Adapting an Experiment-centric Teaching Approach to Increase Student Achievement in Biology

Summer 2021 Workshop
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Participating Faculty: Dr. Adedayo Ariyibi, Dr. Akinyele Oni

What is Experiment Centric Pedagogy (ECP) ?

A teaching technique that utilizes hands-on-activities through an inexpensive, safe, and portable electronic instrumentation system that can be used in classrooms and student laboratories to teach STEM concepts.

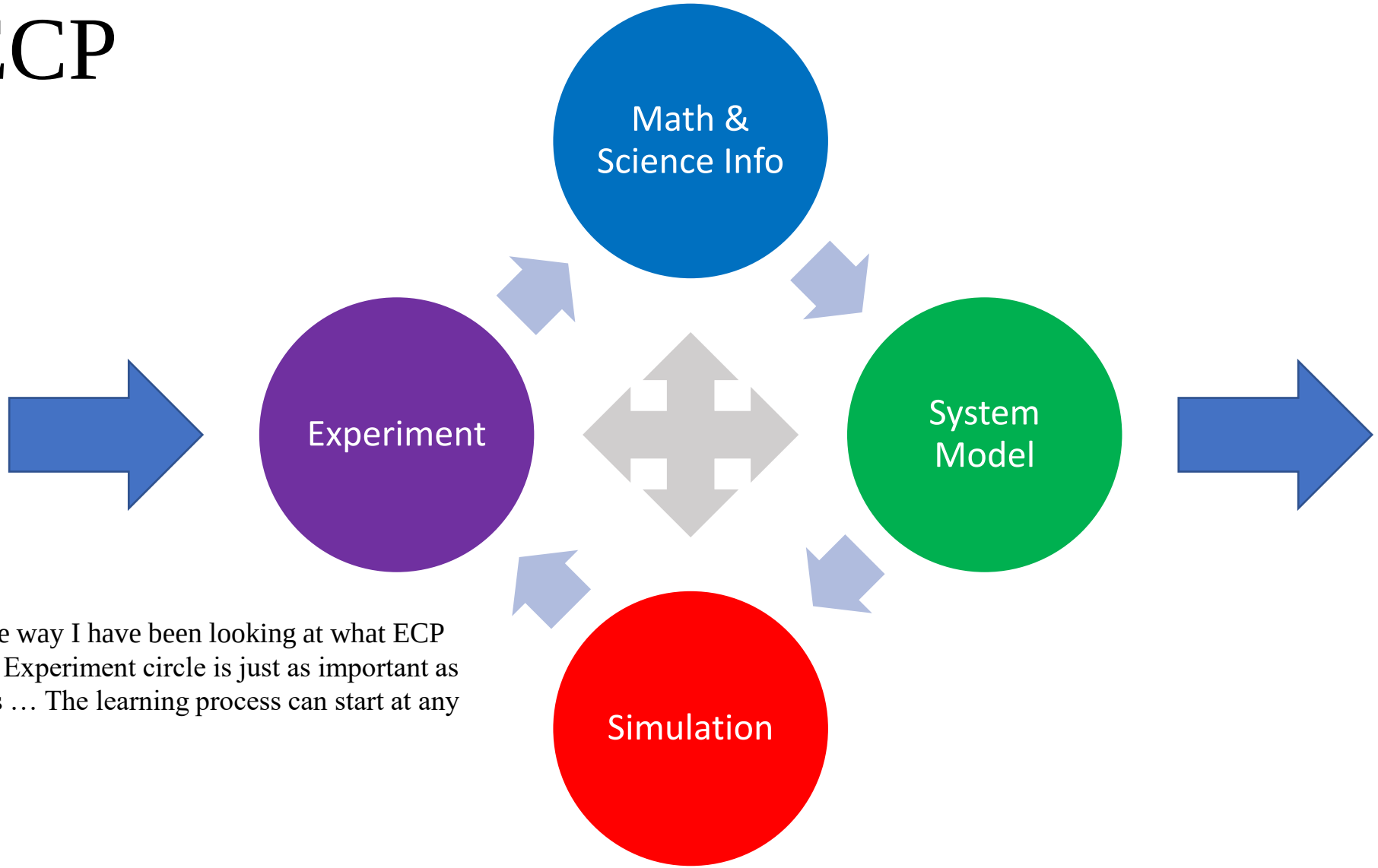
ECP implementation can be varied based on different instructional use

(instructor demonstration, cooperative and independent student setting) and learning setting (traditional classroom, lab setting, homework), (Astatke, et al 2016)

What is Experiment Centric Pedagogy (ECP) ?

