Learning STEM using Arduino: an open-source electronic platform

Danielle Balistrieri
Fennimore High School
Friday, March 17th, 2:00-2:50

Want to follow along?
Go to: https://goo.gl/eyh0i5
Background
Applied STEM

- Inspiration- Masters at UW-P

- Rural school, more opportunity

- Thematic units

- Computer programming
  - Research- platforms
Team building

- Set norms
- Design logos

Assessed different ways

- Paper or video option
- Presentation
- Poster session
- Debate

Reflection

- Team dynamics
- Habits of Mind

Students designed an experiment and took measurements using Google’s *Science Journal* app.
1. Persisting
   Stick to it!
   Persevering in task through to completion; remaining focused. Looking for ways to reach your goal when stuck. Not giving up.

2. Managing Impulsivity
   Take your time!
   Thinking before acting; remaining calm, thoughtful and deliberative.

3. Listening with understanding and empathy
   Understand others!
   Devoting mental energy to another person’s thoughts and ideas; Make an effort to perceive another’s point of view and emotions.

4. Thinking flexibly
   Look at it another way!
   Being able to change perspectives, generate alternatives, consider options.

5. Thinking about your thinking
   (Metacognition)
   Know your knowing!
   Being aware of your own thoughts, strategies, feelings and actions and their effects on others.

6. Striving for accuracy
   Check it again!
   Always doing your best. Setting high standards. Checking and finding ways to improve constantly.

7. Questioning and problem posing
   How do you know?
   Having a questioning attitude; knowing what data are needed & developing questioning strategies to produce those data. Finding problems to solve.

8. Applying past knowledge to new situations
   Use what you learn!
   Accessing prior knowledge; transferring knowledge beyond the situation in which it was learned.

9. Thinking & communicating with clarity and precision
   Be clear!
   Strive for accurate communication in both written and oral form; avoiding over-generalizations, distortions, deletions and exaggerations.

10. Gather data through all senses
    Use your natural pathways!
    Pay attention to the world around you. Gather data through all the senses, taste, touch, smell, hearing and sight.

11. Creating, imagining, and innovating
    Try a different way!
    Generating new and novel ideas, fluency, originality.

12. Responding with wonderment and awe
    Have fun figuring it out!
    Finding the world awesome, mysterious and being intrigued with phenomena and beauty.

13. Taking responsible risks
    Venture out!
    Being adventuresome; living on the edge of one’s competence. Try new things constantly.

14. Finding humor
    Laugh a little!
    Finding the whimsical, incongruous and unexpected. Being able to laugh at one’s self.

15. Thinking interdependently
    Work together!
    Being able to work in and learn from others in reciprocal situations. Team work.

16. Remaining open to continuous learning
    Learn from experiences!
    Having humility and pride when admitting we don’t know; resisting complacency.
UNIT I: TEAM BUILDING
Unit 2: Gears

- Math of gears - gear ratios
  - Had to design a 24-tooth gear
- Gears as technology
- Mechanical Advantage
- Mechanical engineering: Jack & Jill Engineering Challenge
Unit 4: Biotechnology

- Proteins to Climate Change curriculum - Cheryl Redman, UW Madison (she’s at WSST!)
- Before the Flood documentary
- Genetic engineering
  - Zika- book
  - GM Mosquitoes in South Florida- debate

Unit 5: Mish Mash

- Race to the Future- team building
- Balloon Car
- Barbie Launcher
- Barbie Bungee Jump
- Marble Roll
Unit 3: Circuits

- Milton-Pella Grant ($1000)
- Circuit Basics- pHET simulator
- Snap Circuits
- Arduino

https://cdn.sparkfun.com/assets/3/2/0/f/1/515b5745ce395fc83c000001.png
The Arduino Unit
pHET simulator  *(does not work on Chromebook)*

- Symbols/schematic drawings
- Series & parallel circuits
- Relationship between voltage, resistance, current
- Ohm’s Law \((V=IR)\)
Vocabulary Dominoes
Snap Circuits

- Build 10 projects
- Relate concepts from pHET simulator
- Open source
- Circuits/electricity
- Computer programming
Purchased with grant money:

- 12 Arduino kits from Amazon (Vilros), $60 each
  - I’d actually recommend buying directly from Arduino (about $105 each)
- 12 Tackle boxes for storage of pieces
- Project books
  - Make Electronics
  - Arduino Workshop
- Miscellaneous pieces
  - Multimeter
  - 9V Batteries
  - Magnifying Glasses
  - LEDs, push buttons, etc.
Codebender

