Beat Breakdown: Decomposing Drum Kit Beats

Computational Thinking Focus: Decomposition

Computational thinking in computer science is a way to get students thinking about how they solve problems, and to generalize and transfer problem solving strategies across subjects. Computational thinking is broken down into five parts: abstraction, decomposition, pattern recognition, algorithm design, and debugging. **_Decomposition_** in computer science is an aspect of computational thinking that involves _breaking a complex problem or system into parts that are easier to conceive, understand, program, and maintain._

Additional Computational Thinking Concepts Supported: Algorithm

Neurodiverse Workplace Skills: Problem Solving, Communication, Persevering

Elements of Telematics: Embodied learning through movement

Arizona Computer Science Standards
*Computing Systems (CS), Networks and the Internet (NI), Data and Analysis (DA), Algorithms and Programming (AP), Impacts of Computing (IC)

- 6.CS.D.1 Compare computing device designs based on how humans interact with them.
- 6.AP.M.1 Decompose problems into parts to facilitate the design, implementation, and review of programs.
- 6.AP.PD.3 Test programs using a range of inputs and identify expected outputs.
- 6.AP.A.1 Identify planning strategies such as flowcharts or pseudocode, to simulate algorithms that solve problems.
- 6.AP.V.1 Identify variables that represent different data types and perform operations on their values.

Arizona Academic Standards in the Arts: General Music
*Creating (CR), Performing (PR), Responding (RE), Connecting (CN)
- MU.CR.16b Generate musical ideas (e.g. rhythms, melodies, and accompaniment patterns) within related tonalities, meters, and simple chord changes within a specified form.

Objectives

- Students will use decomposition to break down music into its component parts.
- Students will break down a beat into its component parts.
- Students will use coding to make their own beats. **(Extension)**

Timeline

Day 1: Activation and Foundations (40 – 60 minutes)

Day 2: Application and Culmination (40- 60 minutes)

Day 3: (Optional) Extensions

Vocabulary

- Computational Thinking (CT)
- Decomposition
- Input
- Outputs
- Beat
- Measure

Materials

- Whiteboard
- TV/screen
- Laptops (one per group of 3 students)
- Wearable Music Sensor (3 per group) e.g. M5Stick
- Drumsticks (3 per group)
- Sticky notes
- Wearable Jazz instrument group
- Sonic Introduction instrument group
- YouTube
- [Google Slide presentation on CT concepts](#).
- Earsketch website: https://earsketch.gatech.edu/earsketch2/
- Visual of a drum set with labels for kick, hi-hat, snare
- Optional: metronome

Day 1:

Activation (Engage & Explore)

Jam Session 1 (20 minutes)

Divide students into groups of 3. Give each group a laptop with the Wearable Jazz instrument group (Drums, Melody, Harmony instruments) loaded and each student a Wearable Music Sensor that is connected to the app. For each Sensor select a part, such as drums, harmony, melody, or effects, to assign to each stick. If you have more than three you can create more instances of the instruments. Make sure the drums Sensor is set to EASY or Gyroscope mode, and the Sensors connected to the melody and effects are set to EASY or Accelerometer mode (to do this click on the Sensor's mode switching button which is the big button in the middle of the sensor). Once the groups are prepared with their materials, explain that you will be having a jam session. Encourage students to move and dance any way they want, while playing with their Sensors.

During this free play exercise ask probing questions such as:

- "What kinds of sounds do you hear?"
- "What happens when you make this motion?"
- "Cool sound! How did you make it?"
- "What movements make sound? Are there any movements that don't make a sound?"
- "Can you show us how you did that or made that sound?"

👫 Communication:

occurs as students are encouraged to share their discoveries with each other, as teachers ask probing questions, and as students find ways to explain or demonstrate what they are learning. Communication does not have to be spoken or written.

? Problem Solving:

occurs during play as students experiment with toys, tools, and technology. Students are naturally breaking down a very complex app (Wearable Jazz) into easy-to-understand parts. This is decomposition, where any task that seems complex or difficult at first can be broken down into more manageable pieces. This is also a problem-solving strategy that is used in other subject areas and in life. The goal of this activity is to get students to discover that they can conceptually break something complex into smaller parts. Some students may have been able to break down the app into multiple distinct inputs and outputs during this activity.