ECP is a valuable STEM teaching approach, because using electronic instrumentation to make scientific measurements is common in all STEM disciplines.

ECP



This is the way I have been looking at what ECP is … The Experiment circle is just as important as the others … The learning process can start at any point.

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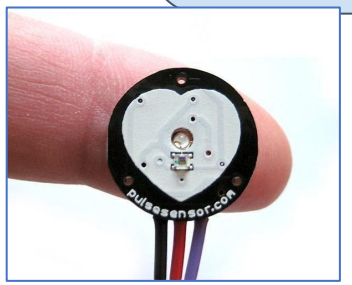
ADALM2000

Signal Conditioning

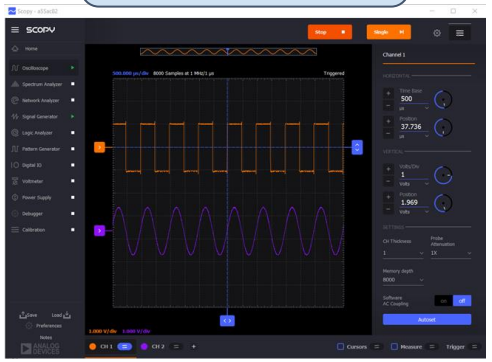
A/D Converter

Processor

Pulse Sensor



Display



Data logging

ADALM2000 Instrument

Research Questions

1. Does the Experimental Centric Pedagogy (ECP) enhance student learning, motivation and curiosity beyond the field of biology?
2. How do the biology field integrate and customize the Experimental Centric Pedagogy to meet the learning objectives of coursework?
3. Does an Experimental Centric Pedagogy increase the engagement of undergraduate students in their biology learning and lead to measurable and lasting learning gains?
4. How does the implementation of the Experimental Centric Pedagogy impact students' learning in biology?

Objectives

1. To provide workshops at which biology faculty will learn how to use ECP as an active learning pedagogy.
2. To integrate ECP into biology and in various settings, such as in traditional classrooms and teaching laboratories, and at home use by students.
3. To measure student success outcomes resulting from the use of ECP. Student success will be measured by academic performance as well as retention and graduation rates.
4. Validated instruments will be used to measure key constructs associated with student success, such as motivation, epistemic and perceptual curiosity, engineering identity, and self-efficacy.
5. To demonstrate positive impacts on more than 500 biology students, a considerable proportion of whom are from groups historically underrepresented in biology.

Number of Students Impacted From Spring 2020 to Spring 2021

Discipline	Number of Courses	Number of Faculty	Number of Students
Biology	4	2	342

Spring 2020

Courses	**No. of Students**	**Experiment Title**
BIO 101-H01 Introductory Biology I	25	Photoplethysmography (Heart rate Measurement)
BIO 101-H02 Introductory Biology I	24	Heart rate Measurement
BIOL-106-002 Introductory Biology for Major II	20	Heart rate Measurement

Fall 2020

Courses	**No. of Students**	**Experiment Title**
BIO 103-001 Introductory Biology for Nursing Major	25	Photoplethysmography (Heart rate Measurement)
BIO 103-005 Introductory Biology for Nursing Major	25	Heart rate Measurement
BIOL-201-001 Anatomy and Physiology I	25	Heart rate Measurement

Spring 2021

Courses	**No. of Students**	**Experiment Title**
BIO 101-006 Introductory Biology for Non-Major	35	Heart rate Measurement
BIO 101-007 Introductory Biology for Non-Major	35	Heart rate Measurement
BIO 101-W09 Introductory Biology for Non-Major	36	Heart rate Measurement
BIO 101-W10 Introductory Biology for Non-Major	35	Heart rate Measurement
BIO 103-003 Introductory Biology for Nursing Major	7	Heart rate Measurement
BIO 105-001 Introductory Biology for Major I	22	Heart rate Measurement
BIO 109-001 Foundations in Biology, Diversity, & Organismal Systems	20	Heart rate Measurement
BIOL 201-002 Anatomy and Physiology	25	Heart rate Measurement
BIOL 201-004 Anatomy and Physiology	13	Heart rate Measurement

