Jamila Husbands
209117615
Mathematics in Music Script

Hello, my name is Jamila Husbands and this is my first podcast for Math 2590.

In this podcast, I am going to explain the links between mathematics and music.

The first place that you may notice math in music is sheet music.

Sheet music or scores are the written notation of the musical notes of a song. It shows the musician how the piece should be performed.

Sheet music consists of the notes, time signature, key signature, and dynamics. These elements act as a guide for the musician when playing a piece.

The notes found on sheet music have their own distinctive name and value. Notes indicate how long a note should be held and a rest indicates how long the musician shouldn't play. Whole notes and rests are both worth four beats. Half notes/ rests are worth two beats. Quarter notes/rests are worth one beat. Eighth notes and rests have a value half of a quarter note, .50 beats. Sixteenth notes and rests are worth a quarter of a quarter note, 0.25 beats.

Have you noticed anything about the worth and names of the notes and rests?

Their names are similar to fractions. They also add up like fractions.

The key signature also looks like a fraction 4/4. The top number of the key signature specifics how many beats are in a bar of music. The bottom number indicates which note gets the beats.

If we have a time signature of 4/4, there need to be 4 beats in a bar. For example, in a bar there could be 3 quarter notes each worth one 1 beat and two eighth notes worth 0.50 beats each. The math sequence would look like 1+1+1+.50+.50= 4. As long as the notes add up to four beats, this bar will work in a song of a time signature of 4/4.

Frequency also plays a role in music. Frequency is the number of times the wave of energy completes a cycle of oscillation in one second. So basically it refers to the sound that we hear. So, the higher the frequency is, the higher the pitch. Hertz is the unit of frequency.

Jason Brown is a mathematician who looks at the links between math and music. In his book *Our Days are Numbered* he states that "all sound is due to vibrations, air molecules moving back and forth in rapid succession. The basic building blocks of all music sounds are pure tones, which correspond to objects vibrating in a wave" (Brown, 2009: 247-248)

The wave is called a sine wave. The x axis is time and the y axis is amplitude. Brown states that "the loudness of a pure tone corresponds roughly to the sine curve's amplitude, that is, how high

and low it goes from midpoint. The "pitch of the tone corresponds to the frequency of the curve, that is, how fast it repeats." (Brown, 2009: 248)

If we take a note that has a frequency value of 55Hz and another note at 110 Hz the second note is the double of the first. It could be written in a ratio of 2:1. This represents the relation between two notes.

Again if we take a note that has a frequency value of 110Hz and a different note that has a frequency of 165Hz , it could be written in a ratio of 3:2. This ratio represents the ration between notes C and D

Pythagoras was a Greek philosopher and mathematician and he is known for making contributions to the idea that there are links between music and math.

An article written by Alex Donnelly, it states that Pythagoras believed everything in life could be represented as a fraction.

Pythagoras discovered something interesting with a string instrument. If you pluck the string of a guitar and then divide the string into half, the second note played is the same as the original note. So if note C is plucked on a string and then divided into half, the second note played is C too. The second C will sound twice as high as the first C plucked; this means the second C has a frequency that is twice as high as the first. This could be written in a ratio 2:1.

The second note is an octave higher that the first note.

An octave is an interval between two notes with one note having a frequency exactly twice the original note.

Octaves can be represented in fractions and ratios.

Ratios in music are used to describe the relationships between pitches/notes.

Patterns are also very much present in music as it is in math.

Many of the songs that you may be familiar with have patterns within the songs. Composers use patterns within their music and the musical term for these patterns is motif. A motif is a short rhythmic or melodic passage that repeats.

If you think of the song Twinkle Twinkle Little Star, you can hear how patterns are used. (Lee & O'Reilly, 2007)

In the song there is a pattern in the differentiation of the pitches/notes.

One of the patterns in the songs is "Up above the world so high, like a diamond in the sky". The notes repeat and create a pattern. The notes are G G F F / E E D / G G F F / E E D.

Jamila Husbands
209117615
Mathematics in Music Script

Patterns also used to create a major scale. A major scale is made up of 7 notes. These are the 7 notes between an octave. The seven notes include the first note played but not the top note. The top note will be the same as the first note played but at a higher pitch. If we use the C major scale as an example, the 7 notes are, the notes between a lower C and a higher C.

The sequence of notes for C major is C, D, E, F, G, A, B, C. In that scale the notes are ascending in order, the pitch is getting higher.

To find the major scale of C, a pattern is used. The major scale formula is 2 2 1 2 2 2 1. 2 represents the two half steps used to find the next note in the scale.

Starting with C, two half notes up from C is D. The white and black keys are counted and they represent a half step. The first half step up from C is a black key and the name of the key is C#/Db. The second half step from C is D. To get the next note of the scale you have to add two half steps to D and you get E.

In my education class, Teaching Language in the P/J Division our professor bought in a guest speaker. Her name was Gillian O'Reilly and she is an editor and author. One of the books she co-wrote was The Great Number Rumble and it is about a student who tries to stop the Director of Education from banning math by showing him the many different places math could be found.

The book shows how composers in the 1770s used probability to compose music.

The book also looks at how MIDI equipped keyboards could be used to compose music by only using numbers.

If you are interested in learning more please look into this book. It is written for kids and it would be a great way to show your students the many places mathematics can be found.

So I hope after listening to this podcast you will get a better understanding of how mathematics and music are connected.

Work Cited

Brown, J. (2009). *Our days are numbered*. Toronto: McCLelland and Stewart.

Donnelly, A. (2008, May 25). The connections between music and mathematics: revised and better than ever. Retrieved from http://scienceray.com/mathematics/the-connections-between-music-and- mathematics-revised-and-better-than-ever/.

David, J. Jr. (1995). The mathematics of music. Retrieved from http://jackhdavid.thehouseof david.com/papers/math.html.

Music theory: the major scale. (n.d.) Retrieved November 28, 2010, from http://www.jazzguitar.be/music-theory.html.