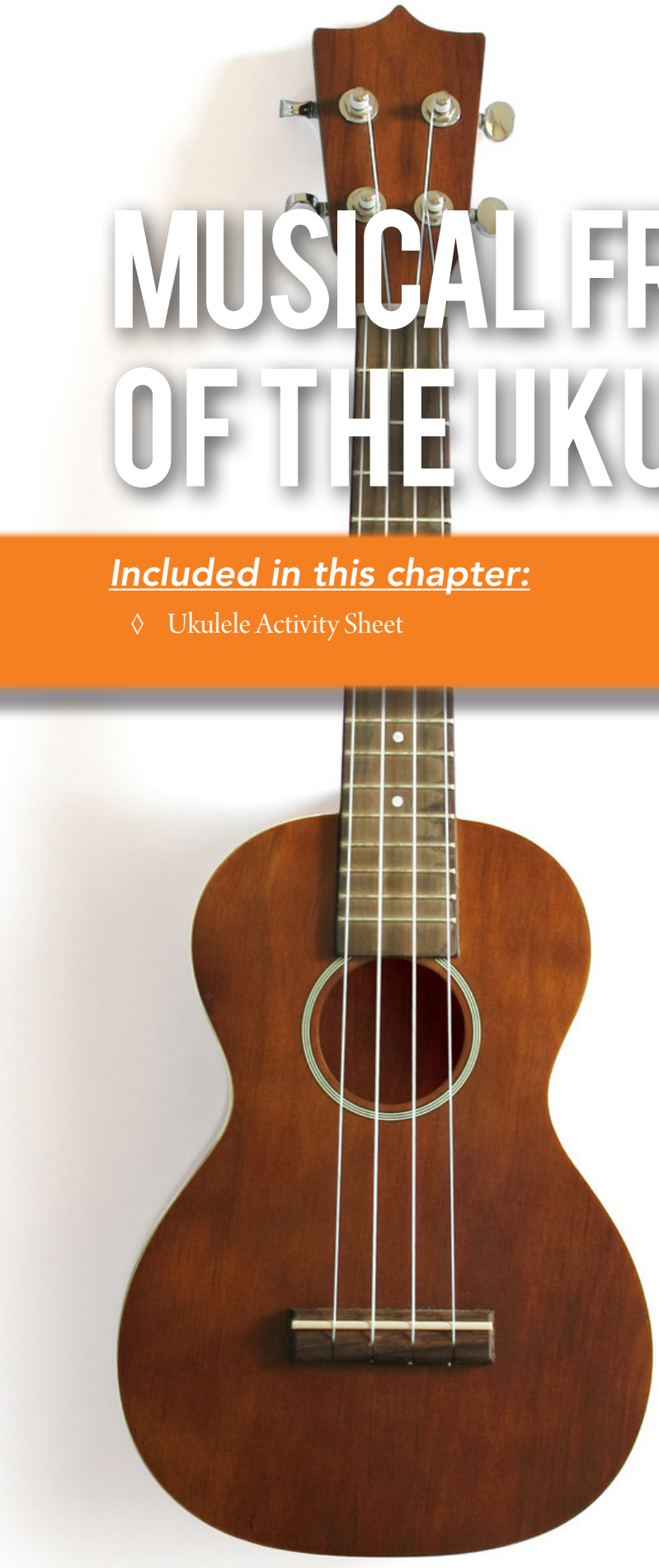


MUSICAL FREQUENCY OF THE UKULELE

Included in this chapter:

- Ukulele Activity Sheet

Written by Jacqueline Salazar

Part 1: Introduction and History

The history of Hawaiian music is both significant and relevant to students and educators. One particular musical instrument that is renowned in Hawaiian music is the ukulele. In 1879, the ukulele was first introduced with the inception of Portuguese immigrants from the island of Madeira (King John). Hawaiians were particularly impressed by the Portuguese instrument "ukulele". Ukulele got its name from Queen Lili'uokalani by combining the two Hawaiian words "uku" (gift or reward) and "lele" (to come) (King & Tranquada, 2003). Before contact with the western civilization, Hawaiians celebrated nature, their gods and love of life through the expression of chants and hula. Hawaiian chants come in two basic styles "Mele oli" are chants without musical instruments and "Mele hula" are songs accompanied with dance and musical instruments (James, 2005).

