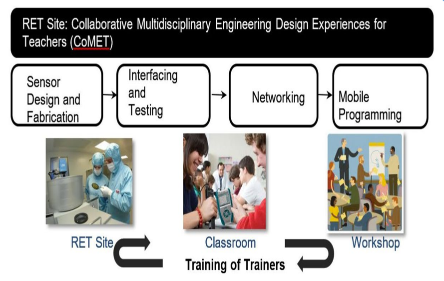
The Effectiveness of Introduced STEM in Intensive Mathematics Courses

UCF College of Engineering & Computer Science

Kevin Scott

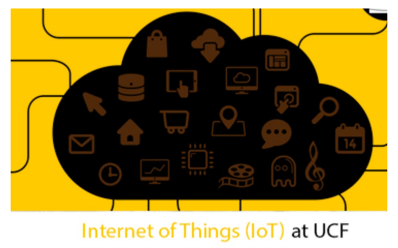
Colonial High School

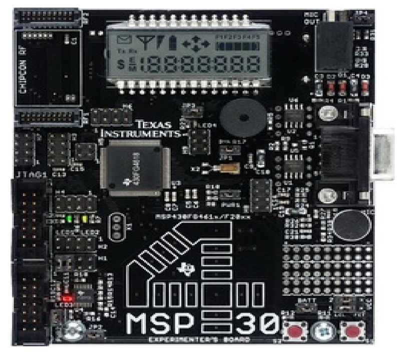
Summary



RET Program – an observation and experience with the engineering lifecycle

The RET Program has provided a great opportunity for educational professionals to not only learn applicable STEM activities, content, and principles not readily experienced or taught in the classroom but also to learn the engineering lifecycle. The engineering lifecycle provides a unifying picture of the foundational STEM elements required for accomplishing a design and implementing an engineering project. These practical and classroom applicable experiences are great experiences for STEM educators. For instance before this program, many educators had no knowledge of a programmable tool that we could use in the classroom to further our students STEM exposure. Through the Pi, we gained research and engineering experience, and now we can implement such lessons. Going through networking, computer science, electrical engineering, and real applicable research are opportunities many educators can dream for. This by far has been the best professional development an educator can ask for.



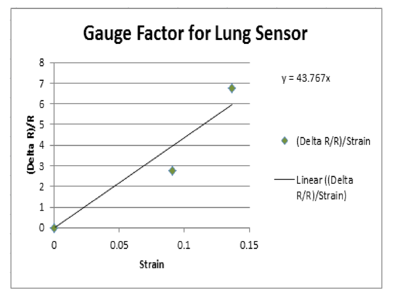


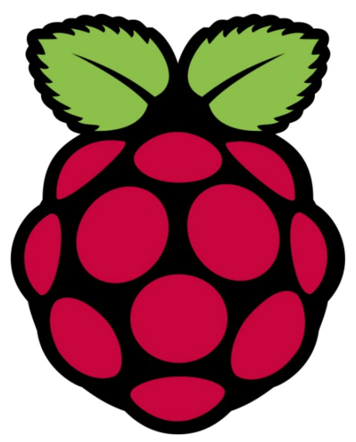
```c
//With SW1 switches
#include "msp430fg4618.h"

int main(void) {
  volatile unsigned int i;
  WDTCTL = WDTPW | WDTHOLD;

  P2DIR |= 0X06;
  P2OUT=0x00;

  for (;;) {
    for (i=0;i<=10000;i++);
    if(!(P1IN & 0x02))
      P2OUT ^= 0x02;
    if(!(P1IN & 0x01))
      P2OUT ^= 0x04;
  }
return 0;
}
```

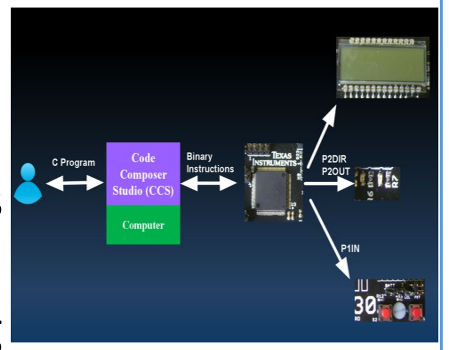
Research Activities

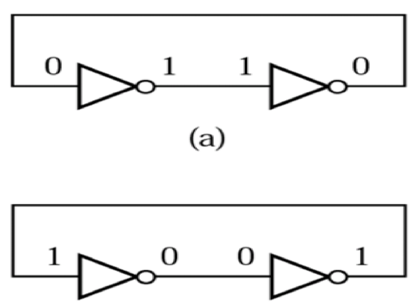
Computer Science, Electrical Engineering, Mechanical engineering, and Material Science

