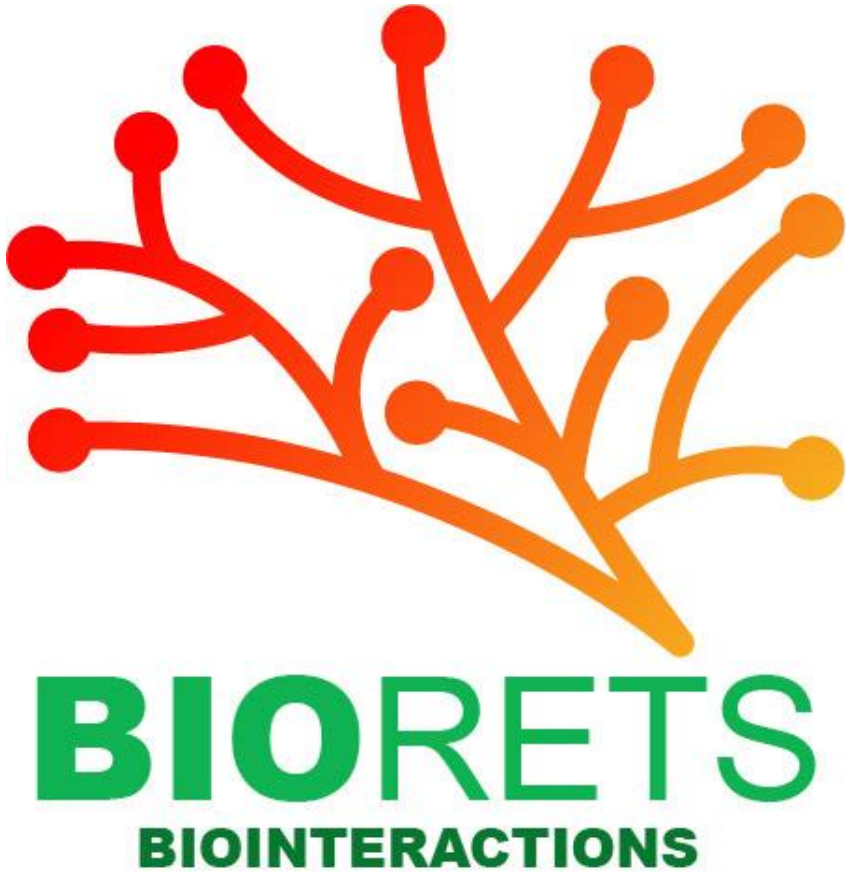
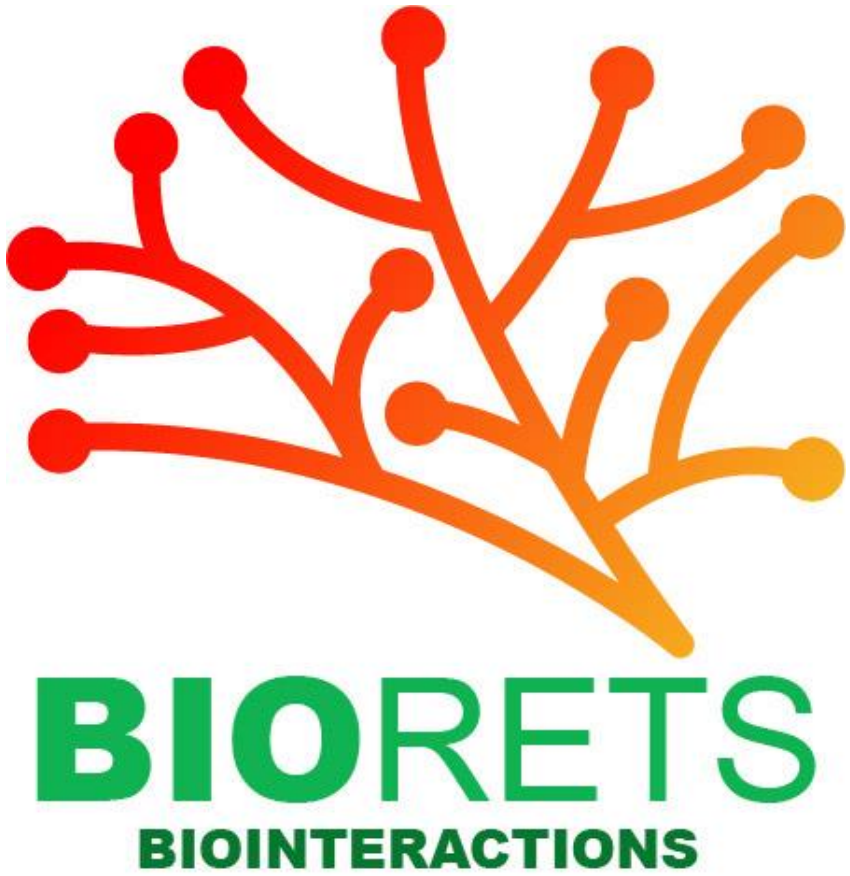


Research Experiences for Teachers: Key to Developing Students' Scientific Practices

MICHELLE BORRERO, CRUZ M. VÁZQUEZ, SANDRA BELTRÁN, MABEL RODRÍGUEZ, AND ANGELA M. DEL TORO

BIORETS: BIOINTERACTIONS

UNIVERSITY OF PUERTO RICO, RÍO PIEDRAS CAMPUS

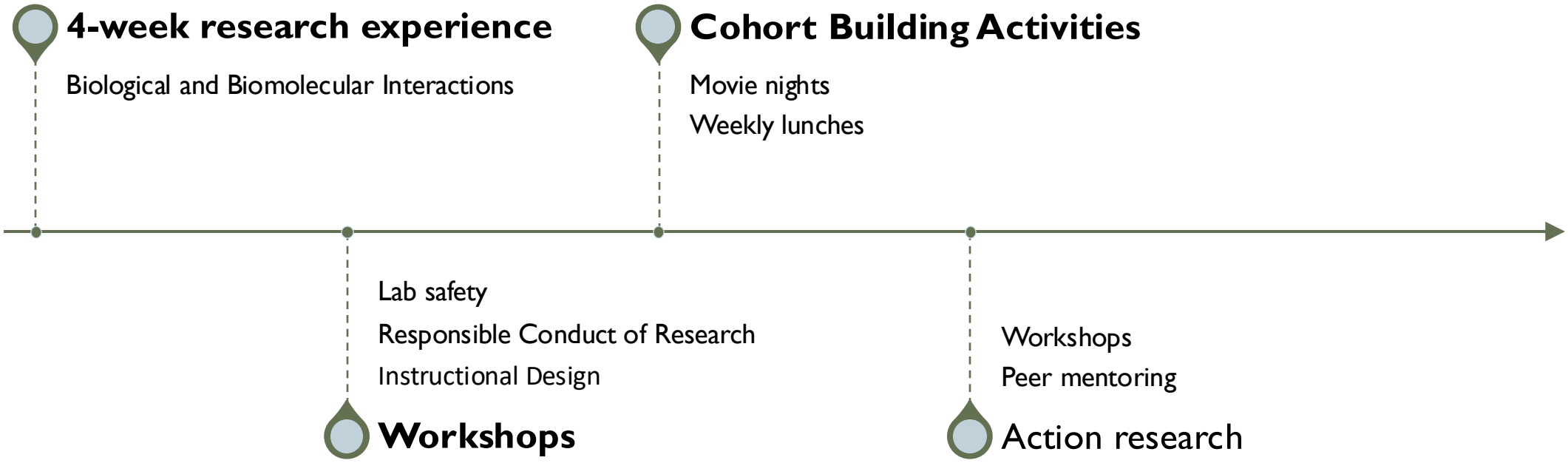


BIORETS: BioInteractions is a NSF funded project at the University of Puerto Rico that aims to provide research experiences for secondary school biology teachers on the overarching theme of biological and biomolecular interactions.

