA, 2012). Academic achievement on the MAP test is measured on a RIT scale. It is important to note that like ruler units, the scale is divided into intervals – called Rasch Units (RIT) – which are independent of grade level. In 2012 the NWEA published RIT norms for each subject area.

The mathematics Map test is considered a reliable instrument. Using the Test-Retest model, the reliability at the grade six level has remained stable since 1999, ranging from .91-.93. When a Marginal Model is used, reliability is higher, at the .94-.95 level. Further, test of validity show a .759 correlation between the NWEA Mathematics MAP and the Virginia Standards of Learning, the end of course test used in the state of Virginia. The researcher did not collect the data on the organized participation of music outside of the school setting such as private lessons or church or community choirs, and acknowledges this limitation.

Data Collection and Analysis

The research for this study was ex-post facto in nature. Therefore, only approval from the university and county institutional review boards were required to begin the data collection procedures. NWEA - MAP scores from the spring and fall 2013-2014 administrations were released to the researcher. Cases were coded with additional information including: a) student gender, b) music participation status, and c) mathematics course placement. In an effort to further protect the privacy of students, and individual schools, no student names or other potential identifiers were attached to the data. The researcher was provided with the data as a PSPP file, that was subsequently uploaded to SPSS statistics software (version 22), in preparation for analysis.

In order to determine if students' academic progress differed based on whether or not they participated in non-band music, a causal comparative research design was used. To begin the data examination process, the researcher constructed and investigated frequency polygons. Next, SPSS version 22 was used to create a set of descriptive statistics for each group. Subsequently a *Mann Whitney U* test was used to compare the mean rank scores for each group, as the dependent variable was continuous, but abnormally distributed. A Mann-Whitney U Test, instead of a t-test was used to compare differences since the dependent variable was ordinal but not normally distributed. Additionally, even though the t-test is considered robust, a Mann-Whitney U was chosen for this research as the differences in group sizes were greater than 1.5, when comparing smaller to larger. To determine effect size, the difference between the group of students who participated in non-band music and the group of students who did not was divided by the standard deviation of the group of students who did not participate in non-band music class, using alpha level >.05 (Gall, Gall, and Borg, 2007). In order to test the predictor variable mean ranks of the NWEA- MAP scores for each group were examined.

Results

This study employed an ex-post facto causal comparative design, which used NWEA mathematics MAP scores for students who participated in non-band music class and those who did not. As it was the most updated version available, IBM SPSS version 22 was used for all data analysis.

Null Hypothesis

The null hypothesis for this study states: There is no difference between the mathematics achievement of 6th grade mathematics students who participate in non-band music class and those who do not, as measured by the Northwest Evaluation Association’s (2011) Mathematics Measures of Academic Progress (MAP) assessment. This hypothesis focuses on the overall scores of the group of students who participated in non-band music class and those who did not, by comparing the NWEA mathematics MAP test data between the two groups.

The groups were considered statistically separate, and with the exception of one score, did not contain any outliers, as shown in Figure 1.