📝 Persevering:

occurs when students are encouraged to keep playing with an object or idea until they have answered their own questions or wonderings about how it works.

Observe student discoveries of cause-and-effect relationships, such as how moving a certain way produces a unique tone or beat. Audio record examples of student learning, such as beat and tempo.

Foundations (Explain)

Introducing vocabulary (20 minutes)

Use the slide presentation on CT concepts linked above. Explain that *decomposition* is a CT concept. When you break a big and complex problem into smaller parts, you are using decomposition.

Lead students in a round robin discussion. Explain that the music they've been making is very complex, with lots of different sounds, and making different movements *(input)* results in different kinds of sounds *(output)*. Encourage students to share their many discoveries from the Jam Session. Which movements caused which sounds? Why do they think this happened? Some students may also notice that each of their devices controls a different part of the music (effects, beat, melody). Also, ask the students to share anything they noticed about the differently labeled devices (1, 2, 3). Explain to students that decomposition can be a great way to solve problems. Professionals in any career often divide complex tasks or goals into parts so each team member has a role.

Replay the audio recordings you made of the students' jam session. Ask them to copy the beat with their bodies (clap, move, stomp, etc.). Explain that *measure* is a section of music, made up of

👫 Communication:

Communication is being supported by the introduction of content area or field-specific vocabulary. Students can then use these terms to further communicate their learning. Verbally stated vocabulary can be accompanied with the written and pictorial forms of the word. Embodied or gestural forms of the terms can accompany the verbal form when possible. Vocabulary can be posted or made accessible to students to refer to in future lessons.

Communication is also occurring during class discussion. Although the teacher is tasked with ensuring that the new vocabulary is introduced and connected sufficiently to the concepts learned, the discussion should revolve around the students' discoveries and ideas. Teachers can return to the probing questions and observations made during the Activation to support student sharing. Students can also be encouraged to demonstrate ideas through movement with the devices and apps during the discussion.

Communication is further developed through the practice of listening to music (measures and beats) and to people's ideas.

beats, that repeats and *beat* is the steady pulse, or counts, within a measure.

Day 2:

Application (Elaboration)

Apple-One-Orange-One Beat (20 minutes)

To prepare for this activity, attach a Sensor to each drumstick, with 3 Sensor-drumsticks per laptop. Put the sensors in either EASY or GYRO mode, experiment to see which is most intuitive, but most likely EASY mode's pitch axis will work well. Using multiple instances of the Tap instrument, connect the Sensor-drumsticks so that, when flicked, one will play the kick part of a drum set (kick), one will play the hi-hat (hat), and one will play the snare (snare). To do this, change the sound in the Tap section to 'kick', 'hat', or 'snare'. You can have each Sensor connected to a different instance of Tap. Adjust the Threshold control in Tap to activate the sound only when the student flicks the drumstick. See the purple bar moving as your sensor moves, adjust the orange bar to trigger the sound when you do the drum motion. Setting these Sensor-drumsticks up before the lesson will allow for a smoother transition.

Explain to the students that they are ready to use decomposition in making music. Tell the students that the apple-one-orange-one beat, also called "The Beat" or "Rock Beat #1", is one of the first beats students learn when playing the drums.

? Problem Solving:

is occurring as students attempt to decompose the beat into its drum parts.

⬹ Persevering:

occurs when students try different tactics for determining the drum parts as well as when the teacher offers a scaffold (i.e., diagram). The diagram shows the decomposition of the drum parts, but the students are still encouraged to play the beat parts even though they have the written 'solution.'

⛊ Communication:

is supported when connecting visual representations and words to sound/music. (And vice versa.)

Remind students of the definitions for measure and beat. The measure is a section of music that repeats, that is composed of four beats. The Beat can be decomposed into each part of the drum set. Show the visual of a drum set with the kick, hi-hat, and snare labeled.

Play audio recordings with examples of The Beat. Ask the students to use their Sensor-drumsticks to recreate the beat. Give them about 5 minutes.

Display the following diagram on a TV, screen, or whiteboard. Explain that The Beat has been decomposed for them in this table.