Each year 8 teachers participate in the program

- Develop standards-centered curricular materials
- Action research

Program Activities



Research Projects

Research Topic
Macro and Microscopic Changes During Regeneration and Aestivation in Echinoderms
Study of Ethanol and Nicotine Tolerance in the *Drosophila melanogaster* Fly.
Morphological and Molecular Identification of Mosquitoes.
Study of Changes in the pH of the Intestinal Tract of a Fly Model with Autism Upon Probiotic Supplementation.
Macroalgae-based Nanostructured Biocarbon Membrane used for Soil Remediation
Hydrophilic - Photoresponsive Polymeric Membranes
Microplastic Ingestion by Macroinvertebrates in Rio Piedras Urban Watershed
Role of Septin9 in the Cell Cycle of Breast Cancer Cells

Curricular materials

Based on summer research experience

Aligned to standards

Develop biological conceptual understanding

- Different courses

Pertinent to students' context

- Inclusion

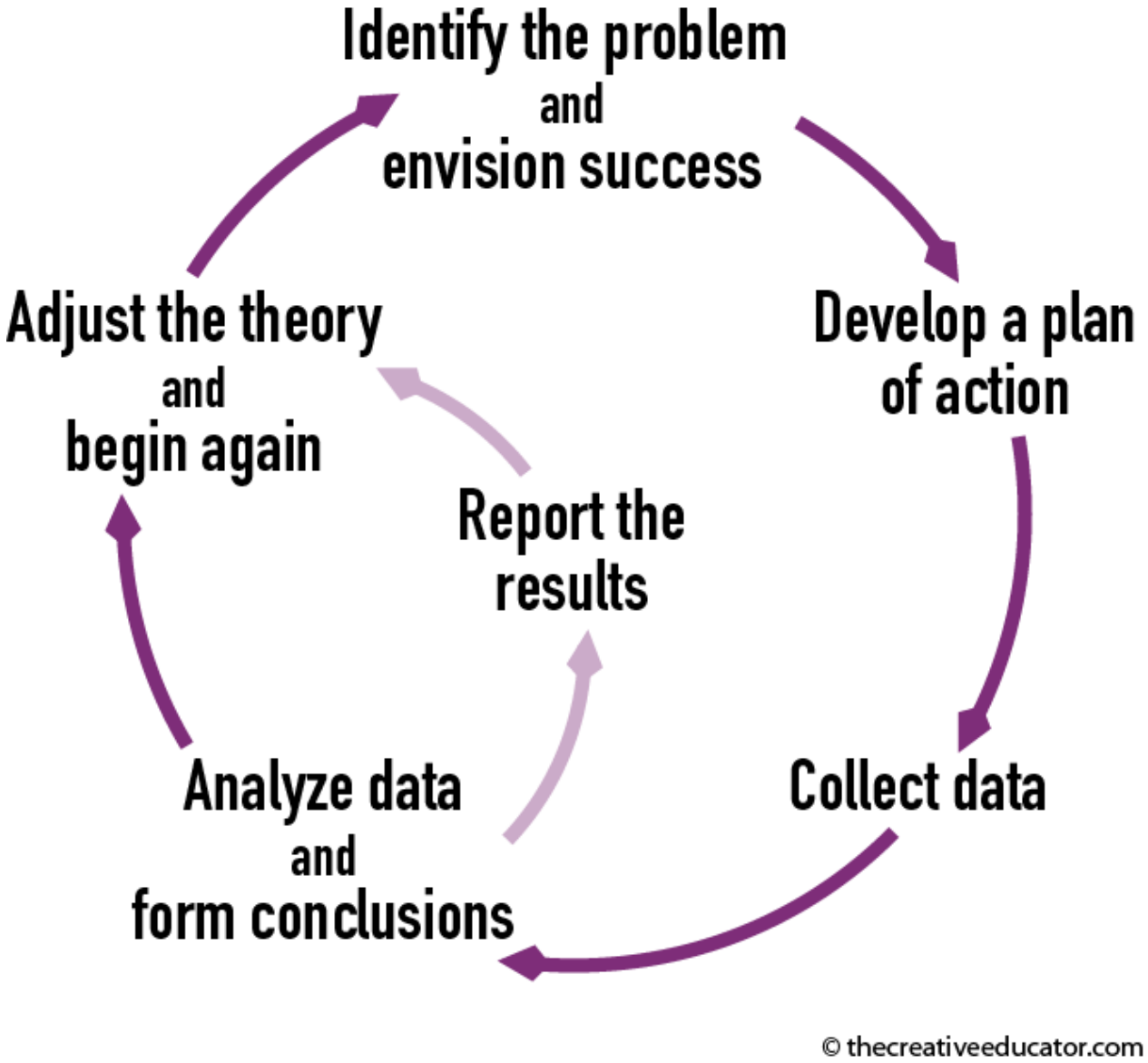
Evidence-based practices

Seek to promote students’ scientific literacy and positive attitudes towards STEM

Action research

Action research

- Teachers do research on their practice
- Tool to empower them



https://www.thecreativeeducator.com/v07/articles/Embracing_Action_Research

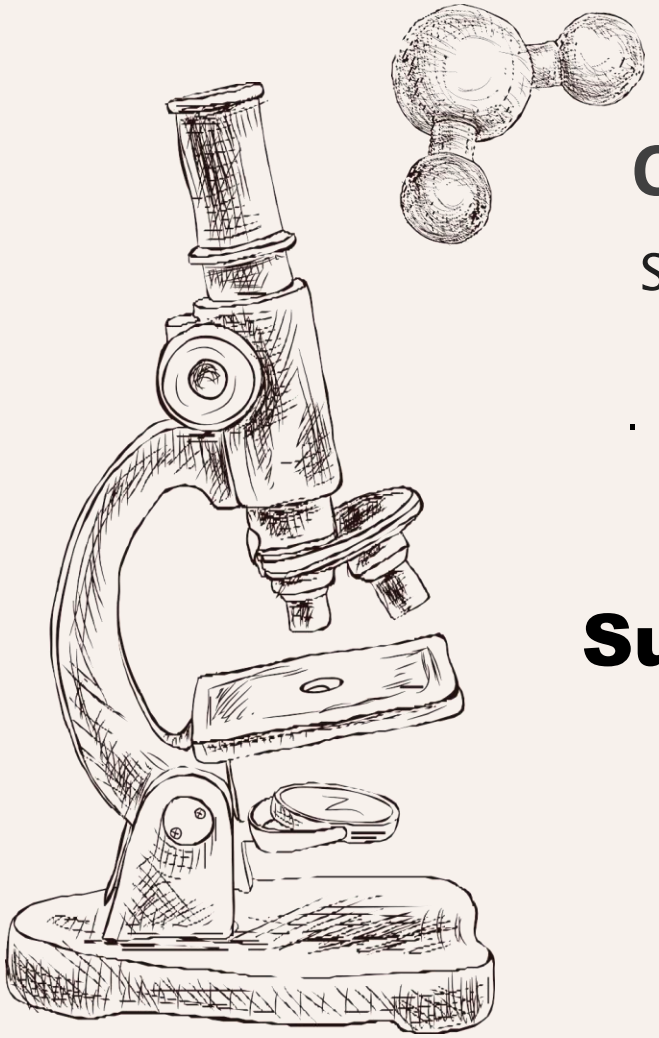
BIORETS: BioInteractions' participant schools

Questions to be discussed

- Which scientific practices are challenging for stud ents?
- Which scientific practices are challenging for you to teach?
- Do you think a RET can help you? How?
- What support would you need to transfer a RET to the classroom?