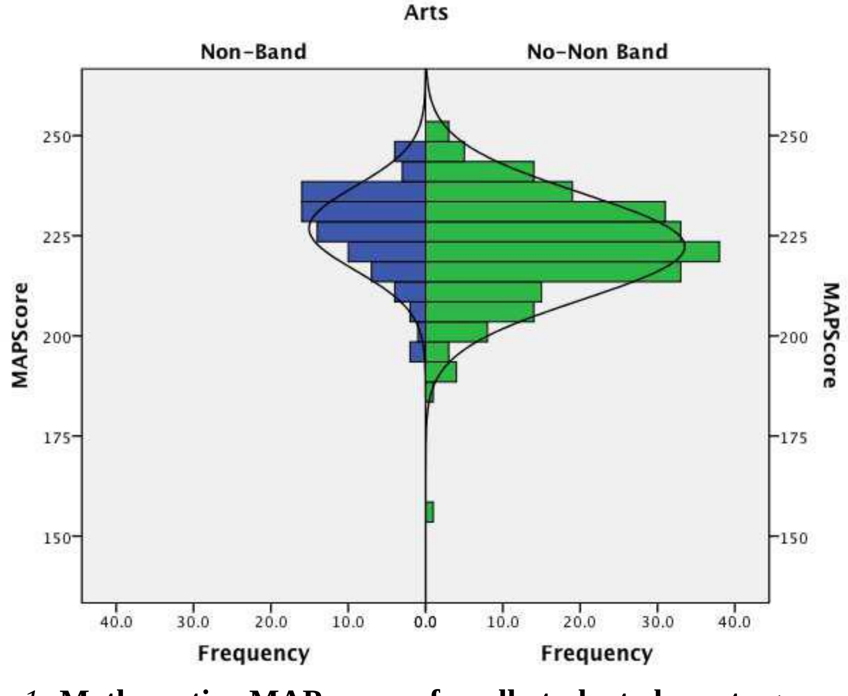

Figure 1. **Mathematics MAP scores for all students by arts group (non-band and no non-band).**

A *Mann-Whitney U* test was conducted in order to examine whether or not there were differences in NWEA mathematics MAP scores, based on participation in non-band music. A visual inspection of histograms revealed that distributions of scores for each group were similar. MAP scores for the group of students who participated in non-band music (mean rank = 176.01) and the group of students who did not participate in non-band music (mean rank = 142.10) were different, U = 6,793.5, z = -2.927, p = .003. The group of students who participated in non-band music had a higher mean rank and a higher median score (228) than the group of students who did not participate in non-band music class (median =222). It is vital to note that the p-value of .003 suggests a very low probability of falsely rejecting the null hypothesis. Figure 2 displays the results of the Mann-Whitney U Test on the NWEA Mathematics Map scores for both the group of students who participated in non-band music and the group of students who did not. Based on the results of the *Mann Whitney U* test, the researcher was able to reject the null hypothesis.

Discussion

The Elementary and Secondary Education Act (2010), also known as No Child Left Behind (NCLB) was drafted and passed, in order to address academic achievement concerns across the nation. However the legislation has divided the country. One major point of contention is the manner in which the law outlines a focus on the achievement of all students, in the core content areas, with an intense focus on improving the mathematics and reading skills of children across the nation (NCLB; U.S. Department of Education [USDOE], 2010). Despite the good intentions behind the law, and the hard work of educators across the country, mathematics achievement continues to be an area of weakness in the United States (Wagner, 2008). While no one is certain what is causing American students to stagnate, it is apparent that the No Child Left Behind (NCLB) legislation is not helping to bring America’s children up to the level of their peers from other developed countries (Wagner, 2008). More recently, the Race to the Top Program was enacted by the Obama administration. This program has worked to change the educational landscape at local and state levels alike, with localities opting for more charter schools and more stringent teacher evaluations in order to ensure that learning is occurring (McGuinn, 2011). However, Henwood and Featherstone (2013) purport that the No Child Left Behind (2010) legislation and laws like it, fall short because of the way in which it causes educators to hyper-focus on reading and mathematics. The argument is that this type of focus inherently devalues arts, history, science, and music.