- Distinct areas of the engineering life cycle in 4 modules including: general engineering, mechanical engineering, material science, and computer science.
- Strain Sensors composed of Carbon Nanotubes - hollow cylindrical shapes made out of a two-dimensional hexagonal carbon lattice(s)
- Internet of Things concepts using MSP430, Code Composer Studio, and the C language. This module involves understanding bit code, ASCII values, hexadecimals and more. The researchers complete an assignment that requires the manipulation of MSP430 C code and research information on ethical hacking - specifically the relationship to the hacking of IoT devices (such as the *Honeywell* and *Nest*).
- Utilized the Raspberry Pi 3 and Java programming language. A great deal of content is covered: concepts of variables, assignments, objects, classes, methods, and numerous aspects of programming are outlined and used in the lab.









Lesson Plan

Course: Math for College Readiness; Grade Level: 12; Suggested Length of Lesson: 1 – 2 days

- **Materials/Technology Needed**

Computer, Internet Access, Paper, Pen/pencils

- **Lesson Objective(s)/Learning Goal(s)**

Practice variable assignments, solve equations, utilize order of operations, and examine the use of inequalities in the context of programming using a PHP sandbox (https://www.tehplayground.com)

- **Where this Fits**

Solving Equations, Order of Operations, Examining Inequalities

- **Standard(s)/Benchmark(s) Addressed**

Standards:

MAFS.912.A-REI.1.1 - Solve Equations, Inequalities, Apply problem solving to real world scenarios

- **Description of Lesson Activity/Experiences**

Pre-test – QR Code Below

PowerPoint - Showing the needed steps to solve simple equations or inequality

- Using operational properties to justify the step used.

Notes - Operational Properties practiced on paper

PHP sandbox practice solving equations and expressions on PHP Sandbox

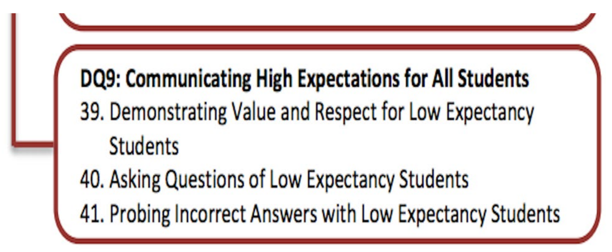
Post-test

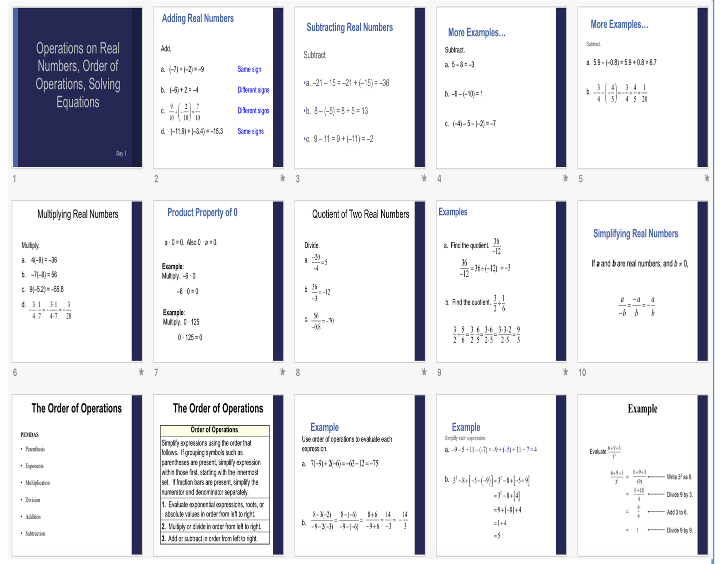
- **Recommended Assessment(s) and Steps**

Pre-test using a Google Form - https://goo.gl/forms/O7RbSwtjqQdyavvl2

Post-test using a Google Form - https://goo.gl/forms/99BMZTrpur5DTUJu1

Discussion Board helping to process, elaborate, and record/represent knowledge of content






```php
<?php
$x = 5;
$y = 4;
$z = 12;
$w = -5;
$answer = "";

// if x is greater than 4 solve the equation
if ($x > 4 ) {
  $answer = $x + $y * $w + 100;
  echo "The first answer is ".$answer."\n";
  $x = 3;
}

echo "<hr>";

// if x is less than 4 solve the equation
if ($x < 4 ) {
  $answer = $x + $y * $w;
  echo "The second answer is ".$answer."\n";
}

// if z is greater than 12 solve the equation
if ($z > 12 ) {
  $answer = $z + $y * $w;
  echo "The answer is ".$answer."\n";
}

// if w equals 0 solve the equation
if ($w == 0 ) {
  $answer = $x + $y * $w;
  echo $answer;
}
```