Studying the sea cucumber to learn to use scientific instrumentation

CRUZ MARIE VÁZQUEZ-ENCHAUTEGUI



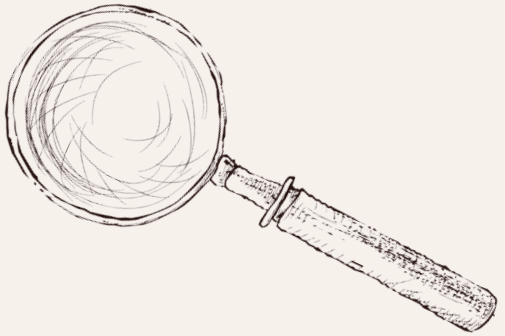
Cruz Marie Vázquez Enchantegui

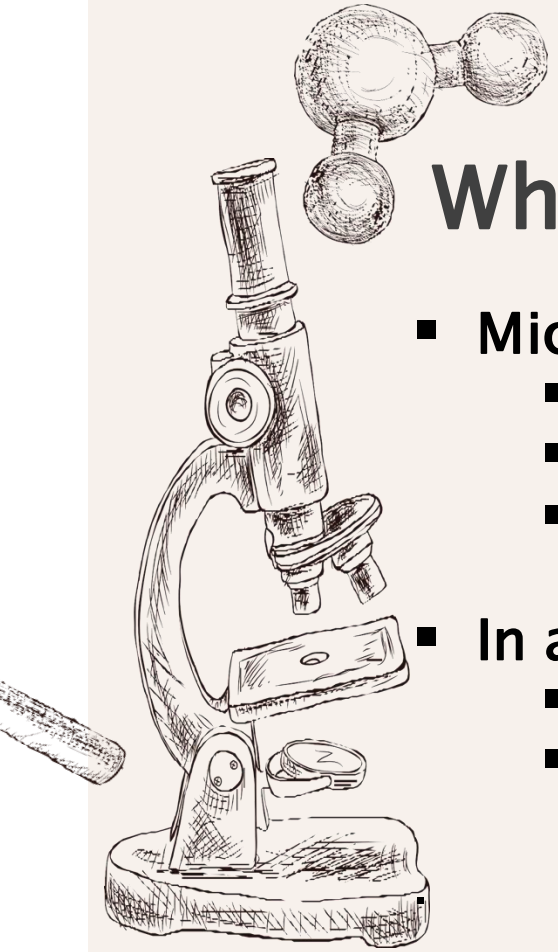
Specialized School Genaro Cautiño Vázquez

Guayama, Puerto Rico

BIORETS

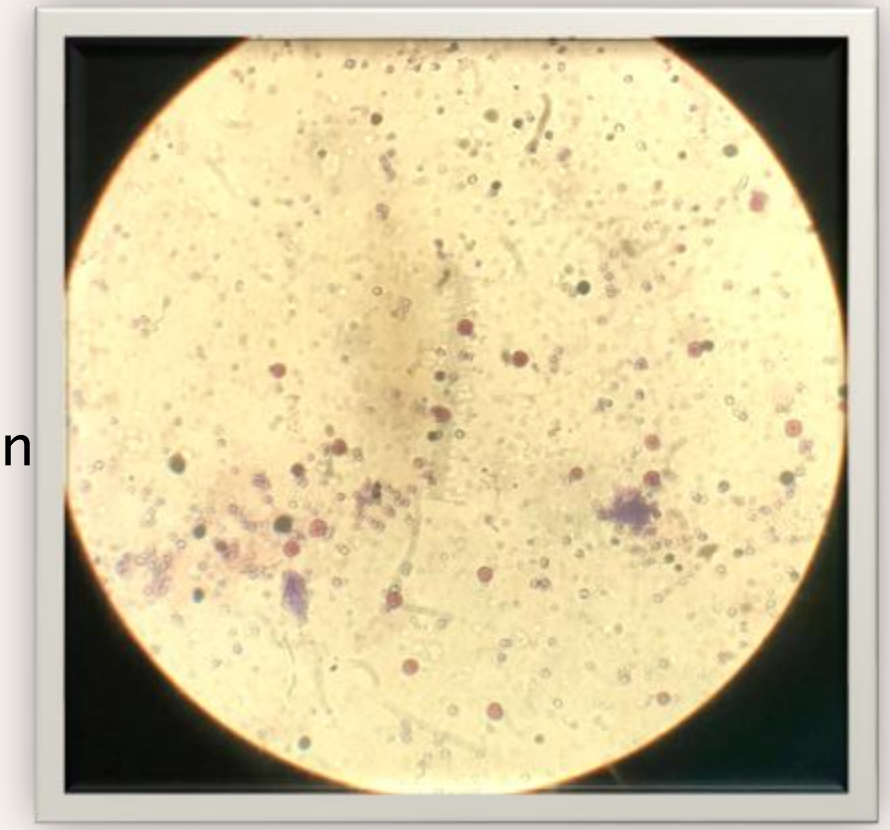
Summer research experience

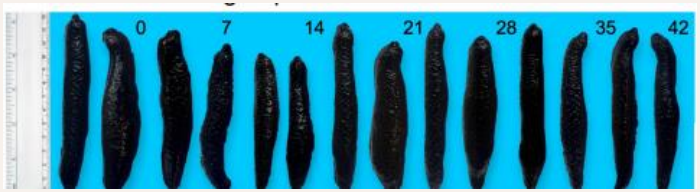




What I Learned

- **Microscopy**
  - use of the microscope
  - slide preparation
  - staining cells for better visualization
- **In addition, I worked with:**
  - Cellular measurements
  - Cell counting and differentiation in holothurians and sea urchins.





- Different holothurians cells are analyzed to determine if the organism is regenerating.
- We can identify them by their form and can quantify them.

How I transferred this research experience to my classroom:

1 My school does not have a science laboratory classroom

2 Students are not familiar with the use of the microscope

VIRTUAL LABORATORY

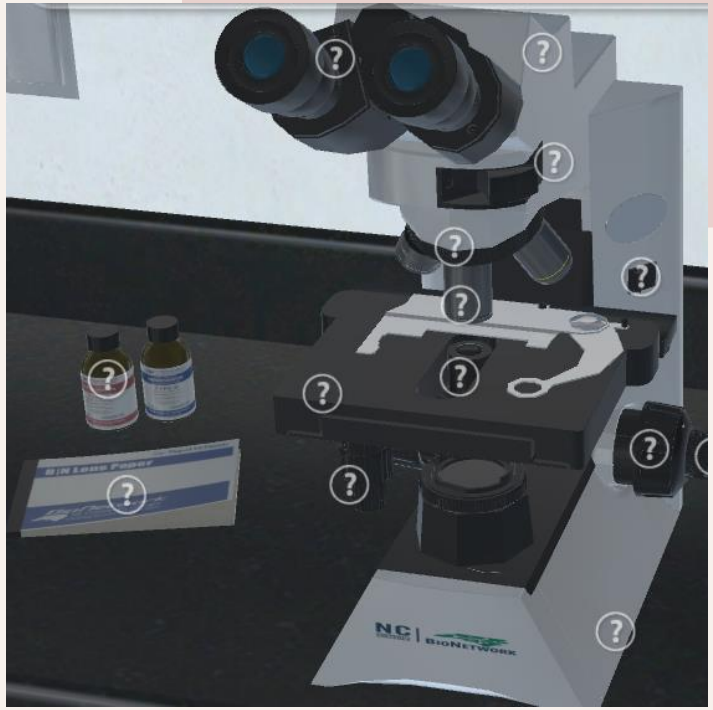
PRACTICAL DEMONSTRATION

SAMPLE PREPARATION

VIRTUAL LABORATORY

http://virtuallabs.nmsu.edu/micro.php

https://www.bionetworkapps.com/iet/microscope



PRACTICAL DEMONSTRATION

Students draw what they saw using the different magnitudes of the microscope

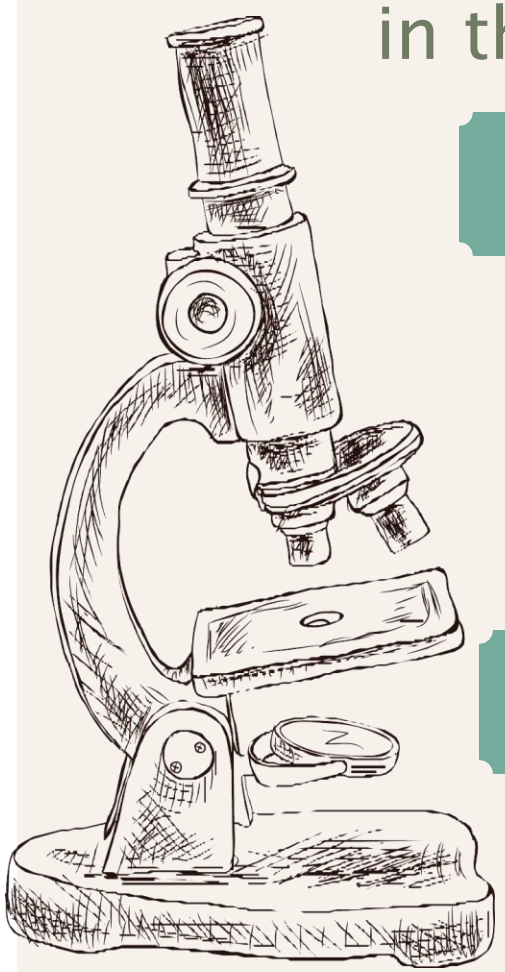
SAMPLE PREPARATION

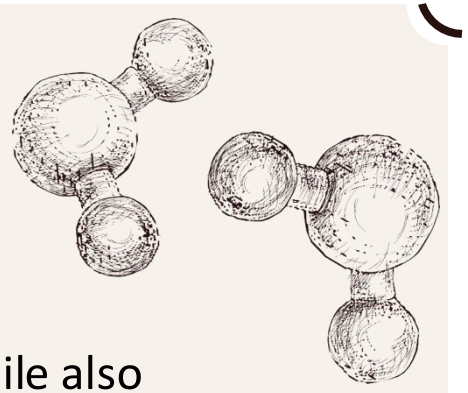
Observation guide

Observation record

Analysis and discussion

Importance of the scientific practices in the classroom





1

Integrating the use of the microscope in scientific practices in the classroom, will help students develop important practical skills while also improving their understanding of scientific concepts and their ability to make detailed and systematic observations.

This is also a way to encourage their scientific curiosity.

2

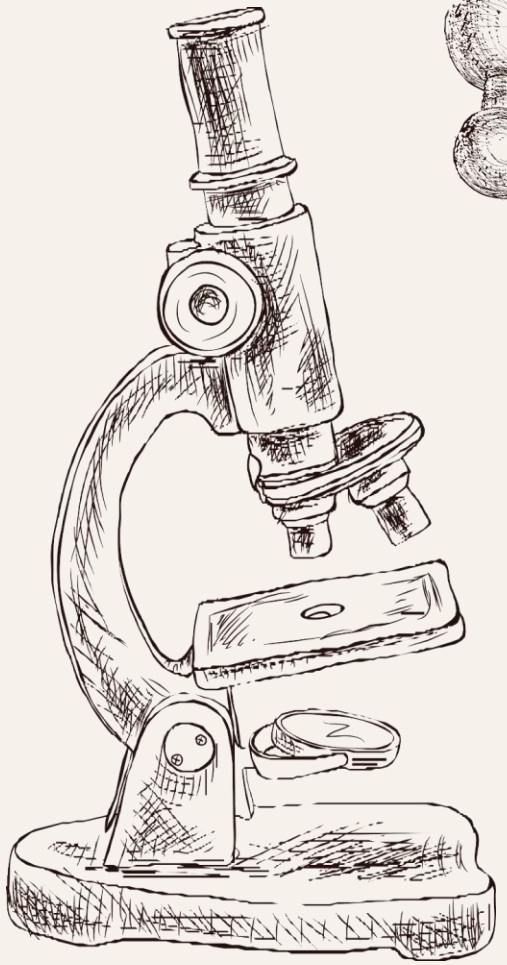
As a teacher this experience empowered me to expand my love for research and to translate it to my students.

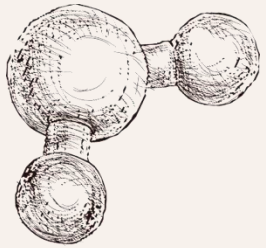
I will like to continue to provide this experiences to my students to foster problem solving and research skills.

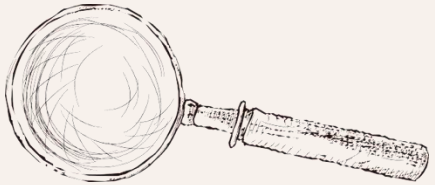
Acknowledgments

- BIORETS project
- Dr. José García Arrarás Team

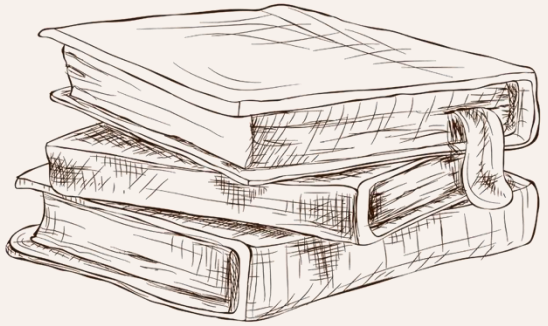
For this opportunity to improve my research and educational practices.







Thank you!



Using *Drosophila melanogaster* to increase scientific literacy

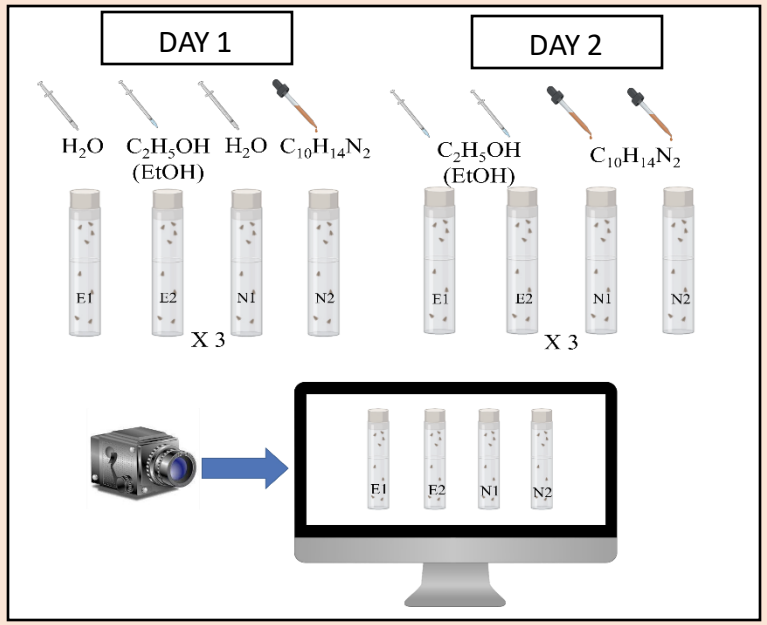
SANDRA BELTRÁN

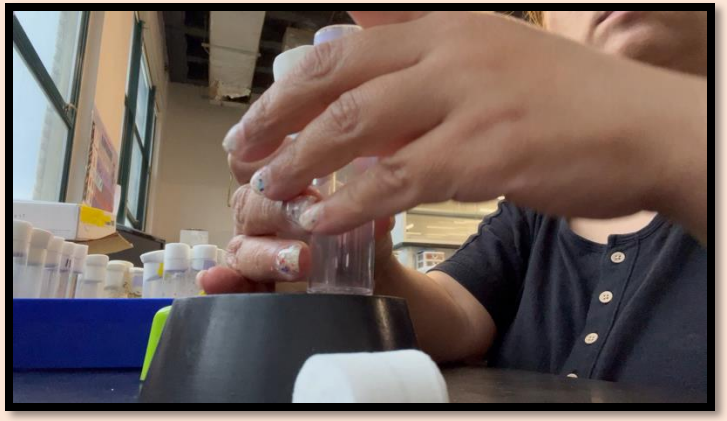
Sandra Beltrán Morales

- Biology High School Teacher
- BIORETS Project
- Department of Education of Puerto Rico
- Francisco Gaztambide Vega High School

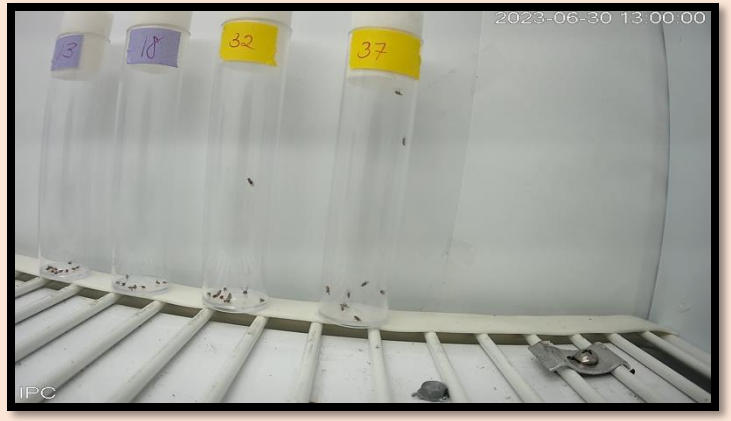
SUMMER SCIENTIFIC RESEARCH EXPERIENCE

Study of Ethanol and Nicotine Tolerance in the Fruit Fly *Drosophila melanogaster*





Sedation time for 50%	Ethanol First exposure	Ethanol Second exposure
Female (minutes)	56	46
Male (minutes)	22	34



Sedation time for 50%	Nicotine First exposure	Nicotine Second exposure
Female (minutes)	38	16
Male (minutes)	12	34

ACTION RESEARCH

TEACHER'S OBSERVATION

Low level of scientific literacy skills in tenth grade students of the biology course.