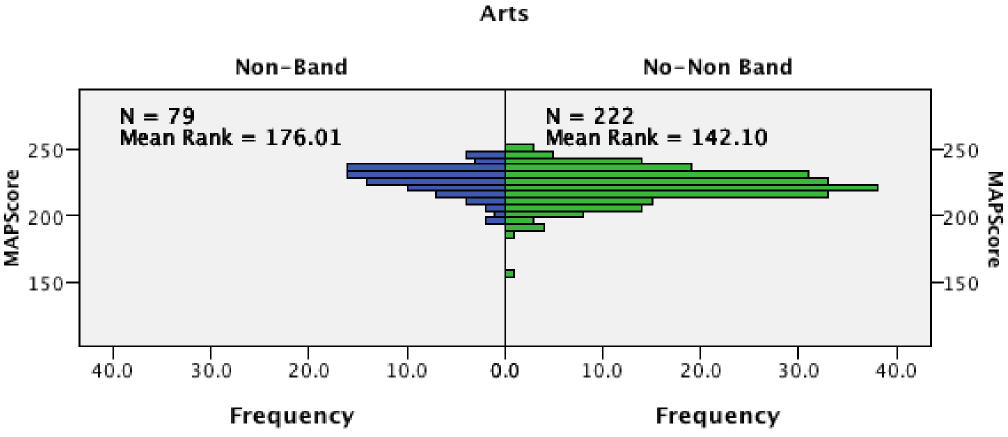

Figure 2. **Independent samples *Mann-Whitney U* Test results for the group of students who participated in non-band music class and the group of students who did not.**

Theoretical Practices for Academic Performance

Motivation, academic achievement, and engagement work together, each impacting the others (Deci and Ryan, 2008). This idea is especially salient, when one considers the middle school years. Mora (2011) suggests that it is during these years that students build their identities. One of the ways in which identity is cultivated is through the act of collaboration (Spires *et al.* 2008). To add to this notion, Turner, Warzon, and Christensen (2011) suggest that it is through acts of collaboration that students fulfill their need for belongingness. Music can serve as a vehicle for collaboration, allowing middle school students to build their identity as an individual, and become part of the whole.

Unlike much of the current research, this study asserts that the connection between music, belongingness, and motivation is not confined to band. Rather this connection extends to participation in non-band music class (Deci and Ryan, 2008; Gardner, 1983). For teachers of mathematics, this is an important point, as the non-band music class experience is easy to create. It is important to note that Spires *et al.* (2008) is clear that each student is an individual, and that the school should be adaptable, in order for individuals to learn. Hence, while the group of students who participated in non-band music scored higher than the group of students who did not, in this particular study; music should not be seen as a tool for reaching every student. However, the study does suggest that incorporating choral music into the mathematics classroom, and the overall school experience may be beneficial.

Tackling Boredom

Students in middle schools all across the United States report that school is boring (Mora, 2011). The frequency of this feeling amongst those in middle school, suggest that boredom is not an anomaly, rather it has become part of the middle school experience. Music can be a reliable tool for combating rampant boredom, leading to the cessation of the cycle of low motivation and achievement (Gorey, 2009; and Spires *et al.* 2008).

Middle school does not have to be boring. However, it is acknowledged that its structure tends to create a mundane environment. When students enter middle school, reading, writing, and mathematics requirements become heavy, as teachers attempt to ready students for high school. This means that engagement is often cut in the name of learning (Mora, 2011). Still, middle schools do not have to make a decision to be engaging and motivating, or to have student reach high levels of academic achievement. Rather, when run correctly, middle schools provide an educational experience that encompasses all three (Donner and Shockley, 2010). This will occur when teachers, and other instructional personnel learn to instruct in a manner that meets the needs of their students. When this happens engagement, motivation, and academic achievement will follow. (Gorey, 2009; Spires *et al.* 2008).

Culturally Responsive Educators

This research supports the body of work that shows the benefit of culturally responsive teaching practices. When students are taught in a culturally responsive manner, the result is often a positive engagement, motivation, and academic achievement cycle (Parker, 2010; Sparrow and Hurst, 2010; Spires et. al, 2010). The converse is also true. When students do not feel as if they have a cultural connection to the teaching and learning process, this leads to low levels and motivation and engagement and academic achievement suffers (Parker, 2010).

