COSMOS Educational Toolkit

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https://cosmos-lab.org/outreach

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*The COSMOS testbed design and deployment is joint work with the COSMOS team (www.cosmos-lab.org).
COSMOS Outreach

- Global economy changing via technological advances
- **All students** should have quality access to science, technology, engineering, and math (STEM) precollege coursework
- Higher education is **critical** in preparing the next generation of STEM professionals
- **This work →** Develop a teacher’s professional development (PD) program and an educational toolkit, using wireless communications and Next Generation Science Standards (NGSS)

*How could engineers and educators collaborate to create a wireless communications teacher PD program in order to develop NGSS lessons with STEM teachers?*
Program Overview (1/3)

a. **Lecture and lab phase:** The participants are introduced to fundamental and some advanced concepts in wireless communications and networking
   • $8K stipend for summer

b. **Design phase:** The participants conduct research on potential educational NGSS STEM lessons with a hands-on wireless labs using the ‘COSMOS Educational Toolkit’

*Fig:* Participants attend an instructor-led lesson using the ‘COSMOS Educational Toolkit’

*Fig:* Participants conduct research using sensors
c. **Development phase:** teachers co-develop with the researchers their best ideas on how to use the wireless labs for NGSS-aligned STEM lessons

d. **Implementation phase:** teachers and students use the developed lessons in the class during the school year

*Fig:* Teachers present their developed NGSS lesson plans at Silicon Harlem

*Fig:* Middle school students using the ‘COSMOS Educational Toolkit’ in a Mathematics Class
Program Overview (3/3)

e. **Feedback phase:** teachers provide feedback in order to improve the NGSS STEM lessons and develop new ones

*Fig:* Teachers present the PD Program and the developed NGSS Lesson Plans at the NE-ASTE Conference 2018
COSMOS Educational Toolkit

• Hardware components:
  • **Processing Units**: Intel NUC, Raspberry PI
  • **Software Defined Radio**: ADALM Pluto SDR, RTL-SDR
  • **IoT Nodes**: Arduino/Micro:bit, XBEE/BLE, sensors

• Software components:
  • **Web front-end interface**: HTML, CSS and Javascript
  • **Web back-end server**: Python
  • **SDR Software**: GNU Radio
  • **IoT management**: influxdB and Chronograf

Fig: Hardware components of the ‘COSMOS Educational Toolkit’
Example Lab: Destructive Interference
Example Lab: Photosynthesis

- **outdoor sunlight**
  - bkgrd CO₂ = 715 ppm

- **Japanese boxwood**
  - CO₂ = 700 ppm (4%)

- **COSMOS tool kit**

- **background CO₂ = 1.44 kppm**

- **plant photosynthesis**
  - CO₂ = 1.40 kppm (3%)

- **light bulb lit indoors +CO₂ (exhale)**
  - bkgrd CO₂ = 32.4 kppm
  - Magnolia CO₂ = 31.0 kppm (5%)
Example Lab: Bandwidth

Student Worksheet

| Student Name __________________________ | Class ________ |

**Bandwidth**

Bandwidth is the range of frequencies “occupied” by a signal – in particular, the width of the range of frequencies. Recall, that when looking at a signal in the frequency domain, we saw that the signal may not be only confined in a narrow range of frequencies but may have energy on a wider set of frequencies. See below:

Let us take a closer look at the top graph showing the "Power of the radio
“Everyday we would work on our labs and constantly communicate with our mentors to help us fix any problems we encountered with the toolkit. They are extremely knowledgeable and very helpful. We would be lost without them.”

- Richard Foster (Parkside Preparatory Academy MS2)

“Panagiotis is adjusting my Toolkit remotely. WOW!!!”
Conclusion

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