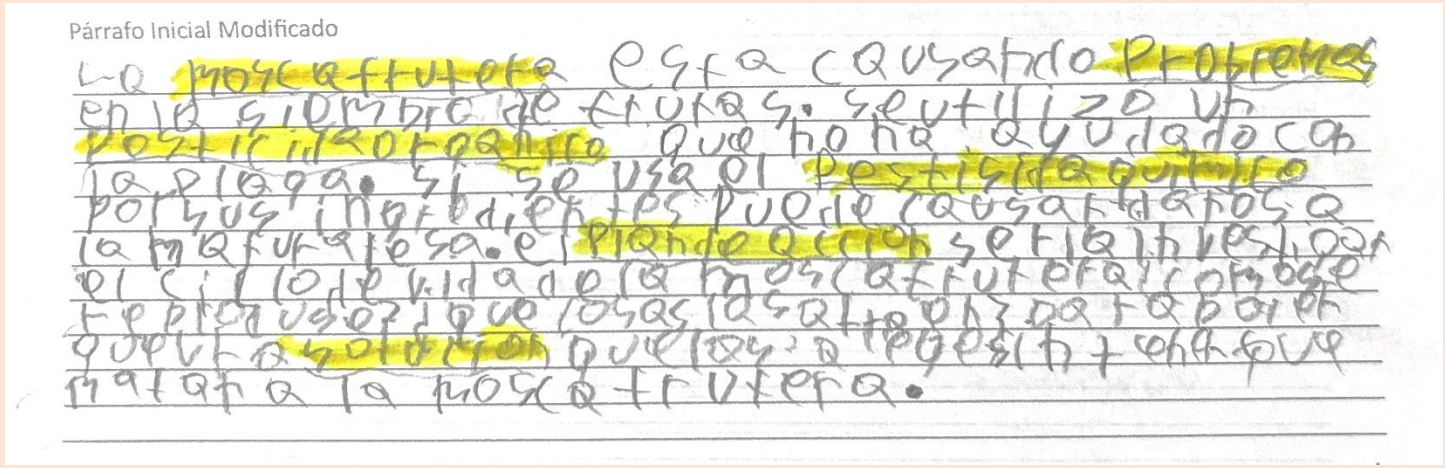
MAIN OBJECTIVE

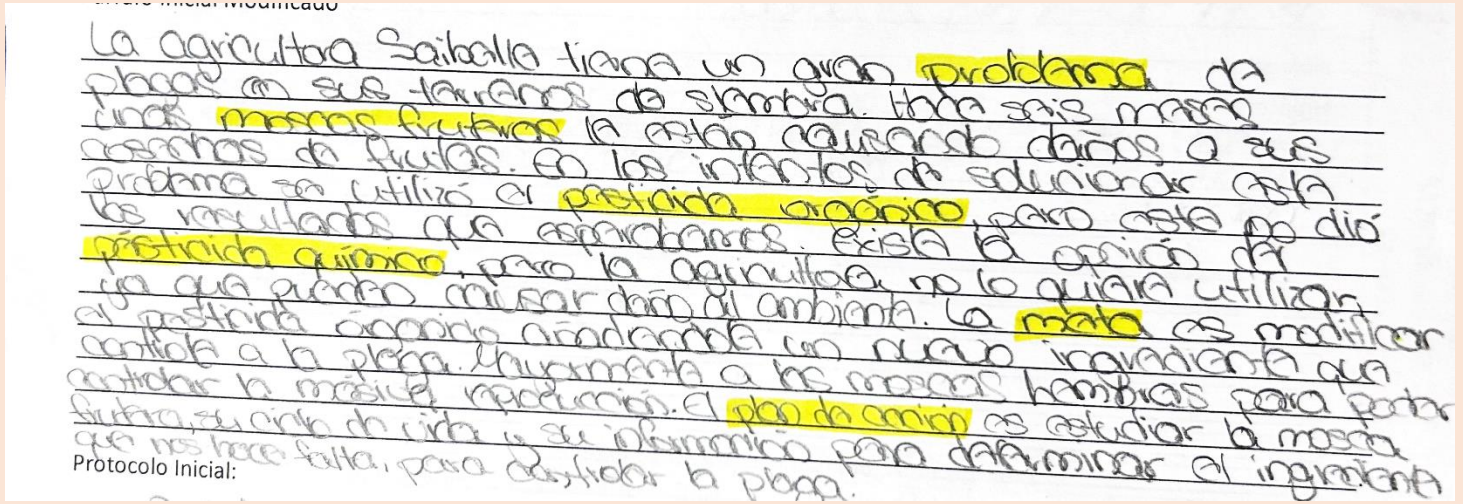
To determine whether the implementation of various teaching strategies promotes an increase in scientific literacy skills among tenth-grade students.

1. Working on a real-life problem through the scientific research process.
2. Creation of a community where the exchange of ideas and teamwork is promoted.
3. Promote constant reflection on acquired knowledge.
4. Transfer acquired knowledge in written form using the scientific concepts discussed in the research process.

