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Mathematics and Music: A Search for Correlation

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Running Head: MATHEMATICS AND MUSIC

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Abstract

Several studies have been conducted, which have shown connections between content in music and mathematics. Concepts such as fractions, ratios, etc. are mathematical concepts that also can be found or expressed through music. Although these connections have been made, they primarily address connections within the subject matter of music and math. This study attempts to find a correlation between a high school student participating in a school sponsored music program and receiving a higher average math grade. In the study, two school districts provided anonymous student math score data, while also showing which students participated in a music program. From the received data, I determined averages for each math class, standard deviations for each class, maximum and minimum scores, and combined math averages for the two schools.

Based on the data received from Louisville High School and Waterloo High School, it was found that there is a correlation between a student participating in a music program and receiving a higher average math score. Limitations of the study included the sample size, whether the music students achieved higher in all subjects, as well as not being able to determine *why* the music students achieved higher than the non-music students.

Introduction

The idea of patterns can be seen woven into each of our daily lives. Many of the subjects of study that are offered are put into place with the goal of teaching people to recognize these patterns in our world. In an English class, the goal may be to have students recognize patterns of verbal and written language, such as voice inflections for questions vs. comments or where to place the subject and predicate in a sentence. In a science classroom, the teacher may engage the students in viewing environmental patterns, such as the water cycle or how elements bond to one another to create molecules. Although so many of our school subjects focus on the patterns that we find in each of the subjects, it is rare that a classroom, A, will use patterns talked about in a classroom, B, to help students to recognize and understand the patterns that exist in the subject of classroom A. However, many commonalities exist between subjects, in syntax, symbols, strategies, and general concepts. My goal behind the research and surveys highlighted in this paper is to draw correlations between the patterns learned in music and math and showing whether or not the additional practice of musical patterns improves mathematics scores.

Other tests have been used to show correlations between teaching some musical and mathematical concepts, such as fractions. In Jones and Pearson's (2013) article, "Music: Highly Engaged Students Connect Music to Math", the time signature, $\frac{4}{4}$, was used to connect music with math by having students show how many $\frac{1}{4}$ notes would be in one measure. Since $\frac{1}{4}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}=\frac{4}{4}$, the students could see that four quarter notes would be in one measure. At the same time, this was used to reinforce the students' ability to add fractions. Another portion of the activity was that the students would be given part of a measure such as two quarter notes, and had to determine the length of the last note of the measure, the length of the note that would

make the total counts of the measure be $\frac{4}{4}$. This was used to help the students practice their subtraction of fractions because they would first have to add the two quarter notes, $\frac{1}{4}+\frac{1}{4}=\frac{1}{2}$ and then subtract that from $\frac{4}{4}$ to determine the length of note that was left. Since fractions are such a large, reoccurring topic in mathematics, giving the students the extra practice with dividing a measure into fractional pieces allows the students the extra fraction addition practice that may cause them to succeed in future math courses.

Another reinforcement of the benefits of learning music to help learn math is found in Jeanne Bamberger and Andrea DiSessa's 2003 paper, titled, "Music as embodied Mathematics: A study of a mutually informing affinity". In this paper, the authors state that although it "may seem unremarkable that the principal mathematics that college students spontaneously put to work involved ratio, proportion, fractions, and common multiples", that these same concepts "are found to be most problematic for middle school children." It would follow from these observations that integrating the connections found between the subjects of music and mathematics could be the support that many middle school students need to recognize and understand the mathematical concepts of fractions, common multiples, proportions, and ratios. Other studies, such as Gaab and Zuk's 2017 article, "Is There a Link between Music and Math?", discuss the observance of higher math grades and standardized test scores found in music students, compared to non-music students. Although these studies find connections between mathematics and music, finding whether math causes achievement in music or vice versa appears to be elusive and highly debated.

Although the data collected for this paper does not specifically look for classrooms where connections between music and math are being pointed out to the students, it does try to answer

whether the students may be making those connections on their own. If the students are making the connections between music and math, the students who are involved in a music program will likely have higher math grades, on average, since many of the high school students who are in a music program were also involved in that music program throughout middle school, when many of these foundational mathematical concepts were being introduced.