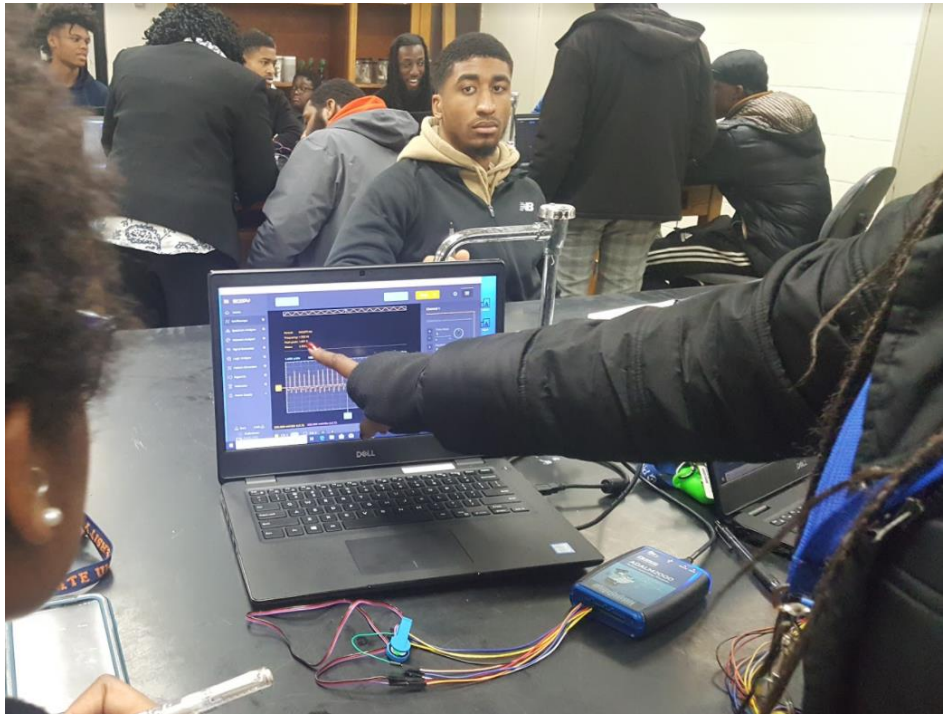
Participating Faculty

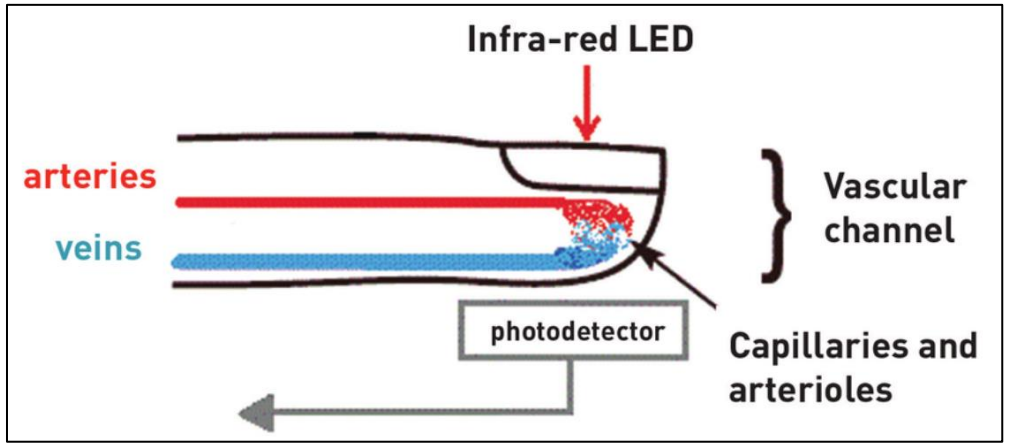
Name	**Discipline**
Dr. Adedayo Ariyibi	Biology
Dr. Safar Ham doun	Biology
Dr. Akinyele Oni	Biology
Dr. Kenneth Samuel	Biology