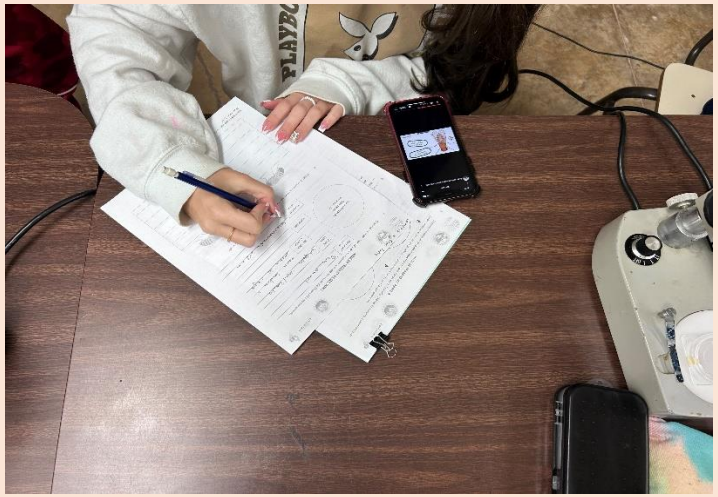
CLASSROOM ENVIRONMENT
PRESENTATION OF THE REAL-LIFE PROBLEM

TRANSFER OF ACQUIRED KNOWLEDGE
CONSTANT REFLECTION

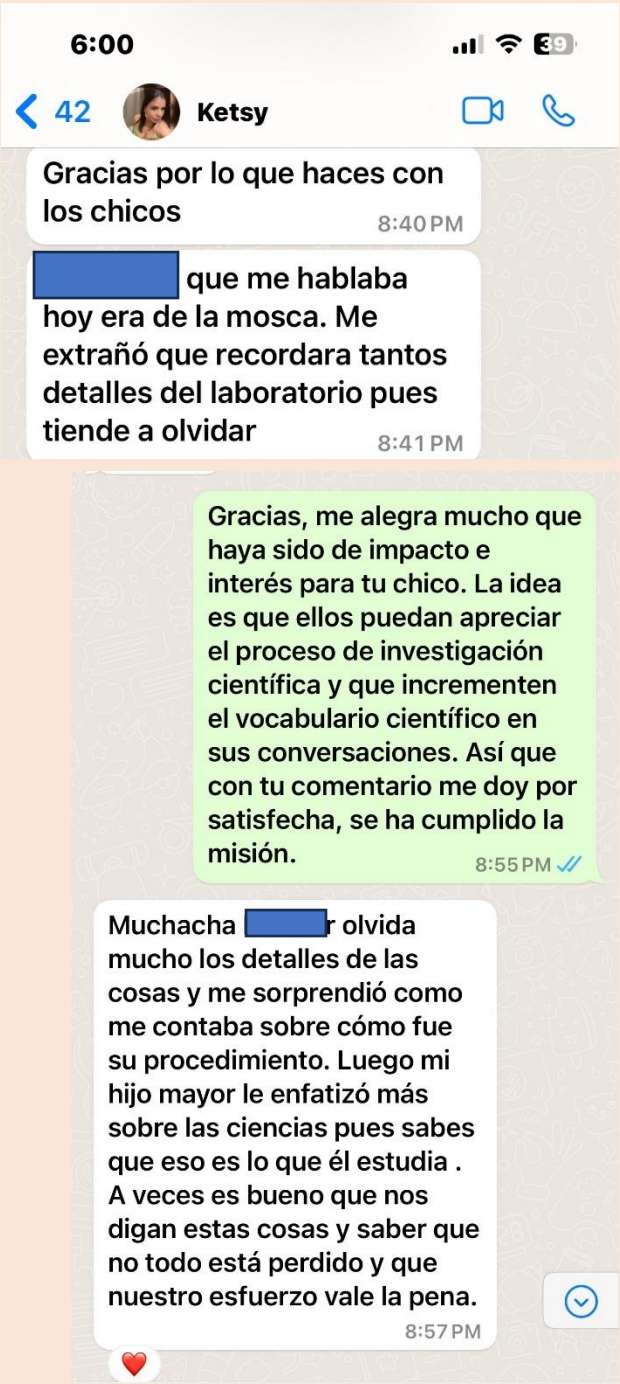




UNDERSTANDING THE PROBLEM
STUDY OF THE *Drosophila melanogaster* FRUITFLIES



IMPLEMENTATION OF THE EXPERIMENT PROTOCOL



KNOWLEDGE, BENEFITS, AND FUTURE PROJECTIONS

K

- Increase in scientific research skill
- Carrying out action research in the classroom

B

- Partnerships with scientists from the University of Puerto Rico
- Being part of a learning community
- New teaching strategies to enhance my students' learning

FP

- Incorporate the strategies into my course planning.
- Preparation of a module with activities to share with other teachers.

Acknowledgments

I would like to thank Drs. Michelle Borrero and Marta Fortis, and Ms. Brenda Santiago and Ángel Pérez for allowing me to participate in the BIORETS Project and to acquire new scientific research skills.

I would also like to thank Dr. Alfredo Ghezzi, Airined Montes and Christian del Valle for receiving me in the research laboratory and taking the time to teach me all the processes.

I would also like to thank my school principal for allowing me to implement this project at school. To my students for their willingness to participate in innovative activities. They are the best!

And finally, to my personal cheerleading team, my family. Thank you for following my inventions and sometimes giving your time to share mom.

Questions to be discussed

- Which scientific practices are challenging for stud ents?
- Which scientific practices are challenging for you to teach?
- Do you think a RET can help you? How?
- What support would you need to transfer a RET to the classroom?

Researching Mosquitoes to develop students' scientific practices

MABEL RODRÍGUEZ

RESEARCH EXPERIENCES FOR TEACHERS: KEY TO DEVELOPING STUDENTS' SCIENTIFIC PRACTICES

MABEL RODRÍGUEZ ESPINOSA
BIORETS PROJECT
DEPARTMENT OF EDUCATION OF PUERTO RICO
ESCUELA JUAN J. MAUNEZ PIMENTEL

JUAN J. MAUNEZ PIMENTEL HIGH SCHOOL

$15,773

Naguabo

Mediana de Ingresos de Familias con menores
[2017-2021]

70%

Naguabo

Niños, niñas y jóvenes bajo el nivel de pobreza
[2017-2021]

The school is located in a coastal area of Puerto Rico. The most recent statistics show that 70% of the children and youth live below the poverty level. The median income for families with children is $15,773.

SUMMER RESEARCH: IDENTIFICATION OF MOSQUITOES

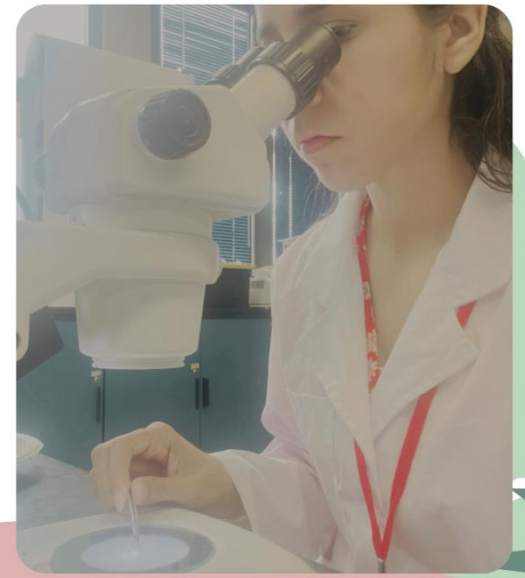
BIORETS
BIOINTERACTIONS

Talks on mosquito identification and the use of traps.

Visit to the insectarium and laboratories of the Puerto Rico Vector Control Unit.

Mosquito DNA extraction.

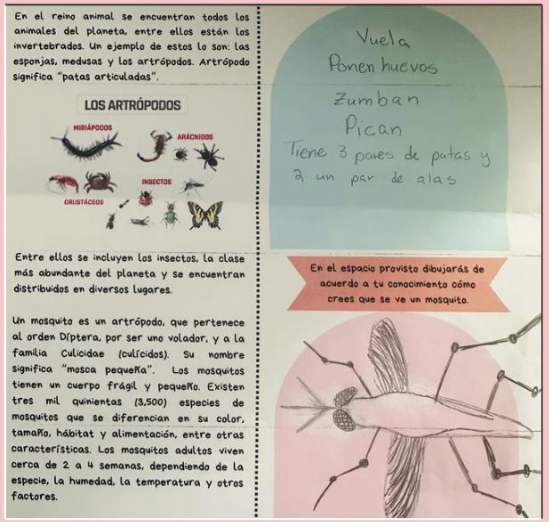
Identification of mosquitoes morphologically.



TRANSFER TO CLASSROOM MOSQUITOES:

BIORETS
BIOINTERACTIONS

1



Auscultate students' knowledge

2

Lifecycle

3

Parts and functions

4

Observation of the adult mosquito using the microscope

SKILLS AND ABILITIES OF STUDENTS

- Students show greater enthusiasm
- They have acquired skills in the use and management of the microscope.
- Observation skills
- They have improved their collaborative work skills in science class.

ACTIVITIES THAT WILL CONTINUE

- Conduct research projects
- Make prediction and hypothesis
- Strengthen data collection and analysis skills
- Promote students' participation in science fair

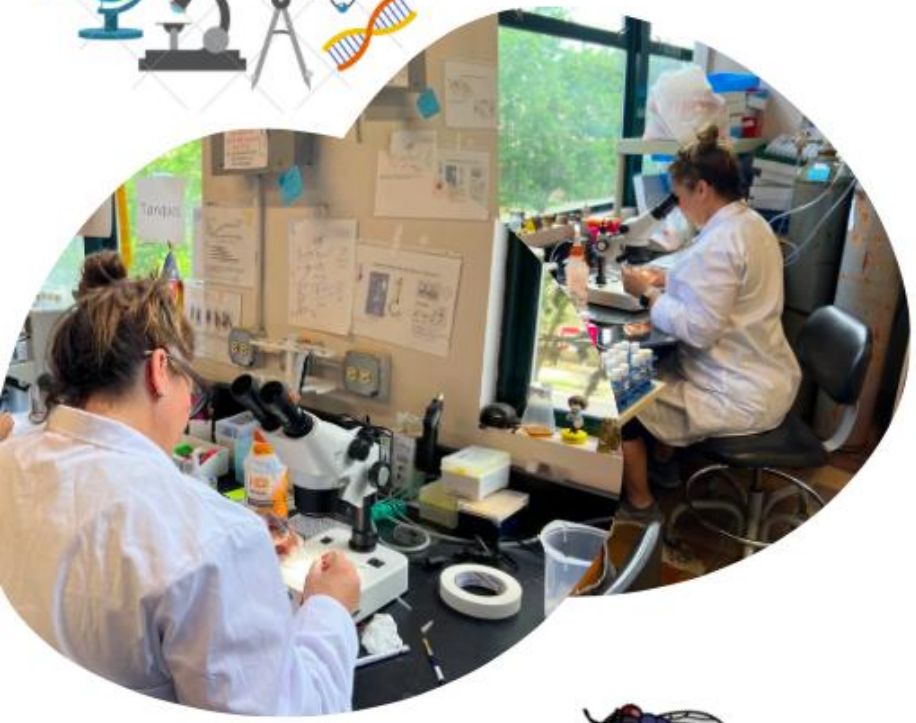
ACKNOWLEDGMENTS

I thank Dr. Jose L. Agosto's laboratory and graduate students Lizbeth Alvarado and Ernesto Espada for the opportunity to work in such a pleasant environment with them. I also thank the Puerto Rico Vector Control Unit for all the guidance provided.