Method

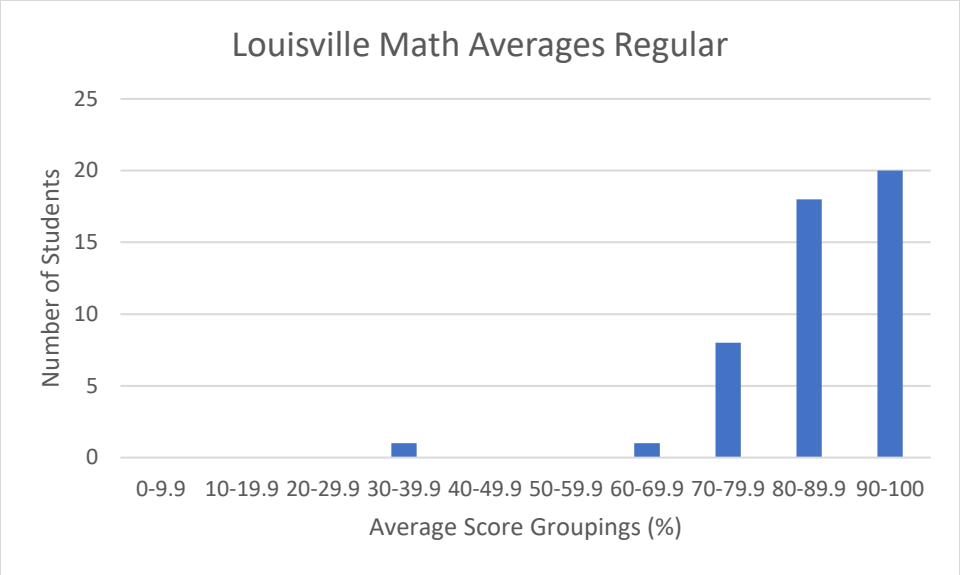
To determine if mathematics scores and musical participation have a correlation, I asked principals at high schools to send me reports of their ninth through twelfth grade math classes for a 9-week period, circling the grades of the students who are in band and/or choir. The data that was sent to me left the students anonymous, not giving the name, race, sex, etc. of any of the students. This allowed for a completely unbiased observation of the grades, only being given a student's grade and an indication of whether the student was involved in a music program at the school. Although over 8 districts were contacted in the Northeast Ohio area, Waterloo High School and Louisville High School were the two districts that contributed student data to the study. From these 9-week averages, I could calculate out an average percentage grade for the students who are involved in band or choir, and an average percentage grade for the students who are not involved in a school-sponsored music program. I also calculated the standard deviation of each of these groups, found each of the group's minimum score and maximum score, and created charts to show the number of students that were present in each of the percentage groupings (0-9.9%, 10-19.9%, etc.). Based on these calculated averages, I was able to compare the average of all the "music students" to the average of all the "non-music students". From these averages, I could generalize weather or not students involved in a school-sponsored

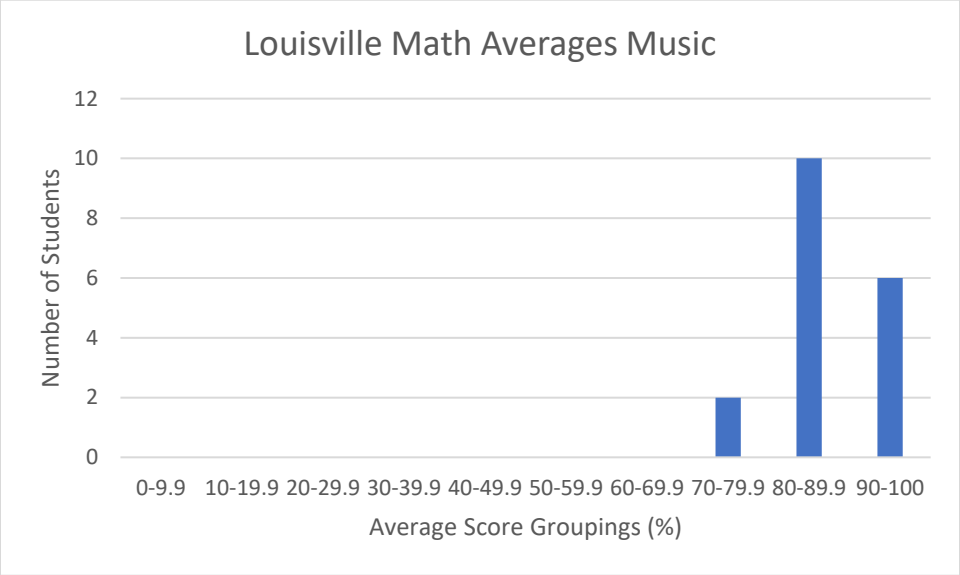
music programs achieve higher in math classes than their peers who are not involved in school-sponsored music programs. Although the determination of correlation for this study will primarily be based upon the overall math averages between music and non-music students, patterns relating to standard deviations among the groups and minimums and maximums will also be discussed.

