Motivating Minorities to Move into STEM:

Exposing Students to Wireless Network Sensors in the Middle School Classroom

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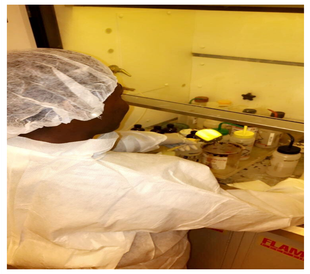
Summary

According to the National Science Foundation, minorities are underrepresented in the computer science and engineering college programs, and career fields.(NSF,) The primary reasons are the lack of exposure which influences their interest in the fields, respectively. Minorities are not introduced to STEM career fields at an early age. The majority of their home environments do not afford them the opportunity to experience STEM activities, nor are values in this field instilled. Also, the schools they attend may lack the resources, or recently were exposed to the resources. “Studies report by instilling utility values, intrinsic values, and expectancies for success into young students, we may be able to further “pressurize” the STEM pipeline, thereby increasing the flow of minority students into STEM careers.” Moreover, schools can help bridge this gap by incorporating innovating science technologies and activities in the science classroom in primary school years.

RET Research Activities

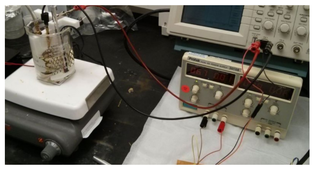
Photolithography

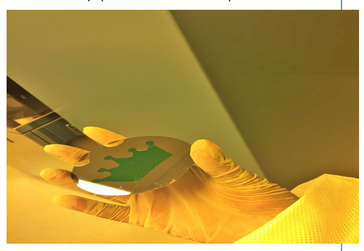
- Created a design for a mask using AutoCAD (computer software program)
- Fabricated the mask design using silicon based wafer (coated through wet oxidation)
- Photoresistor (Shipley), Spin coater, UV Mask Alignment machine



Fabricating Environmental Sensors

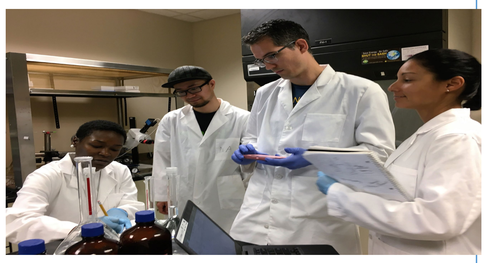
- Electroplating (carbon paste screen printed electrode, Bismuth Nitrate, Tin Chloride)
- Made an Alloy ($BiNO_3$)($SnCl_2$) using a hotplate
- Photolithography (used to deposit parent design on electrode) (thick metal film)
- Evaporation & Sputtering (create thin metal film)
- Etching





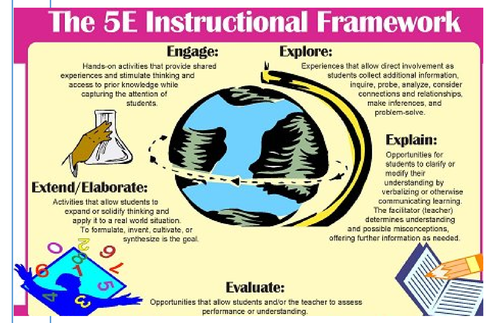
Testing Environmental Sensors for Application

- Testing the sensor- measure current, potential, and resistance in the working line compared to the reference line.
- Calibration
- Selectivity and Sensitivity
- Anodic Stripping Voltammetry



Instructional Plan

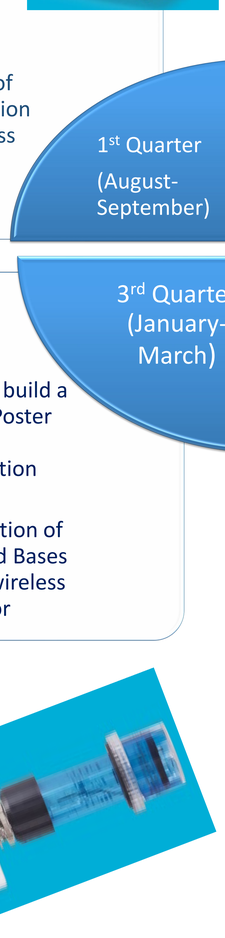
The instructional plan developed is designed to incorporate the RET research experiences and activities in the middle school content at significant points during the school year to align with the appropriate standards mandated by the Florida Department of Education. In each quarter, students will engage in a lesson that requires them to interact with a wireless sensor network. In addition to students conducting labs utilizing the sensor network, they will research college programs that study wireless network sensors, and careers that are involved with the invention and innovation of these sensors.