Spring 2020 – BIO 101

Lab: Heart rate Measurement

- Photoplethysmography (PPG) is a simple and low-cost optical technique that can be used to detect blood volume changes in the microvascular bed of tissue.
- *Pulse Rate = (Frequency × 60) bpm*

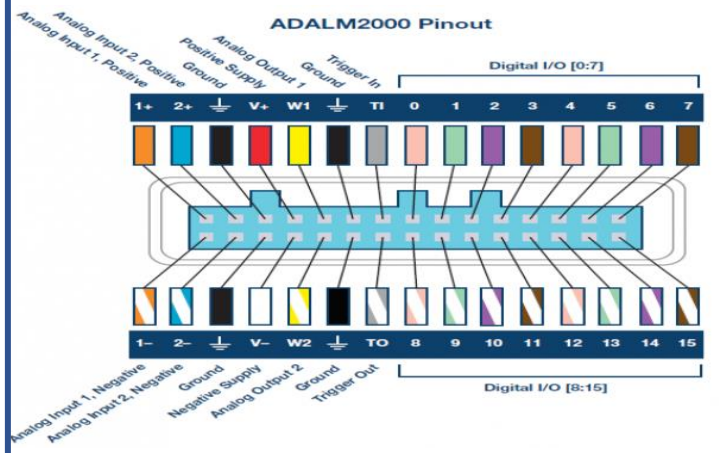




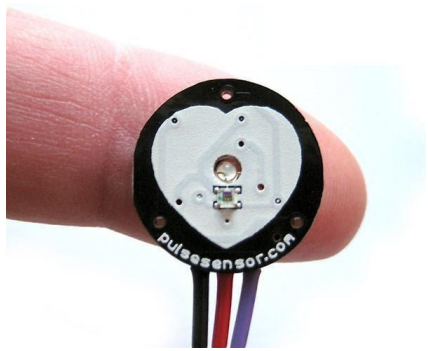
Source: (Wilkes, 2015)

Devices and Equipment

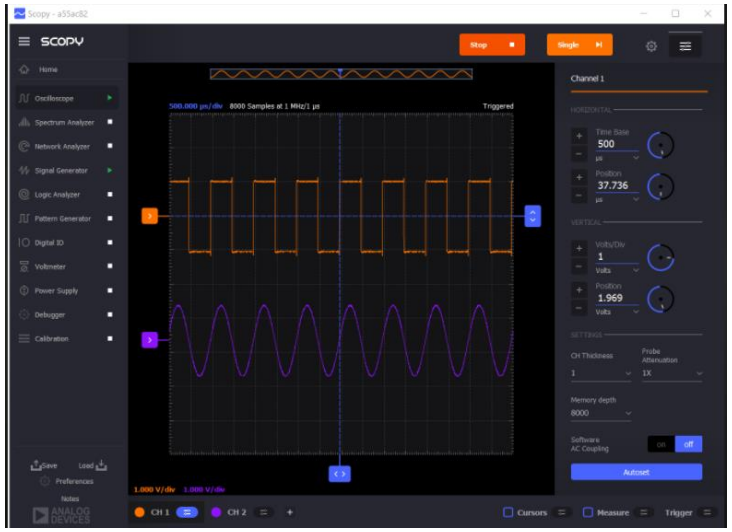
- ADALM2000 (M2K)



- Pulse Sensor



- Scopy Software



Fall 2020 – BIOL 103.001

Lab: Heart rate Measurement

- Virtual Classroom
- Instructor: Dr. Adedayo Ariyibi

Changes in Student Motivation Strategies (STEM Courses Spring 2020)