	MEASURE			
BEAT	1	2	3	4
Kick	✓			
Hi-Hat	✓	✓	✓	✓
Snare			✓	

Have three students as volunteers each take a drumstick and practice the beat until they can play it successfully as a group. It is helpful to have each person practice their part as you clap and count 1, 2, 3, 4, or use a metronome. Once each person can do their part alone, have them play all together. Then, have each group practice playing The Beat collaboratively.

Finally, have one student try to play the beat using all three drumsticks at once. Have the students explain which way was easier. Discuss the ways that decomposition can make any complex task easier.

Culmination (Evaluate)

(20 minutes)

To assess how well students can use decomposition using the Sensor-drumsticks and their knowledge of beats, measures, and the drum kit, have students view the first beat in this video: **https://www.youtube.com/watch?v=DdPJTM1BKBI** This beat is called Apple Orange, or the 4/4 beat. For another example, you can also view the first minute and 28 seconds of "How to Play a 4/4 Drum Beat" video. **https://www.youtube.com/watch?v=9BP7Sk4uFu0 (0:00-1:28)**

Put students in groups of 3 and give them a copy of the beat/measure table. Tell the students they are to fill in the table to show how to play the drumbeat that is being shown in the video. They should be able to use their Sensor-drumsticks and the Tap or Drums instruments to help them with this task.

	MEASURE			
BEAT	1	2	3	4
Kick				
Hi-Hat				
Snare				

Once the table has been completed, the group should discuss the following questions:

1. How is this drum beat different from the one we heard last time?
2. How is this drum beat similar to the one we heard last time?
3. How does decomposing the Apple Orange (4/4) drumbeat help people learn to play music?
4. Give an example of another activity where people can use decomposition to help learn something new.

One person can be designated as scribe to either write down the group's answers/discussion or to audio record the discussion for the teacher.

Plan an extension activity in case the class completes the assessment early.

Answer Key:

	MEASURE			
BEAT	1	2	3	4
Kick	✓		✓	
Hi-Hat	✓	✓	✓	✓
Snare		✓		✓

Adaptations:

1. Before starting the Application activity, the instructor can model, by trying to use all three Sensors at once, that one person trying to make music with more than one part is very difficult. Explain to students that groups like bands already divide tasks between musicians because one person can't do it alone. For example, the guitarist, the drummer, and the bass work together to make music. The reason we often work in groups is to divide up the work and make it easier. If each person in a group focuses on one thing, the group is more successful as a result.

2. Participation in Wearable Jazz activities can be non-verbal. Students show decomposition by moving and creating specific sounds. Students can have the option to demonstrate the steps rather than write steps down. Groups can also choose one person to be the scribe. The scribe can write or draw each step. Group discussions could also be audio recorded.

3. The beat/measure table could be printed out and marked on with a pencil or made large format on a poster board. Students can then use post-it notes or other items to mark the spaces.

4. For practice with decomposition, there are many other familiar tasks to choose from, such as brushing your teeth or tying your shoes. (See **Expansions** for an example.) Instructors should pick a relevant activity that challenges students to break down into smaller steps. Breaking a task into smaller steps helps in the creation of discrete steps in an algorithm. This also connects to algorithm design in the last lesson.

5. To facilitate a shorter lesson time or for students with less experience with coding in **Extension 2**, laptops can be preloaded with the Earsketch webpage and The Beat script ahead of time.

6.

Extensions:

1. Using YouTube, play a game with students where they listen to an audio track from a famous song, and using decomposition, try to listen for when "The Beat" is played

during the song. Students raise their hands when they think they hear the beat. Pick any song from the following list or find other examples:

- "Kashmir" - Led Zeppelin
- "One More Time" - Britney Spears
- "We Didn't Start the Fire" - Billy Joel
- "Just Dance" - Lady Gaga
- "Enter Sandman" - Metallica

- "Billy Jean" - Michael Jackson
- "Bad Day" - Daniel Powter
- "Without Your Love" - Chris Stapleton
- "Octopus's Garden" - The Beatles
- "Brothers in Arms" - Dire Straits

2. Students can continue learning the patterns for more drumbeats by decomposing those demonstrated in the rest of this video: **https://www.youtube.com/watch?v=DdPJTM1BKBI**
3. To extend learning with the functions of the apps, students can be paired up to use Sonic Introduction. One student would play a musical loop with their sensor by choosing a sound from the Loop sound bank. The other student would use the drum-sensor and the Tap sound bank. Together they can create their own music. Making the group larger and adding more parts could also be a fun way to 'jam' together with NEWMT.
4. Jam Session 2

Explain that the students will apply decomposition to a complex task in which they make their own drumbeats using coding in Earsketch.