- Survey (STEM college program and/or career field)
- Scientific Tools (Sensor Introduction)

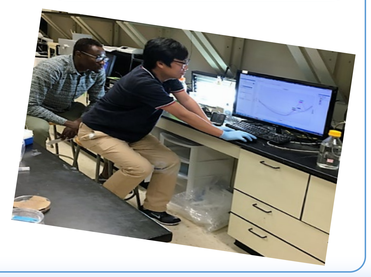
- Investigation of force and motion using a wireless smart car

- Investigation of thermal energy, temperature, and heat using a wireless temperature sensor
- If I could build a sensor- Research and Reflection Paper



- If I could build a sensor- Poster and Oral Presentation
- Investigation of Acids and Bases using a wireless pH sensor

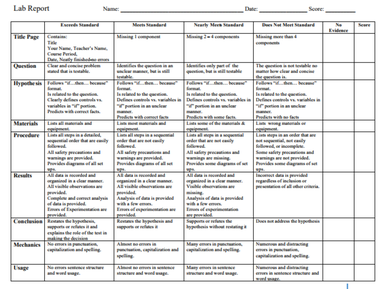
- Build a water sensor (engineering design challenge)
- The STEM career for me (Research paper, poster, and oral presentation)



Instructional Strategies

Project Based Learning

Cooperative Learning



Lab Report Name: _____ Date: _____ Score: _____

	Exceeds Standard	Meets Standard	Nearly Meets Standard	Does Not Meet Standard	No Evidence	Score
Title Page	Contains: Title, Your Name, Teacher's Name, Course Period, Date of Lab. Embellishes errors	Missing 1 component	Missing 2 or 4 components	Missing more than 4 components		
Question	Clear and concise problem stated that is testable.	Identifies the question in an unclear manner, but is still testable.	Identifies only part of the question, but is still testable	The question is not testable no matter how clear and concise the question is.		
Hypothesis	Follows "if…then… because" format. Is related to the question. Clearly defines controls vs. variables in "if" portion. Predicts with correct facts.	Follows "if…then… because" format. Is related to the question. Defines controls vs. variables in "if" portion in an unclear manner. Predicts with correct facts.	Follows "if…then… because" format. Is related to the question. Defines controls vs. variables in "if" portion in an unclear manner. Predicts with some facts.	Follows "if…then… because" format. Is related to the question. Defines controls vs. variables in "if" portion in an unclear manner. Predicts with no facts.		
Materials	Lists all materials and quantities.	Lists most materials and quantities.	Lists some of the materials & quantities.	Lists wrong materials or quantities.		
Procedure	Lists all steps in a detailed, sequential order that are easily followed. All safety precautions and procedures are listed. Provides diagrams of all set ups.	Lists all steps in a sequential order that are not easily followed. All safety precautions and procedures are listed. Provides some diagrams of set ups.	Lists all steps in a sequential order that are not easily followed, or incomplete. Some safety precautions and procedures are listed. Provides some diagrams of set ups.	Lists steps in an order that are not sequential, not easily followed, or incomplete. Incorrect safety precautions and procedures are listed. Provides some diagrams of set ups.		
Results	All data is recorded and organized in a clear manner. Many observations are provided. Complete and correct analysis of data is provided. Errors of experimentation are provided.	All data is recorded and organized in a clear manner. Some observations are provided. Analysis of data is provided with a few errors. Errors of experimentation are provided.	All data is recorded and organized in a clear manner. Few observations are provided. Analysis of data is provided with a few errors. Errors of experimentation are provided.	Incorrect data is provided regardless of inclusion or presentation of all other criteria.		
Conclusion	Restates the hypothesis; supports or refutes it and explains the role of the test to making the decision	Restates the hypothesis and supports or refutes it	Supports or refutes the hypothesis without restating it	Does not address the hypothesis		
Mechanics	No errors in punctuation, capitalization and spelling.	Almost no errors in punctuation, capitalization and spelling.	Many errors in punctuation, capitalization and spelling.	Numerous and distracting errors in punctuation, capitalization and spelling.		
Usage	No errors in sentence structure and word usage.	Almost no errors in sentence structure and word usage.	Many errors in sentence structure and word usage.	Numerous and distracting errors in sentence structure and word usage.		

Modeling

Generating and Testing Hypothesis

Current Events

Direct Instruction

Reflective Essay Name: _____ Date: _____ Score: _____

	Exceeds Standard	Meets Standard	Nearly Meets Standard	Does Not Meet Standard	No Evidence	Score
Reflect personal learning stretch in Science Project	Shows great depth of knowledge and learning. Reveals feelings and thoughts. Abstract ideas reflected through use of specific details.	Relates learning with research and project, personal and general reflections included, uses concrete language.	Does not go deeply into the reflection of learning, generalizations and limited insight, uses some detail.	Little or no explanation or reflection on learning, no or few details to support reflection.	Shows no evidence of learning or reflection.	
Organization-Structural Development of the Idea	Writer demonstrates logical and subtle sequencing of ideas through well-developed paragraphs; transitions are used to enhance organization.	Paragraph development present but not perfected.	Logical organization; organization of ideas not fully developed.	No evidence of structure or organization.		
Conclusion	The conclusion is engaging and restates personal learning.	The conclusion restates the learning.	The conclusion does not adequately restate the learning.	Incomplete and/or unfocused.		
Mechanics	No errors in punctuation, capitalization and spelling.	Almost no errors in punctuation, capitalization and spelling.	Many errors in punctuation, capitalization and spelling.	Numerous and distracting errors in punctuation, capitalization and spelling.	Not applicable	
Usage	No errors in sentence structure and word usage.	Almost no errors in sentence structure and word usage.	Many errors in sentence structure and word usage.	Numerous and distracting errors in sentence structure and word usage.	Not applicable	

Conclusion

This research program has extended my knowledge of the engineering field. I have gained an insight on the importance of incorporating STEM lessons in the middle school classroom to not only enhance science instruction, but also inspire minorities to get involved in STEM.

Acknowledgments

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