MSLQ Items	MSLQ Constructs	Pre % Agree* n=89	Post % Agree* n=50	% Change
In a class like this, I prefer course material that really challenges me so I can learn new things.	Intrinsic Goal Orientation	58	68	+10
In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	Intrinsic Goal Orientation	66	74	+8
The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible	Intrinsic Goal Orientation	84	77	-7
I am very interested in the content area of this course	Task Value	58	49	-9
I like the subject matter of this course	Task Value	61	52	-9
It is important for me to learn the course material in this class.	Task Value	83	83	-
I believe I will receive an excellent grade in this class.	Expectancy Component	92	68	-24
I expect to do well in this class	Expectancy Component	93	83	-10
I'm confident I can do an excellent job on the assignments and tests in this course	Expectancy Component	92	72	-20
I have an uneasy, upset feeling when I take an exam	Test Anxiety	64	70	+6
I feel my heart beating fast when I take an exam	Test Anxiety	57	57	-
I often find myself questioning things I hear or read in this course to decide if I find them convincing	Critical Thinking	49	64	+15
Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	Critical Thinking	46	62	+13
I try to play around with ideas of my own related to what I am learning in this course.	Critical Thinking	49	60	+11
If course materials are difficult to understand, I change the way I read the material.	Metacognition	70	81	+11
Before I study new course material thoroughly, I often skim it to see how it is organized	Metacognition	66	65	-1
When I become confused about something I'm reading for this class; I go back and try to figure it out.	Metacognition	87	79	-8
I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	Metacognition	69	56	-13
When studying for this course, I often try to explain the material to a classmate or a friend.	Peer Learning/Collaborating	47	57	+10
When studying for this course, I often set aside time to discuss the course material with a group of students from the class.	Peer Learning/Collaborating	53	62	+9
I try to work with other students from this class to complete the course assignments.	Peer Learning/Collaborating	60	64	+4

**MSLQ uses 7-point Likert scale whereby 1=Not at all true of me to 7=True of me. % Agree=5, 6, & 7 choices in scale collapsed.*

Changes in Student Motivation Strategies (Biology Courses Fall 2020)

MLSQ Items	Constructs	PRE % Agree, n=151	POST % Agree, n=106	% Change
In a class like this, I prefer course material that really challenges me so I can learn new things.	Intrinsic Goal Orientation	66.2	65.1	-1.1
In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	Intrinsic Goal Orientation	73.5	66.9	-6.6
The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	Intrinsic Goal Orientation	80.1	66.7	-13.4
It is important for me to learn the course material in this class.	Task Value	90.1	79.3	-10.8
I am very interested in the content area of this course.	Task Value	78.8	68.9	-9.9
I like the subject matter of this course.	Task Value	76.2	72.6	-3.6
I believe I will receive an excellent grade in this class.	Expectacny Component	82.1	65.1	-17
I'm confident I can do an excellent job on the assignments and tests in this course.	Expectacny Component	76.2	64.2	-12
I expect to do well in this class.	Expectacny Component	82.1	67.9	-14.2
I have an uneasy, upset feeling when I take an exam.	Test Anxiety	80.8	68	-12.8
I feel my heart beating fast when I take an exam.	Test Anxiety	78.1	68	-10.1
I often find myself questioning things I hear or read in this course to decide if I find them convincing.	Critical Thinking	70.9	64.1	-6.8

MLSQ Items	Constructs	PRE % Agree, n=151	POST % Agree, n=106	% Change
I try to play around with ideas of my own related to what I am learning in this course.	Critical Thinking	66.9	63.2	-3.7
Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	Critical Thinking	63.6	63.2	-0.4
When I become confused about something I'm reading for this class; I go back and try to figure it out.	Meta Congnition	81.5	70.8	-10.7
If course materials are difficult to understand, I change the way I read the material.	Meta Congnition	72.2	71.7	-0.5
Before I study new course material thoroughly, I often skim it to see how it is organized.	Meta Congnition	68.2	71.6	3.4
I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	Meta Congnition	68.9	64.2	-4.7
When studying for this course, I often try to explain the material to a classmate or a friend.	Peer Learning	47.7	59.5	11.8
I try to work with other students from this class to complete the course assignments.	Peer Learning	57	67.9	10.9
When studying for this course, I often set aside time to discuss the course material with a group of students from the class.	Peer Learning	46.4	67	20.6

% Agree=5,6, &7 where 1=Not at all true of me, 7=Very true of me

Changes in Student Motivation Strategies (Biology Courses Spring 2021)