Results

The data that was collected from Louisville High School consisted of three math courses: Algebra 1, Algebra 2, and Statistics. The sample size of the regular students from Louisville was 48 students and the sample size of the "music" students was 18 across the three math courses. Waterloo data consisted of seven math courses: Transitional Math, Algebra 1, Geometry, Algebra 2, Advanced Math, College Algebra, and Calculus. The sample size of regular students across these seven courses was 257 students and the sample size of the "music" students was 36 students.

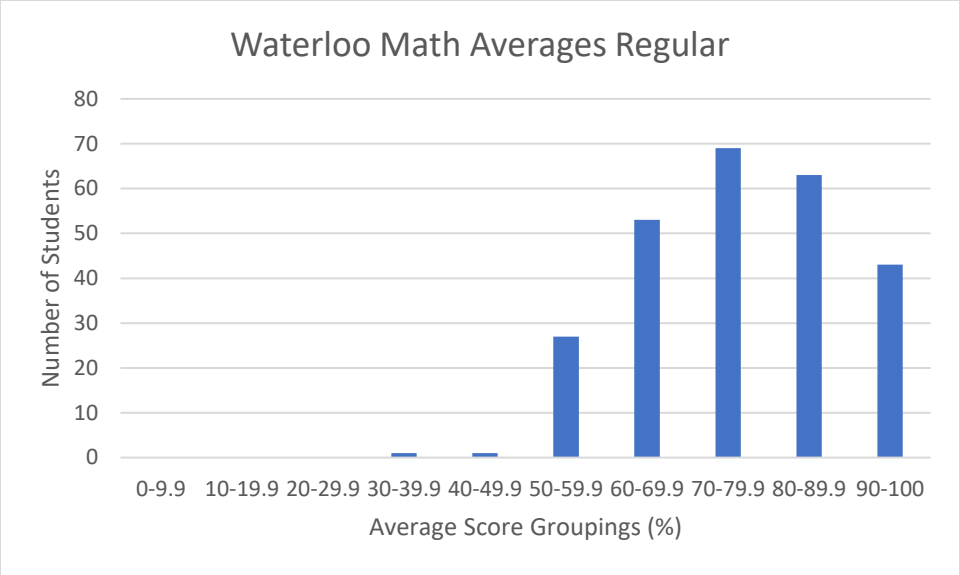
Louisville High School's average for Algebra 1 was 87.00% for the non-music students and had a standard deviation of 6.31%. The music students in Algebra 1 at Louisville High School had an average of 85.80% and had a standard deviation of 4.85%. For the Louisville Algebra 2 class, the non-music students had an average of 81.69% and a standard deviation of 14.27%. The music students in Algebra 2 at Louisville High School had an average of 87.31% and had a standard deviation of 7.28%. In statistics, non-music students had an average of 92.37% and had a standard deviation of 9.63%. The music students in statistics had an average of 85.03% and had a standard deviation of 2.69%.