Development of critical thinking skills using *Drosophila melanogaster*

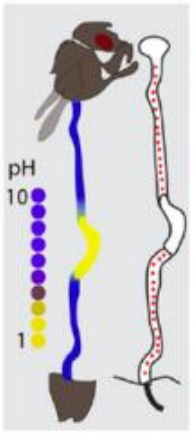
ÁNGELA M. DEL TORO

STUDY OF CHANGES IN THE PH OF THE INTESTINAL TRACT OF A FLY MODEL WITH AUTISM UPON PROBIOTIC SUPPLEMENTATION

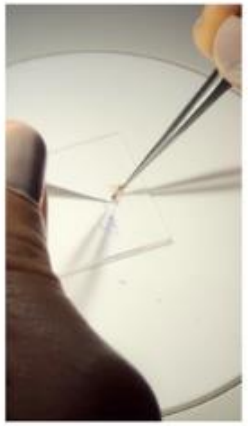


Lab Immersion

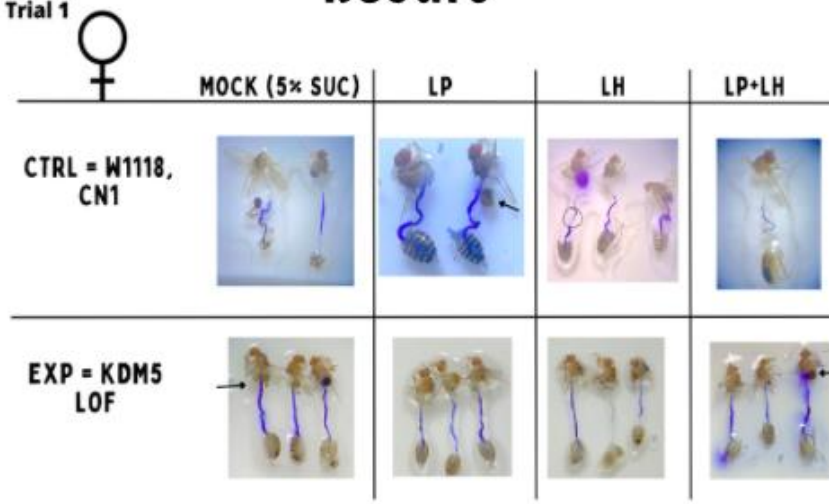
Preparation



Li et al. (2016) Cell Host & Microbe 19, 240–253



Result



The flies used for this research (kdm5LOF and w1118;cn1/+) resulted with blue intestines and no acidic (yellow) region as has been reported in former research. In some cases, yellow areas showed up momentarily, but then turned back to blue during dissection. A possible reason could be that the control fly we used (w1118; cn1/+) had genetic mutations that could cause high levels of acid pH in the midgut. Another possible reason could be the quality of the food given to flies.

Action Research

APPLICATION IN BIOLOGY CLASSROOM:

- Teach how to work with the dissection microscope
- Introduce the main character of the play: the fruit fly (life cycle and gender identification)
- Scientific Method: students will practice all steps through activities

Capture the student's attention

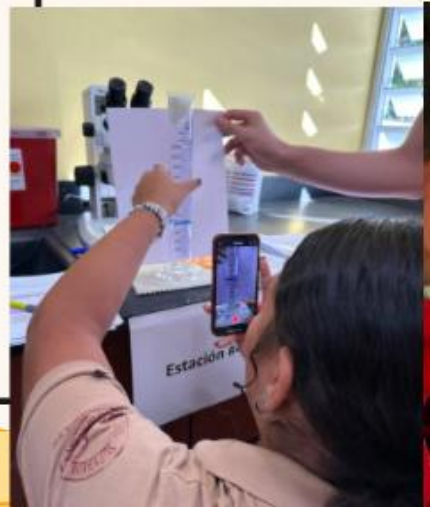
- Activity #1: Getting to know Drosophilas flies and practice how to work with the dissecting microscope

- Activity #2: Identify fly gender with the dissecting microscope, then create pie chart with the results

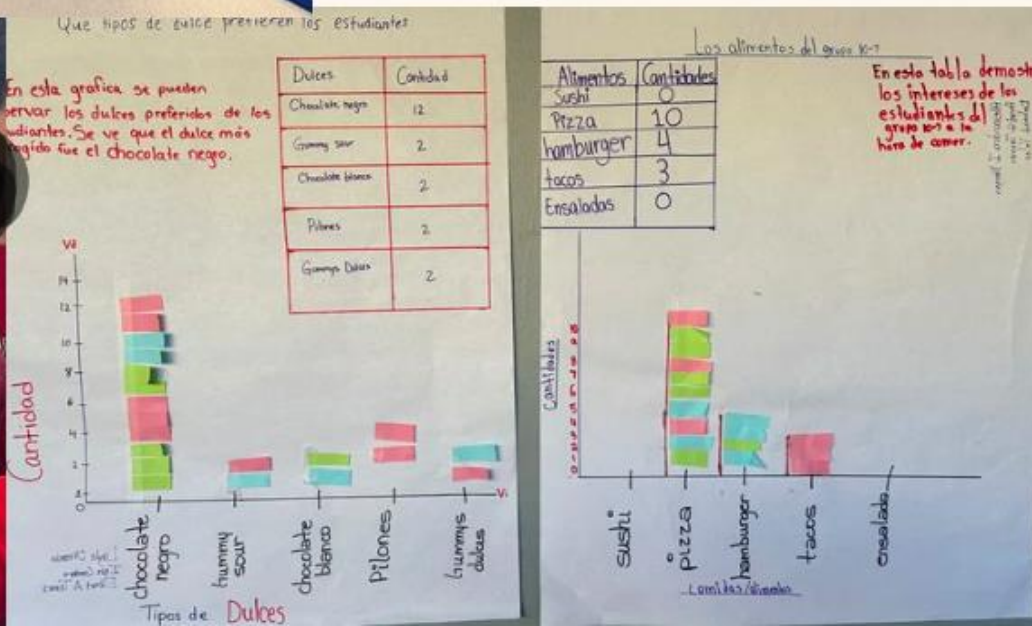
Proficiency in data interpretation (making sense of analysis results)

- Activity #3: Simulation of locomotion time according to variables (use of labyrinth handout to practice bar graph creation with the results)

- Activity #4: Students will observe and record flies climbing and flying performance of Drosophila flies, then practice line graph creation with the results



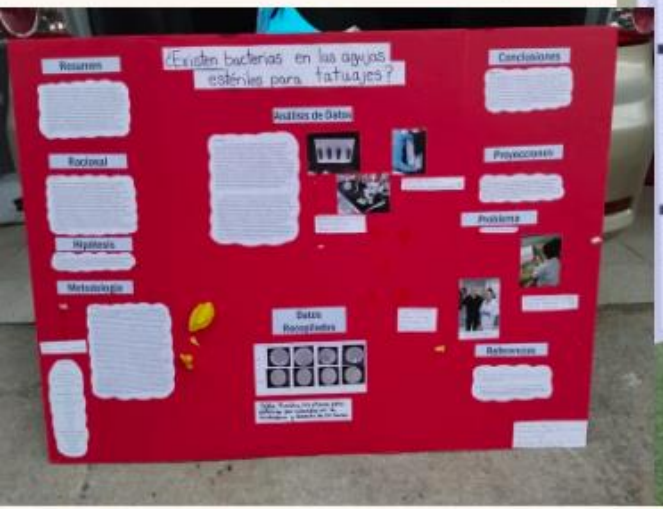
ACTIVITY TO MASTER DATA ANALYSIS SKILLS



STUDENTS DID GREAT!

