**COSMOS EDUCATIONAL TOOLKIT: AM/FM Modulation - Observing Signals from a Microphone**

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| **Grade/ Grade Band**: 7 (6-8) | **Topic:** AM/FM Modulation | **Lesson #** 1 **in a series of** 1 **lessons** |
| **Brief Lesson Description**: Students will build off their learning on [AM/FM modulation](https://cosmos-lab.org/cosmos-toolkit/index.php/8-am-fm-modulation/index.html) in the previous two lessons. Yesterday they looked at AM/FM Modulation of a computer-generated signal; today they will produce the signal using the microphone and examine how amplitude and frequency vary with different signals. |
| **Specific Learning Outcomes:** Students will be able to demonstrate that different types of sounds produce distinct signals. They will also observe how AM or FM modulation affects the representation of a signal and speculate about whether AM or FM modulation is “better.” |
| **Narrative / Background Information**  |
| **Prior Student Knowledge Required:** Students can explain the difference between amplitude and frequency and observe and understand the difference between amplitude modulation of a signal and frequency modulation of a signal. |
| **Problem Solving Practices (Ex: Standards for Mathematical Practice):** **Developing and Using Models****Modeling in 6–8 builds on K–5 and progresses to developing,using, and revising models to describe, test, and predict more abstract phenomena and design systems.****Develop a model to describe phenomena. (MS-PS4-2)** **Obtaining, Evaluating, and Communicating Information****Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods.Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)** | **Main Content Ideas:** **PS4.A: Wave Properties****A simple wave has a repeating pattern with a specific wavelength, frequency,and amplitude. (MS-PS4-1)** **A sound wave needs a medium through which it is transmitted. (MS-PS4-2)** | **Possible Multidisciplinary Concepts:** **Patterns:****Graphs and charts can be used to identify patterns in data. (MS-PS4-1)**  |
| **Possible Preconceptions/Misconceptions:** * confusing amplitude and frequency
* thinking that changing amplitude changes the frequency or vice versa (amplitude and frequency do not affect each other)
* a louder sound makes a higher frequency (false - a louder sound makes a higher pitch)
* a louder sound makes a higher amplitude (true - a louder sound does make a higher amplitude)
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| **LESSON PLAN – 5-E Model**  |
| [**ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:**](http://www.youtube.com/watch?v=PUB1GU_tvpI&safe=active) Discuss: imagine you could see sound waves, and visualize them like we saw waves on the computer screen yesterday. What would the representation of sound waves for a clap look like? A whistle? After talking to your team, draw what you think the waves would look like in your notebook. |
| **EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:** 1. Materials & equipment are set up on students’ desks. Students are in small groups & will assign roles to each other for the activity, e.g. note taker, leader, technology specialists, noisemaker, etc. The leader will read out loud from the handout and the group will perform the activity together.
2. Teacher will review the definitions of modulation, amplitude, and frequency with students. Students will make predictions about what they expect to see when a sound signal is represented with AM modulation versus when a sound signal is represented with FM modulation.
3. **Activity:**
	1. Students will observe the AM signal first. They will see what happens if the information signal is an actual voice signal that is captured from the microphone of their laptop. They will switch the information signal source so that it comes from the laptop microphone. In a quiet environment with no noise, there is no signal, so the top and bottom graphs will look basically like flat lines.
	2. Students will produce signals by speaking, snapping, clapping, etc. close to or far away from the microphone. They will observe how different types and volumes of sounds produce different signals. They will take screenshots of their observations and upload them to Google Classroom for the class discussion/share out later.
	3. Students will repeat the above procedure for the FM modulation and record their observations.
	4. Students will then compare their observations for the bottom left graphs (spectrogram) for the voice signal with AM and FM modulation and record their observations.

**Hardware:** Linux machines (ex laptop, raspberry pi) and 2 Software Defined Radios (ADALM Pluto). **Software:** GNU Radio, COSMOS toolkit framework  |
| **EXPLAIN: Concepts Explained and Vocabulary Defined:** After students complete their experiment the teacher will facilitate a discussion/share out of their observations. The teacher will project student screenshots/observations of graphs to provide support for student thinking. Teacher will guide students to understand their observations and correct any errors they may have made. Students will clarify/strengthen their understanding of the difference between the AM and FM modulation and vocabulary (*frequency, amplitude, modulation,* *signal)*.**Key Vocabulary:** * amplitude
* amplitude modification
* frequency
* frequency modification
* signal
* carrier wave
* sound/sound wave
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| **ELABORATE: Applications and Extensions:** Students will extend their knowledge of AM and FM wave signals and modulation by discussing the following questions: * Do AM signals or FM signals do a better job of representing sound from a microphone?
* Based on your screenshots/observations, what is your evidence?
* What do you think might be advantages of AM modulation? Of FM modulation? Why?
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| **EVALUATE:** **Formative Monitoring (Questioning / Discussion):** 1. Teacher observations
2. Student responses to questions/discussion prompts

**Summative Assessment (Quiz / Project / Report):** 1. Written work (screenshots posted to Google Classroom, answers to questions on worksheet)
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| **Elaborate Further / Reflect: Enrichment:** Turn back to your Do Now (Engage). Compare and contrast the screenshots of the waves you observed with the waves you predicted. What similarities and differences do you see? How closely do your results match your predictions. |