MLSQ Items	Constructs	PRE % Agree, n=101	Post % Agree, n=68	% Change
In a class like this, I prefer course material that really challenges me so I can learn new things.	Intrinsic Goal Orientation	63.3	73.6	10.3
In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	Intrinsic Goal Orientation	71.3	72.1	0.8
The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	Intrinsic Goal Orientation	77.2	80.8	3.6
It is important for me to learn the course material in this class.	Task Value	91.1	79.4	-11.7
I am very interested in the content area of this course.	Task Value	84.1	73.6	-10.5
I like the subject matter of this course.	Task Value	78.3	77.9	-0.4
I believe I will receive an excellent grade in this class.	Expectacny Component	71.3	75	3.7
I'm confident I can do an excellent job on the assignments and tests in this course.	Expectacny Component	76.3	74.9	-1.4
I expect to do well in this class.	Expectacny Component	81.2	76.5	-4.7
I have an uneasy, upset feeling when I take an exam.	Test Anxiety	71.3	66.2	-5.1
I feel my heart beating fast when I take an exam.	Test Anxiety	61.4	69.1	7.7
I often find myself questioning things I hear or read in this course to decide if I find them convincing.	Critical Thinking	57.5	69.1	11.6

MLSQ Items	Constructs	PRE % Agree, n=101	Post % Agree, n=68	% Change
I try to play around with ideas of my own related to what I am learning in this course.	Critical Thinking	59.4	69.1	9.7
Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	Critical Thinking	58.4	66.2	7.8
When I become confused about something I'm reading for this class; I go back and try to figure it out.	Meta Congnition	85.1	77.9	-7.2
If course materials are difficult to understand, I change the way I read the material.	Meta Congnition	72.3	69.1	-3.2
Before I study new course material thoroughly, I often skim it to see how it is organized.	Meta Congnition	70.2	70.5	0.3
I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	Meta Congnition	66.4	72	5.6
When studying for this course, I often try to explain the material to a classmate or a friend.	Peer Learning	42.6	53	10.4
I try to work with other students from this class to complete the course assignments.	Peer Learning	56.5	60.3	3.8
When studying for this course, I often set aside time to discuss the course material with a group of students from the class.	Peer Learning	46.5	54.4	7.9

% Agree=5,6, &7 where 1=Not at all true of me, 7=Very true of me

Perceived Impact of Engineering Devices in Course Work Spring 2020

Statement	Post % Agree*
The use of the M1K or M2K reflected real practice	76
The M1K or M2K provided opportunities to practice content	72
The use of the M1K or M2K reflected course content	70
Use of the device was relevant to my academic area	70
The time allotted for M1K or M2K use was adequate	68
The use of M1K or M2K suited my learning goals	68
My knowledge has increased as a result of use of the device	68
Using such devices help complete lab assignments	66
The device helped me learn how electric circuits are used in practical applications	64
Using the device helped me become motivated to learn course content	56
Using the device helped develop confidence in content area	55
My confidence in the content area has increased because of use of a device	54
Using the device helped me recall course content	54
Using a device helped me to develop skills in problem solving in this subject area	52
The device helped me think about problems in graphical/pictorial or practical ways	52
Using the Analog Device motivated me to learn the content	50
Using the device helped develop interest in the subject area	46
Using such devices help improve grades	42
The hands-on M1K or M2K is important in my preparation for my future career	40

**n=50, %. Agree = Strongly Agree and Agree combined using a five-point Likert scale*

Perceived Impact of Engineering Devices in Course Work Fall 2020 - BIO

MLSQ ITEMS	POST % Agree, n=106
I have seen a personal instrument, also known as M1K or M2K.	38.7
I have used a personal instrument, also known as M1K or M2K.	32.1
I have heard about a personal instrument and its usages.	45.3
I have used Phone Apps.	100
The M1K or M2K provided opportunities to practice content	41.5
The use of the M1K or M2K reflected course content	40.6
Use was relevant to my academic area	40.5
The use of the M1K or M2K reflected real practice	42.5
The time allotted for M1K or M2K use was adequate	37.7
The use of M1K or M2K suited my learning goals	35.9
My knowledge has increased as a result of the use of devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone apps)	36.8
My confidence in the content area has increased because of the use of devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone	34.9
The hands-on devices (M1K or M2K, phone apps) is important in my preparation for my future career	33
Using the devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone apps) motivated me to learn the content	33
Helped me to develop skills in problem solving in this subject area	41.5
Think about problems in graphical/pictorial or practical ways	42.5
Learn how electric circuits are used in practical applications	34.9
Recall course content	33.9
Using such devices help improve grades	34
Develop confidence in content area	39.6
Become motivated to learn course content	37.7
Develop interest in the subject area	38.6
Using such devices help complete lab assignments	40.5

* % Agree=Strongly Agree and Agree Combined using a five-point Likert Scale.