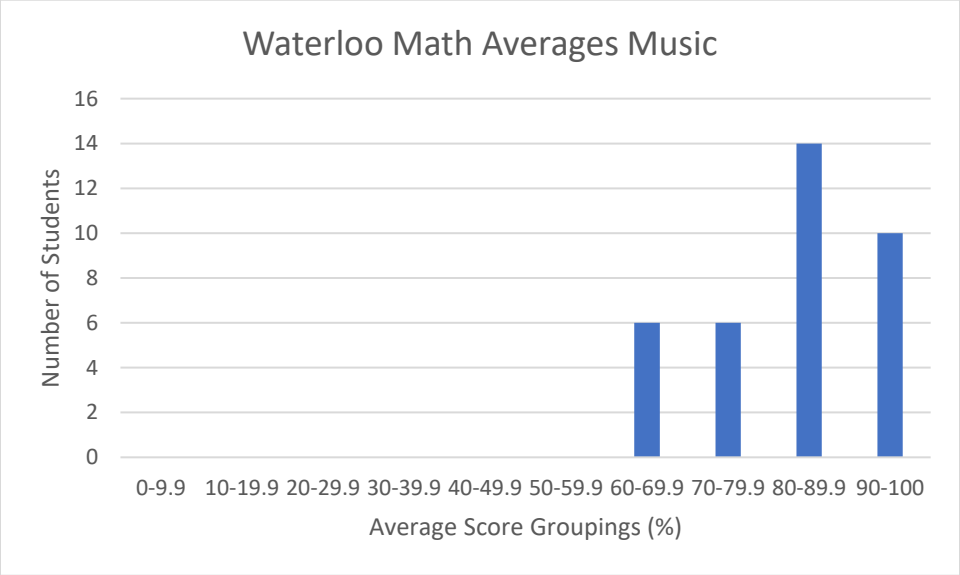




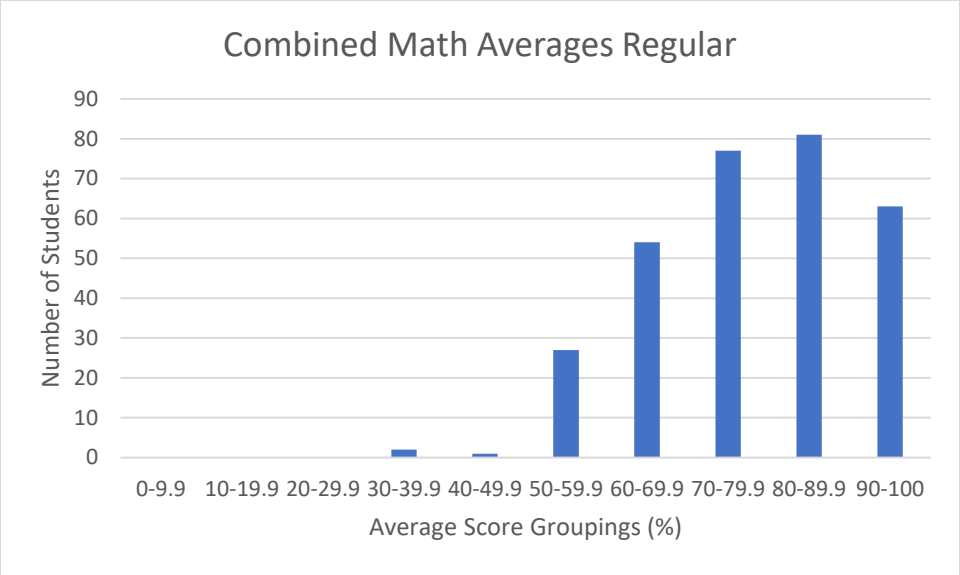
The data from Louisville High School showed that the average grade for the regular students in math was an 87.02% and had a standard deviation of 11.88%. The minimum score was a 31.29% and the maximum was a 100%. Meanwhile, the students from Louisville High School who were in a music program had an average grade of an 86.13% and had a standard deviation of 5.08%. The minimum score was a 76.02% and the maximum was a 95.03%.

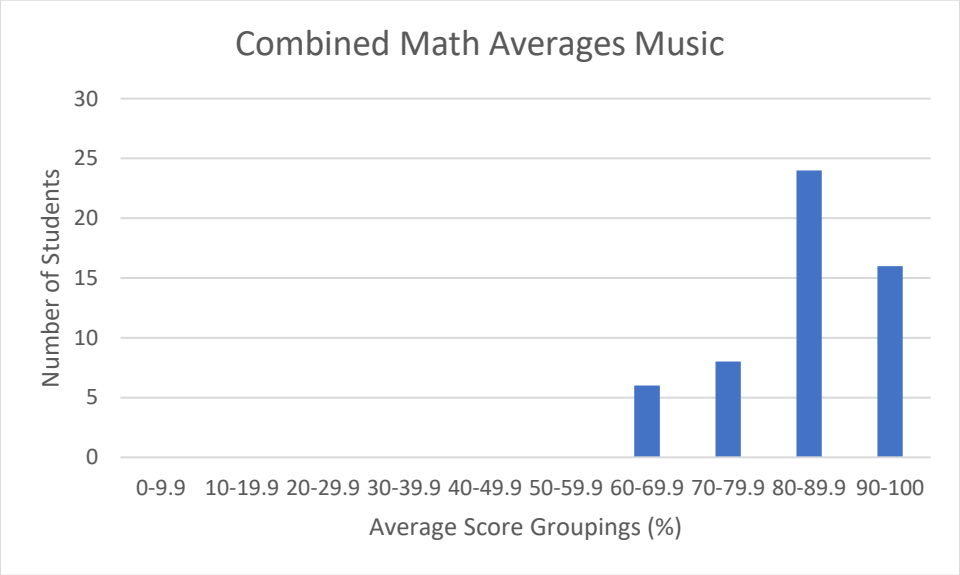
Waterloo High School's average for non-music students in Transitional Math was 71.23% and had a standard deviation of 11.31%. There were no reported music students in Waterloo's Transitional Math course. For the Waterloo Algebra 1 class, the non-music students had an average of 78.86% and had a standard deviation of 11.96%. The music students in Algebra 1 had an average of 80.27% and had a standard deviation of 7.49%. For the Waterloo Geometry class, the non-music students had an average of 76.59% and had a standard deviation of 11.67%. The music students in Geometry had an average of 84.62% and had a standard deviation of 8.41%. For the Waterloo Algebra 2 class, the non-music students had an average of 69.60% and had a standard deviation of 12.29%. The music students in Algebra 2 had an average of 74.98% and had a standard deviation of 11.42%. For the Waterloo Advanced Mathematics and Trigonometry class, non-music students had an average of 82.11% and had a standard deviation of 11.19%. The music students in Advanced Math and Trigonometry had an average of 88.79% and had a standard deviation of 10.63%. For the Waterloo College Algebra class, the non-music students had an average of 75.09% and had a standard deviation of 9.95%. The music students in College Algebra had an average of 88.46% and had a standard deviation of 5.80%. For the Waterloo Calculus class, the non-music students had an average of 86.65% and had a standard deviation of 9.90%. The music student in Calculus had an average of 90.36% and did not have a standard deviation because there was only one music student in the class.





