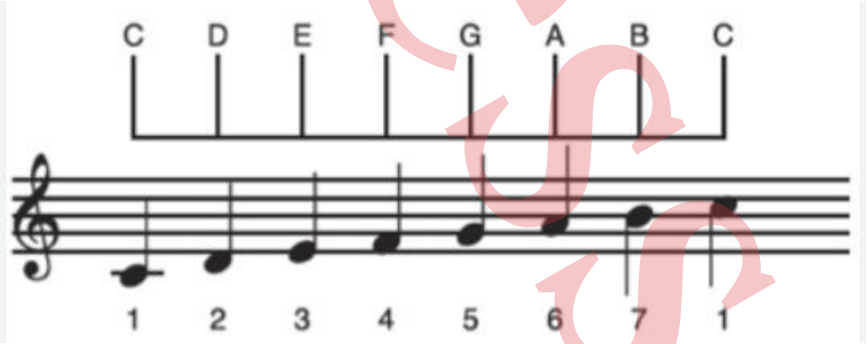
1. Introduction

Numerous literature has explored the application of mathematics in music and the relationship between mathematics and music. One such example is the book “Music, a mathematical offering” written by Dave Benson, in which certain applications of mathematics in music are discussed and explored with interesting examples. To many people, mathematics and music are completely two different matters as math is oftentimes perceived as soulless, rational, and strict, while music incorporates feelings and emotions (Beer, 2008). However, the application of mathematics in music and the relationship between both subjects are undeniably strong.

2.1 The Application of Numbers in Music

There are many mathematical applications in music, namely the number used to represent time signatures, beats, rhythms, and notes (Church, 2000).

(Figure 1.1)



As seen in the figure 1.1, each note represents a number, Do=1, Re=2, Mi=3, so on and so forth, and some musicians use these numbers to mark notes in a simplified format because it is easier for them to transcribe music and communicate with other musicians. This is how number system in mathematics apply in music, specifically the individual notes in music.

Number system can also indicate the duration of a note in music. As seen in the figure 1.2, a whole note has a duration of 4 beats, a half note has a duration of 2 beats, a quarter note lasts for 1 beat, so on and so forth.

(Figure 1.2)

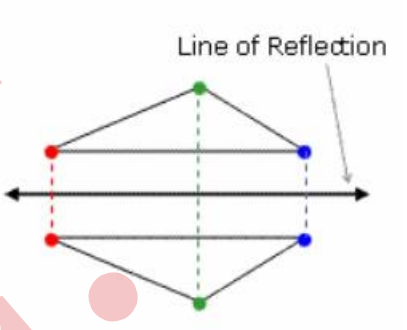
Note	Name	Beats
	Whole note	4 beats
	Half note	2 beats
	Quarter note	1 beat
	Eighth note	½ beat
	Sixteenth note	¼ beat

2.2 Symmetry in Music

However, these applications are not confined to the number only, but also geometric elements and patterns found in music notation and mathematical concept. Symmetry is one of the most profound demonstrations of applying geometric concepts in musical composition.

(Figure 2.1)

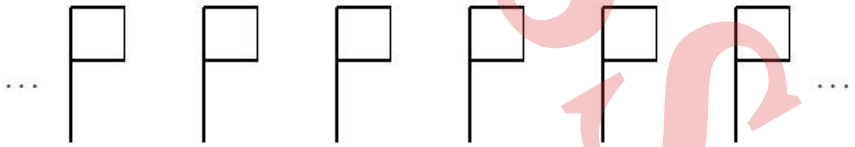
(Figure 2.2)



Reflectional symmetry is found many musical compositions in the form of inversion of a figure or phrase (Benson, 2013). Figure 2.1 is taken from a section of Bela Bartok's Fifth string quartet, which is quite like what is displayed in the figure 2.2. Apparently, this section of notation resembles a vertical reflection where the last note (Bb) plays the role of the line of reflection as well as the horizontal axis. Many musicians unconsciously use this notion of reflectional symmetry to compose their music.

Translational symmetry is yet another application of math in music. Such example can be found in the following figures.

(Figure 2.3)



(Figure 2.4)

Figure 2.4 is taken from a section of Beethoven's Moonlight Sonate, Op. 27 No. 2, and it follows a pattern of translational symmetry in the figure 2.3. In some of

Beethoven's as well as Bach's music compositions, the translational symmetry, which is a mathematical concept, is applied in the aim to create suspense, tension, and other musicality-related purposes through repetition of rhythm and melody (Benson, 2013).

3. Conclusion

The foregoing content just shows two aspects of application of mathematics in music. It is clear that music, as both an art and a science, could not be developed without math. The relationship between mathematics and music is tight-knitted. Interestingly, it is fair to suggest that while math contributes substantially to the development and usage of music compositions and theories, music, on the other hand, does not provide any value in mathematical theories. Nonetheless, a number of research evidence do show that students who engage in musical training can potentially perform well in terms of mathematical reasoning skills and problem-solving skills in the subject of math (Beer, 2008).

4. Reasons for Choosing this Topic

First of all, I have been playing violin and reading musical notations throughout my life, and I also currently major in violin performance. Since I am taking this course, I thought why not choose the application of mathematics in music as my topic. It is something I am familiar with, and it can be eye-opening to my fellow classmates as there might not be so many people know about the correlation between math and music.

5. The Things I Learned from the Materials & Reactions

Since I am already pretty familiar of the use of number systems in music. I cannot

say that using numbers to represent beats and notes is something that I learned from the materials. Nonetheless, I was able to see that how musicians, even the greatest ones like Bach and Beethoven, unconsciously use translational and reflection symmetry in their composition. Besides, according to Beer (2008), students engaging in musical training are more likely to perform well in math compared to those without musical training. This is a meaningful thing I learned because it has implications to educators, parents, mathematicians, and musicians in general.

My reactions were a mixture of amazement and self-affirmation. Despite the fact that I knew the application of mathematics in music and their relationship since I was a child, things like the application of translational and reflectional symmetry in musical compositions still surprised me. I was also amazed at the research findings that students with a certain level of musical training are more likely to perform well in music compared to those without it.

References

Beer, M. (2008). Mathematics and music: Relating science to arts. *Mathematical Spectrum*, *41*(1), 36-42.

Church, E. B. (2000). Math & Music: The Magical Connection. (cover story). *Scholastic Parent & Child*, *8*(3), 50.

Benson, D. J. (2013). *M*usic : a mathematical offering. *Cambridge University Press*, 296–297