Culture is a very import construct, comprised of a variety of characteristics. Culture starts to make it place in the educational environment during the earliest of school experiences (Colbert, 2010). The characteristics of culture include, but are not limited to: a) race, b) ethnicity, c) gender, d) communication, e) language, f)appearance; g) age groups, h) level of mental processing, i) social status, and j) learning tendencies. (Colbert, 2010). Because personal culture is constructed of such a myriad of traits, each student should be seen as an individual. The existence of a diverse, rich cadre of elective classes can aid in creating a cohesive, welcoming learning environment for all (Rickard, Vasquez, Murphy, Gill, & Touksati, 2011; Sparrow and Hurst, 2010).

Conclusion

NWEA mathematics MAP scores for the group of students who participated in non-band music class (mean rank = 176.01) and the group of students who did not participate in non-band music class (mean rank = 142.10) were dissimilar, $U = 6,793.5$, $z = -2.927$, $p = .003$. The group of students who participated in non-band music had both a higher mean rank and a higher median score (228) than the group of students who did not participate (median =222). These results are statistically robust ($p < .05$). The findings of this study support the claim that 6th grade, mathematics students, in a Central Virginia school division, who participated in non-band music performed better on the NWEA MAP test, than their same grade peers who did not participate. If the participants in this study represent the larger population, the findings carry great value.

The United States economy is facing a difficult fiscal period. This coupled with the indirect inclusion of arts in federal education legislation has led to peril and dismantling of music programs around the nation (NCLB; U.S. Department of Education [USDOE], 2010). Music programs are being replaced with curricula that are thought to have a more direct impact on student reading and mathematics skills (Marshall, 2014). However, this has not closed the gap that American children face when compared to their peers from other developed countries (Wagner, 2008). This study and other research suggests that the loss of music and other arts programs may be harmful to students and the educational process, as music can act as a motivating factor to increase engagement, motivation, and academic achievement (Parker, 2010; Spires et al, 2008).

One proposed solution to the problem of waning student achievement is working to increase student engagement and motivation through the arts. More specifically, music can be used as a motivator, while aiding in the critical thinking processes that are involved in mathematics (An *et al.*, 2011; Hallam, 2010; Helmrich, 2010; Legg, 2009; Southgate & Roscigno, 2009). While the aforementioned proposition is fully supported by Maslow's Hierarchy of Needs, the theory of self-determination, multiple intelligence theory, and brain research; educational theory does not directly correlate to educational practice (Covino, 2002; Deci and Ryan, 2008; Gardner, 1983; Maslow, 1948; Shaw, 2002). This is evidenced by the fact that Shilling (2003) states that music is a learning tool that every child has in her or his tool belt; however, it is a tool that goes largely unused by educators. Music is used as a teaching method at the elementary school level, but this practice is all but abandoned in middle school. In fact, students who attend secondary schools are rarely afforded the opportunity to use music to learn (Hallam, 2010; Helmrich, 2010). Shilling (2003) asserts that it is not the implicit connection between music and math that spurs student to glean information, rather it is the enchanting power of music that leads to engagement. The current research study adds to the work of Shilling (2003) in suggesting that participation in music leads to engagement and increased levels of mathematics achievement.

During the middle school years students are actively working to build identity (Mora, 2011), this, coupled with instructional practices that the students cannot connect with, make for a middle school experience mired by boredom. This research posits that music can be used as an educational tool to motivate students from the inside out, by using music as a tool to make connections and to create a context for learning (Covino, 2002). This power to motivate leads to increased levels of engagement, and higher levels of academic achievement (Parker, 2010; Spires *et.al*, 2008).

This quantitative study investigates the impact of non-band music participation on the mathematics achievement of 6th grade students. Self-determination theory, multiple intelligence theory, Maslow's Hierarchy of Needs, and brain research provide a conceptual framework for the interpretation of the findings (Covino, 2002; Deci and Ryan, 2008; Gardner, 1983; Maslow, 1948; Shaw, 2002). This research is important as it addresses a gap in the literature, characterized by an absence of information on the impact of music at the middle school level, and the implicit impact of non-band music participation upon student achievement.

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