In the late 19th century Hawaiians developed a steel guitar which is positioned horizontally and strings are plucked with one hand, while the other hand changes the pitch of one or more strings with the use of a bar or a slide (Greenberg, 1992). This instrument is called the ki ho'alu, or Hawaiian slack key guitar, and is truly one of the great acoustic guitar traditions in the world. Ki ho'alu means "to loosen the key", which is a solo finger picked style. In this tradition, the strings ("keys") are "slacked" to produce many different sounds (Beamer, 2012).

Although, modern Hawaiian music is a combination of ancient music and it has modern influences. It is not uncommon to hear a new Hawaiian song with components of country music (Instant Hawai'i, 2008). The lyrics usually have to do with the places of Hawai'i's love, nature, and culture. Thus, Hawai'i is so diverse; this diversity has made its way into the beauty of music.

The knowledge of Hawaiian music goes throughout the classrooms and it incorporates ethnomathematics. Building methods and strategies for students to play the ukulele will enhance the understanding of math. Thus, the link between tradition and music will be exhibited through this intercultural exercise in mathematics.

Part 2: Goal of Lesson Plan

Learning the ukulele's strings and tunings will focus on the cycle of ethnomathematics and to expand its ideas for future teachers. The goal is to teach seventh graders the relationship between ukulele's four strings (A, E, C, G) and its frequency (Hz). A 26" Tenor ukulele will be played with three different unique tones (G4-C4-E4-A4, A4 D4 F#4 B4, & D4-G3-B3-E4) (Hurd, Costello, & Beloff, 2012). According to the Common Core State Standards for Mathematics (CCSS), grade seven will identify ratios and proportional relationships (7.RP.1, 7.RP.2, 7.RP.3) such as identifying diagraphs, testing for equivalent ratios in a table, graphing points, and relationships between quantities (Common Core State Standards Initiative, 2012).

Furthermore, this activity corresponds to Hawai'i Content and Performance Standards III Benchmark MA.7.10.1-3: Patterns, Functions, and Algebra (i.e., tables, graphs, graphing technology, equations of linear functions, and linear relationships); and Benchmark MA.7.11.1: Data Analysis, Statistics, and Probability (i.e., pose questions, collect data, select the appropriate representation graph and display data) (Hawai'i Standards Database, 2011). Students will learn the basic history of the Ukulele and the importance of the tones. Also, students will identify each string, analyze the three different tuning (C, G, D), record each chord (Audacity), measure the chord's frequency through Audacity and draw a line graph to compare the four string's frequency. Plus, visualizing the Ukulele sound waves through audacity will engage the students to recognize and distinguish the patterns of mathematics.

Part 3: Methodology

Basic Data

To initiate the thought process, the teacher will ask What does the word ukulele mean? Is the ukulele originally from Hawai'i, if not where? What are the differences between "Mele Oli" and "Mele Hula"? After the discussion of ukulele's history, the students will engage in a fun activity and answer each question as a class. The following table is an example how the students will record and write down data.

Audacity Data

Table 1: Ukulele Frequency

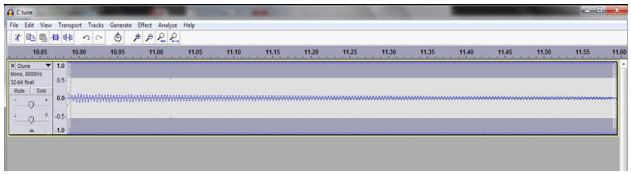
Tuning	"C"	"G"	"D"
First String	A (440 Hz)	E (329 Hz)	B (493 Hz)
Second String	E (329 Hz)	B (246 Hz)	F# (370 Hz)
Third String	C (264 Hz)	G (192 Hz)	D (293 Hz)
Fourth String	G (196 Hz)	D (293 Hz)	A (220 Hz)

To begin, the students will pair up with a partner and they will identify each chord on the Ukulele's strings (shown below).