No longer available :(

```c
/*
* Blink
* Turns on an LED on for one second, then off for one second, repeat.
* This example code is in the public domain.
*/

void setup()
{
    // initialize the digital pin as an output.
    // Pin 13 has an LED connected on most Arduino boards:
    pinMode(13, OUTPUT);
}

void loop()
{
    digitalWrite(13, HIGH);  // set the LED on
    delay(1000);              // wait for a second
    digitalWrite(13, LOW);    // set the LED off
    delay(1000);              // wait for a second
}
```
Arduino

Project 1:

Series & parallel circuits

Project 2:

“Spaceship interface”

Had to change the code
Arduino

Project 3:

- Project of choice
- Had to modify it further
Final Project Options

- Build a project as written (lowest score)
- Build a project & make a minor modification
- Build a project & make a major modification (highest score)
- Create something completely new (extra credit)
My Conclusion: Kids are Amazing

Robot Car 1

Robot Car 2

The Magic Doober

Police Light Bar
Survey Results

Survey Results

Pre- and Post- Arduino unit

About 4 weeks between

Other classes

Forgot original answer

High frustration levels
How would you rate your comfort level with science?

- Not comfortable: 0%
- Somewhat: 68%
- Very: 32%

- Not comfortable: 0%
- Somewhat: 75%
- Very: 25%
How would you rate your comfort level with technology?

Not comfortable: 8%

Somewhat: 52%

Very: 40%

Not comfortable: 0%

Somewhat: 54.2%

Very: 45.8%
How would you rate your comfort level with Math?

Not comfortable: 28%

Somewhat: 44%

Very: 28%

Not comfortable: 25%

Somewhat: 33.3%

Very: 41.7%
How would you rate your comfort level with Engineering?

Not comfortable: 12%

Somewhat: 64%

Very: 24%

Not comfortable: 12.5%

Somewhat: 37.5%

Very: 12.5%
Job Interest in STEM Fields:
Science-based career

No! Definitely not: 12%
Most likely not (but there’s a tiny chance): 28%
It’s a possibility (not throwing the option out): 44%
Yes, strongly considering it; I know I will. 16%

No! Definitely not: 8.3%
Most likely not (but there’s a tiny chance): 12.5%
It’s a possibility (not throwing the option out): 50%
Yes, strongly considering it; I know I will. 29.2%
Job Interest in STEM Fields: Technology-based career

No! Definitely not: 16%

Most likely not (but there’s a tiny chance): 16%

It’s a possibility (not throwing the option out): 44%

Yes, strongly considering it; I know I will. 24%

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No! Definitely not: 8.3%

Most likely not (but there’s a tiny chance): 25%

It’s a possibility (not throwing the option out): 37.5%

Yes, strongly considering it; I know I will. 29.2%
No! Definitely not: 16%

Most likely not (but there’s a tiny chance): 32%

It’s a possibility (not throwing the option out): 36%

Yes, strongly considering it; I know I will. 16%
Rate your critical thinking skills.

Poor: 4%
A little weak: 8%
Okay: 20%
Good: 60%
Very good: 8%
Poor: 0%
A little weak: 4.2%
Okay: 25%
Good: 33.3%
Very good: 37.5%
Rate your cooperation skills.

Poor: 4%
A little weak: 4%
Okay: 16%
Good: 56%
Very good: 20%

Poor: 0%
A little weak: 0%
Okay: 16.7%
Good: 50%
Very good: 33.3%
If you were not enrolled in this class, do you think you would have been exposed to technology like Arduino while at Fennimore?

- I wouldn’t have been exposed whatsoever.
- No, it’s not really one of my interests, so I’m not knowledgeable about it.
- No, I don’t believe I would because I am not in technology classes.
- Maybe. I took a robotics course last year which used VEX robots.
What did you enjoy most about this unit?

- I had to use my brain every day.
- Learning about how much you can actually do with Arduinos and how easy they are to use for all ages.
- Finally figuring out our project after lots of frustration and troubleshooting!
- I like the whole thing - I don’t know why, but I really liked it.
Improvements

- Going over coding more thoroughly
- More time
If you want to know more about any specific activities, please ask me after the session!