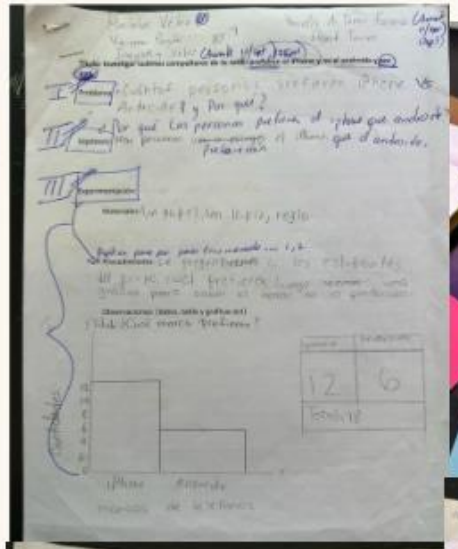
BIORETS PROGRAM HELPED ME TO BE SUCCESSFUL IN HELPING MY STUDENTS DEVELOP THEIR KNOWLEDGE ABOUT SCIENTIFIC METHOD AND RESEARCH SKILLS

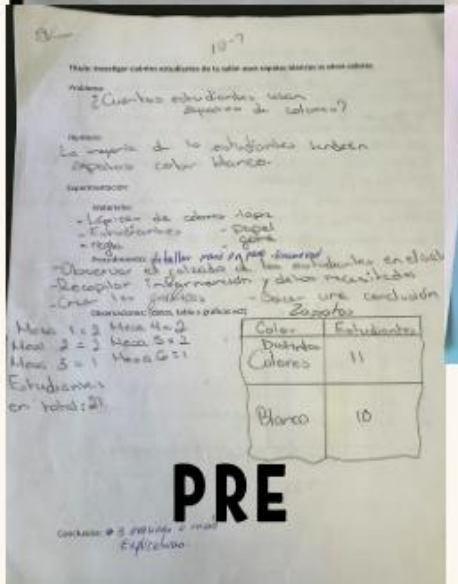
BEFORE



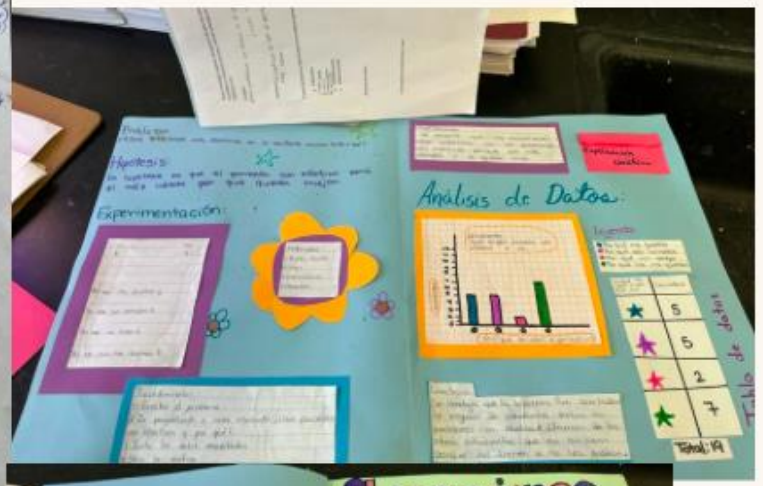
AFTER

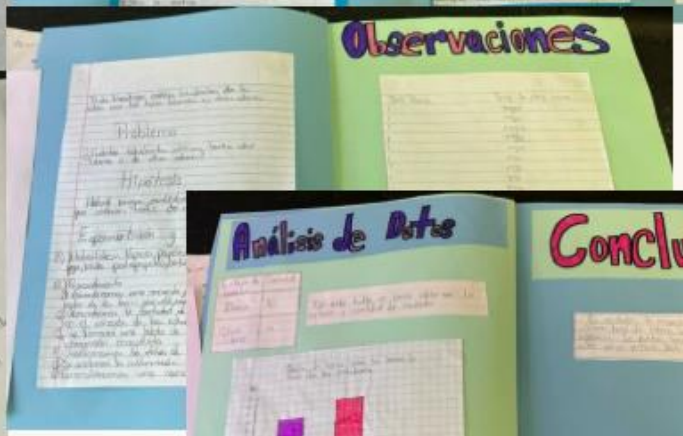
PUERTO RICO DEPARTMENT OF EDUCATION REGIONAL SCIENCE FAIR 2024
3RD PLACE WINNER

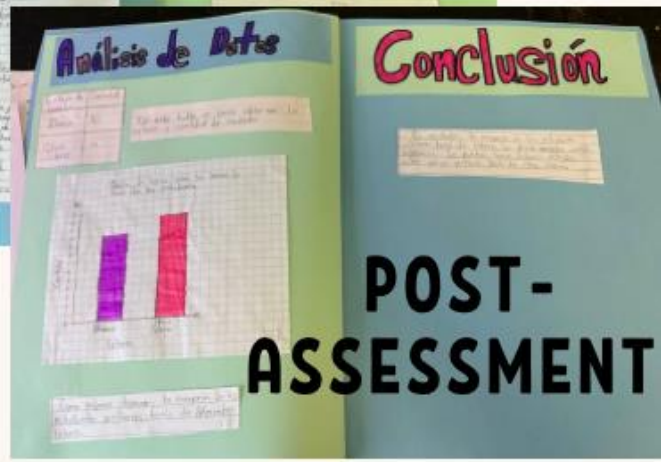




PRE







POST-ASSESSMENT

FUTURE APPLICATIONS OF ACQUIRED KNOWLEDGE

TEACHER

NEW AND EFFECTIVE STRATEGIES TO TEACH SCIENCE

STUDENT

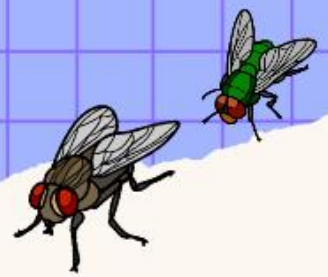
MASTER NEW SCIENTIFIC SKILLS, USING COMPLEX CRITICAL THINKING AND RESEARCH SKILLS LEARNED IN THE CLASSROOM

MOTIVATION FOR STUDENTS

TO CHOOSE STEM CAREERS

ACKNOWLEDGMENT

FOR GIVING ME THE BEST AND SIGNIFICANT EXPERIENCE IN MY LIFE



Graduate and undergraduate students

DR.IMILCE RODRÍGUEZ

BIORETS GROUP

ME

Questions to be discussed

- Which scientific practices are challenging for stud ents?
- Which scientific practices are challenging for you to teach?
- Do you think a RET can help you? How?
- What support would you need to transfer a RET to the classroom?

Acknowledgments

- Cohort 2 BIORETS participants
- Researchers and graduate students
  - Dr. Diaz
  - Dr. Garcia-Arraras
  - Dr. Ghezzi
  - Dr. Nicolau
  - Dr. Perez
  - Dr. Peterson
- Center for Science and Math Education Research (CSMER)
  - Dr. Marta Fortis
  - Ms. Brenda Estevez and Diana Rodriguez
  - Mr. Angel Perez and Ms. Jomarie Ortiz
- Special thanks to Ms. Brenda Santiago

THANK YOU

This material is based upon work supported by the National Science Foundation under Grant No. 2147012. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

DEPARTAMENTO DE EDUCACIÓN

Email: csmer.rp@upr.edu
https://www.facebook.com/biorets

INVITATION

WORKSHOP :

Using the Genome-to Phenome Construct to Change Students' Acceptance of the Theory of Evolution

BLUEBIRD BALLROOM 2G

- 1:00- 2:00 PM