Photo: Daniel Rodriquez's Ukulele by Jacqueline Salazar

1. The first student will play one string at a time while the other student is recording the sound wave through Audacity and switch turns. For instance, the following example is a recording of chord C (Third String).

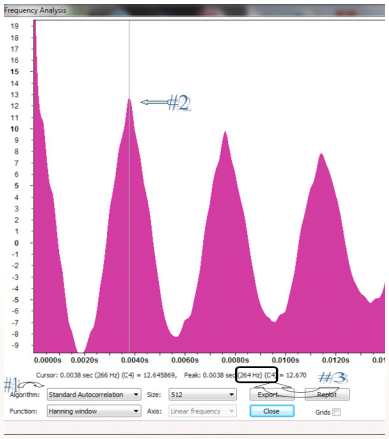
2. Once the students stop recording, they will analyze the frequency by using plot spectrum to make it readable and easier to understand (see below).



a. Go to "Analyze" menu then select "Plot Spectrum"

b. A new window will open (Frequency Analysis) and set the "Algorithm" to Standard Autocorrelation at the bottom left (see #1).

c. Place the mouse cursor on the graph to the first peak or the second peak (see #2) Determine the chord's name and its frequency at the bottom (see #3).

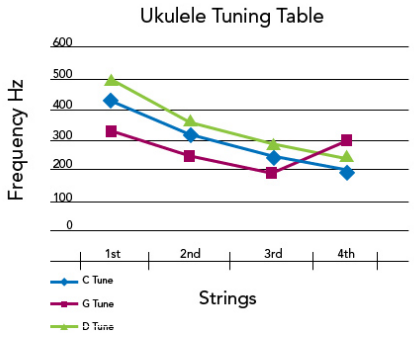


Graphing

3. Each student will have the opportunity to have their own data table and start graphing each point. To have an accurate graph, the students will brainstorm which graph is appropriate. In this activity, a line graph is readable and shows the difference of each tone (shown above).

4. To make the activity more interesting is to find the "mean" (example 1) of each tuning and to discuss the different tuning. Finding the "mean" will enhance the student to identify the different patterns of frequency and improvements on arithmetic functions.

Example 1:



- Tuning C = 307.25 Hz
- Tuning G = 265 Hz
- Tuning D = 344 Hz

Also, the students will have a chance to answer the following question on the activity sheet. These questions will reflect how Math connects to music and its connection outside the classrooms.

5. Finally, have the teacher to explain the data thoroughly and have a 15-30 minute answer discussion as a class.

Part 4: Conclusion

Music and mathematics are closely connected in many ways such as tone, tuning, frequency, rhythm, and pitch (Schmidt Jones, p. 2). This lesson plan integrates mathematical knowledge and fundamentals of culture. Music inspires students with confidence and empowers their intellectual abilities. By introducing students' cultural heritage it will give them positive outcomes in life and the importance of the Hawaiian culture. Doing hands on activities it will show the student to examine, analyze, recognize, and incorporate data without hesitation. In conclusion, the end results will assist students to internalize their understanding of ethnomathematics and encourage them to ponder the uniqueness of mathematics.

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Name: _____ Date: _____

Ukulele Activity Sheet

Directions:

1. Pair up with a partner
    - 1st person pluck every string once while the 2nd person records the data and writes it down on **Table 1**: "C" Tuning
    - Once the 1st person finishes, switch responsibilities and have the 2nd person repeat the same process while the 1st person records data and writes it down on Table 1: "G" Tuning
    - Again switch responsibilities and record + write down data on Table 1: "D" Tuning

2. Draw graphs and connect points *(Each person draws their own graphs)*

3. Answer the following questions:
    - Which String has the highest frequency and at what tuning?
    - Which String has the lowest frequency and at what tuning?
    - Find the Mean of each Tuning C, G, & D separately and analyze
    - Tuning C =
    - Tuning G =
    - Tuning D =
    - What did you notice among the 3 tunings? Were there any surprises?
    - Now that you found the frequency of each chord and the Mean, how & why is Mathematics important in music?

4. Discuss the answers as a class for 15-30 minutes

Table 1. Ukulele Frequency				
Tuning	"C" Tuning	"G" Tuning	"D" Tuning	
First String				
Second String				
Third String				
Fourth String				