Divide students into groups of three with one laptop each. Have the following tasks listed on a document that is accessible to each laptop:

- Go to the Earsketch website: https://earsketch.gatech.edu/earsketch2/
- Click on the link in the center of the screen to create a new script.
- Copy the following code into the editor:

from earsketch import *

setTempo(120)

apple = OS_KICK06

one = OS_OPENHAT03

orange = OS_SNARE05

```
apple_Beat="0+++------------"

one_Beat="0+++0+++0+++0+++"

orange_Beat="--------0+++----"

for measure in range(1,16):

        makeBeat(apple, 1, measure,
        apple_Beat)

        makeBeat(one, 2, measure, one_Beat)

        makeBeat(orange, 3, measure,
        orange_Beat)
```

Direct the students to complete each step (or have each laptop already set up with the code in Earsketch).

Have the students run the script and play the music in the editor. Students should click the green **RUN** button in the code editor to upload their code to the Digital Audio Workstation. If done correctly, a visual display of each beat should appear in the Digital Audio Workstation. To play the music, they should press the green **PLAY** button in the Digital Audio Workstation.

They will recognize that it is the same apple-one-orange-one beat from the **Application** section of the main lesson. Explain to students that each beat in a measure can be broken down into quarters of a beat, for 16 total quarter beats in a measure. Demonstrate 16 beats per measure by clapping it out or playing a video example. Each beat in the code is defined by a list of zeros, pluses, and dashes, 16 in total, in quotation marks.

Note:

The Earsketch web app is divided into four sections: The Content Manager on the left, the Curriculum Library on the right, and the Code Editor and Digital Audio Workstation in the center. For this lesson, students will only be utilizing the Code Editor and Digital Audio Workstation. The Code Editor window is where students copy down the example code. The Digital Audio Workstation is for playing music generated by the Code Editor.

If the task is difficult, offer scaffolds, such as a YouTube 'how-to' video. (See https://www.youtube.com/watch?v=vcNAhUqH9U0). Focus on perseverance as a skill. Reassure students that they are being asked to come up with as many as they can, and that it would probably take longer than 10 minutes to come up with a very detailed list. If they keep trying, they can eventually come up with one set of steps that could be used to teach someone how to brush their teeth.

Direct each group of students to explore how changing the order and frequency of zeroes, pluses, and dashes makes a different beat. (The beat is played on every zero, a plus sign extends the beat, and a dash is a rest where no beat is played).

Students will then make and share their own beats.

Expansions:

1. Toothbrushing Breakdown (20 minutes)

Content areas: Life Skills, Health & Wellness, Occupational Therapy

Remind the students that they have been learning about the CT concept called *decomposition*. Explain that the students will be practicing decomposition by breaking down a familiar activity, the act of brushing their teeth, into as many steps as they can in 10 minutes. Give an example of how missing small steps might keep someone from learning how to brush their teeth. For example, guide students to come up with small steps, such as "grab toothbrush with your hand" and "put the toothbrush under the faucet." Organize students into groups of 3. Have students write each step on a post it note, then organize the post-it notes on a flowchart posted on a wall or whiteboard. As students work, walk around and encourage students to break down the steps even further. Give students a 2-minute warning after they

Note:

Practice with decomposition across the curriculum will help learners become proficient in breaking down complex problems and generalize the skill to other areas in their lives.

With Expansion 1, students can show how well they are able to break a complex task down into smaller steps. Although we can assume that toothbrushing is a common activity, the students' familiarity with the act of brushing teeth and differences between how students and families brush teeth could play a role in how the students perform on this task. The instructor should assess if students are able to break down the task into smaller steps, and the degree of detail (or decomposition) used. Also, keep each group's flow charts to review later.

have been working for 8 minutes. Ask them to begin organizing their post-it notes.

Once the 10 minutes are up, ask for a group to volunteer their flow chart and a student to volunteer to 'learn' how to brush their teeth. Read each step aloud and ask the volunteer to follow the direction. Have the rest of the class raise their hand or indicate in some way when a step might have been missed. Add the step in with a new post-it note.