The data from Waterloo High School showed that the average percentage for regular students in math was a 76.21% and had a standard deviation of 12.33%. The minimum score was a 39.32% and the maximum score was a 98.35%. Meanwhile, the students who were in a music program had an average math percentage of an 83.03% and had a standard deviation of 10.24%. The minimum score was a 61.87% and the maximum score was a 98.45%.





The combined data from the two schools was a sample size of 305 regular math students with an overall average of 77.92% and a standard deviation of 12.88%. The overall minimum score was a 31.29% and the overall maximum was a 100%. The sample size was for the two schools had 54 “musical” math students with an overall average of 84.07% and a standard deviation of 8.98%. The overall minimum score was 61.87% and the overall maximum score was 98.45%.

Discussion

Based on the data presented in the results section, in each of the Waterloo math classes that contained music students, the music students scored, on average, between 1.41% to 13.37% higher than the non-math students and those same classes. Also, the standard deviations for each of the math classes in Waterloo were lower for the music students than the standard deviations for the non-music students. This means that the music students at Waterloo High School had a higher average math score and the music students clustered around that higher average more strictly than the non-music students in the same classes.

With regards to the data retrieved from Louisville High School, only one of the three classes showed the music students receiving a higher average math score. The two classes at Louisville that had non-music students receiving the higher average math score had averages exceeding the music students' score by an average between 1.20% and 7.35%. However, similar to the students at Waterloo, the music students were found to consistently receive a lower standard deviation in each of the three math classes, even in the Louisville Algebra 1 class, where there was a larger sample of music students than non-music students.

Combined, it was found that the music students had an average that was 6.15% higher than the average of the non-music students and had a standard deviation that was 3.90% lower than the standard deviation found for the non-music students. Also, overall, the minimum score was found to be higher for the music students by 30.58% but the maximum score was found to be higher for the non-music students by 1.55%. This shows that the non-music students have a lower average score, but also achieve higher and lower than the music students. The music

students achieve higher, on average, but have higher minimum scores and lower maximum scores, so they are more clustered around that higher average.

Conclusion

This study attempted to determine if there was a correlation between high school students being involved in music programs and having higher average scores in math classes. The data that was found shows that music students did receive a higher average math score over the non-music students. Based on this finding, it can be stated that there does exist a correlation between a high school student being involved in a school-sponsored music program and that same student receiving a higher average score than a student who does not participate in a school-sponsored music program. Limitations of this study include the sample size, the determination of what exactly caused these higher average scores, and what causes music students average scores to cluster more strictly than non-music students. With a greater sample size, trends can be determined more concretely, so having more school districts participate in the study could have potentially yielded different results. This study does not succeed in determining why the music students received higher math scores, with possible explanations ranging from the additional pattern recognition expressed in music to socio-economic background differences between music and non-music students. Lastly, this study does not examine reasons for why music students have math scores that cluster so closely to one another around the music student average.

To further explore connections between music and mathematics, studies could be conducted to determine if music students exhibited higher average scores in other school subjects, such as English and Science, as well or if there only exists this correlation between

music and mathematics. Also, a similar study to this one could be conducted using different types of school districts, such as rural, urban, and suburban, to see if the location of the school has any effect on this correlation found between music and mathematics.

References

Bamberger, J. & DiSessa, A. (2003). Music as embodied mathematics: A study of a mutually informing affinity. *International Journal Of Computers For Mathematical Learning*, 8(2), 123-160.

Gaab, N. & Zuk, J. (2017). Is there a link between music and math? *Scientific American.*

Jones, S. & Pearson Jr., D. (2013). Music: Highly engaged students connect music to math. *General Music Today*, 27(1), 18-23.