QR Code for Pre-Test

Lesson Learned and Assumptions

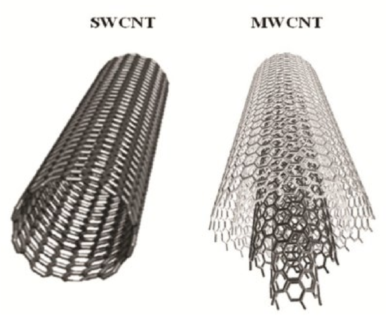
75 percent of 12th grade students are not proficient in mathematics

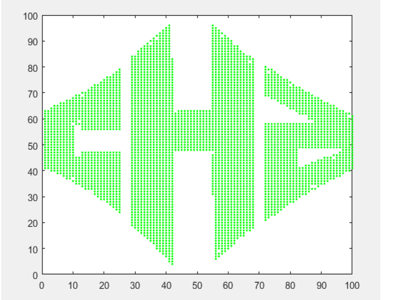
- Studies on introduced STEM lessons and content into secondary education suggest better outcomes for increased student participation in STEM fields (Vennix, J., den Brok, P., & Taconis, R., 2017).
- Secondary education STEM studies often focus on high performing students in contrast to remedial courses such as intensive mathematics.
- Assumption – Increased effective learning occurs when STEM focused content, fields, and lessons are submerged into intensive and remedial mathematics courses.

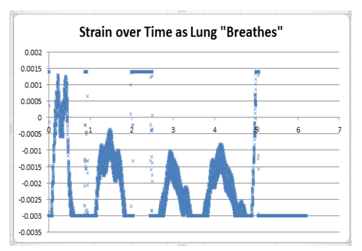
Implementation Strategy

Potential lesson explorations

- Geometric shape/lattice of the carbon nanotube as my main focus or to focus on the uses of MATLAB code in showing the relationship between the conductivity of CNTs and another substance.
- Integer concept of bases - hexadecimal or binary from the standard base 10
- Discuss logic and conditions that translates into discrete math. Discrete math is very helpful with translating word problems and helping students prepare for the math portion of standardized testing







Acknowledgments

RET Site: COMET Program, College of Engineering and Computer Science, University of Central Florida. This content was developed under National Science Foundation grant EEC-1611019.

References

Image and content references

N.a (7 Apr. 2013). *Marzanocenter.com*. Retrieved from http://www.marzanocenter.com/files/Marzano_AST_Domain1234_20130107.pdf

Bethany C. G., Jayda L. E., Sarah Y. L., Chengpeng C., and Dana M. S. (2012). A Review: Carbon Nanotube-Based Piezoresistive Strain Sensors. *Journal of Sensors, 2012*, 15. doi:10.1155/2012/652438

Baughman, R. H., Zakhidov, A. A., & de Heer, W. A. (2002). Carbon Nanotubes--the Route Toward Applications. *Science, 297*(5582), 787.

Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems, 29*(7), 1645-1660. doi:http://dx.doi.org/10.1016/j.future.2013.01.010

Zhang, Z. K., Cho, M. C. Y., Wang, C. W., Hsu, C. W., Chen, C. K., & Shieh, S. (2014, 17-19 Nov. 2014). *IoT Security: Ongoing Challenges and Research Opportunities.* Paper presented at the 2014 IEEE 7th International Conference on Service-Oriented Computing and Applications.

Rose, J., Gamal, A. E., & Sangiovanni-Vincentelli, A. (1993). Architecture of field-programmable gate arrays. *Proceedings of the IEEE, 81*(7), 1013-1029. doi:10.1109/5.231340

Enriquez, A. G., Lipe, C. B., & Price, B. (2014). Enhancing the Success of Minority STEM Students by Providing Financial, Academic, Social, and Cultural Capital. *Proceedings of the ASEE Annual Conference & Exposition*, 1.

Mathematics Transitions in STEM Education. (2012). In: National Science Foundation (U.S.), James A. Rhodes State College, 2012-08-01.

Vennix, J., den Brok, P., & Taconis, R. (2017). Perceptions of STEM-Based Outreach Learning Activities in Secondary Education. *Learning Environments Research, 20*(1), 21-46.

Hadsell, C. S. M., Burwell-Woo, C., & Enriquez, A. G. (2014). Programs to Enhance Retention and Success of Students Enrolled in Two-year College Engineering Programs. *Proceedings of the ASEE Annual Conference & Exposition*, 1.

N.a (23 Mar. 2007.). Archived: Guide to the Individualized Education Program. *Www2.ed.gov*. Retrieved from https://www2.ed.gov/parents/needs/speced/iepguide/index.html