Perceived Impact of Engineering Devices in Course Work Spring 2021 - BIO

MLSQ ITEMS	POST % Agree, n=68
I have seen a personal instrument, also known as M1K or M2K.	41.2
I have used a personal instrument, also known as M1K or M2K.	35.3
I have heard about a personal instrument and its usages.	52.9
I have used Phone Apps.	89.7
The M1K or M2K provided opportunities to practice content	47
The use of the M1K or M2K reflected course content	45.6
Use was relevant to my academic area	51.5
The use of the M1K or M2K reflected real practice	44.1
The time allotted for M1K or M2K use was adequate	44.2
The use of M1K or M2K suited my learning goals	42.6
My knowledge has increased as a result of the use of devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone apps)	54.4
My confidence in the content area has increased because of the use of devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone	50
The hands-on devices (M1K or M2K, phone apps) is important in my preparation for my future career	50
Using the devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone apps) motivated me to learn the content	50
Helped me to develop skills in problem solving in this subject area	55.9
Think about problems in graphical/pictorial or practical ways	
Learn how electric circuits are used in practical applications	48.5
Recall course content	54.4
Using such devices help improve grades	45.6
Develop confidence in content area	45.1
Become motivated to learn course content	51.4
Develop interest in the subject area	50
Using such devices help complete lab assignments	48.5

* % Agree=Strongly Agree and Agree Combined using a five-point Likert Scale.

Results of the Motivated Strategies for Learning Questionnaire Manual: Fall 2020

				Intrinsic goal orientation		Task Value		Expectancy Component		Test Anxiety		Critical Thinking		Metacognition		Peer Learning/ Collaboration	
Dept.	**PRE N**	**POST N**	**Constructs**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
BIO	149	105	Mean	5.517	5.200	5.881	5.394	5.687	5.178	5.919	5.410	5.137	5.054	5.414	5.293	4.516	5.098
			SD	0.211	0.094	0.313	0.173	0.129	0.080	0.074	0.067	0.116	0.009	0.184	0.071	0.213	0.104
			Δ	-0.317		-0.487		-0.509		-0.509		-0.083		-0.121		0.582	
			P-Val	0.156		0.145		0.014		0.037		0.419		0.35		0.042	
ALL	255	169	Mean	5.387	5.283	5.770	5.459	5.676	5.315	5.581	5.324	5.063	5.158	5.394	5.388	4.528	5.085
			SD	0.258	0.058	0.292	0.177	0.135	0.085	0.089	0.076	0.038	0.034	0.164	0.063	0.170	0.076
			Δ	-0.104		-0.311		-0.361		-0.257		0.095		-0.006		0.557	
			P-Val	0.630		0.281		0.042		0.163		0.059		0.954		0.028	

Results of the Motivated Strategies for Learning Questionnaire Manual: Spring 2021

				Intrinsic goal orientation		Task Value		Expectancy Component		Test Anxiety		Critical Thinking		Metacognition		Peer Learning/ Collaboration	
Dept.	**Pre N**	**Post N**	**Construct**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
BIO	101	68	Mean	2.870	3.550	2.240	5.570	5.390	2.370	2.790	4.930	4.630	3.090	5.060	2.600	4.160	4.450
			SD	1.590	1.610	1.460	0.810	1.680	1.530	1.950	1.810	1.620	1.550	1.380	1.190	1.630	1.610
			Δ	0.680		3.330		-3.020		2.140		-1.540		-2.460		0.290	
			P-Val	0.003		0.000		0.000		0.000		0.000		0.000		0.199	
ALL	264	158	Mean	3.010	3.560	2.610	5.650	5.310	2.370	4.650	3.050	4.510	3.110	4.850	2.710	4.090	4.440
			SD	1.460	1.630	1.500	0.800	1.600	1.390	1.850	1.740	1.470	1.350	1.410	1.180	1.630	1.630
			Δ	0.550		3.040		-2.940		-1.600		-1.400		-2.140		0.350	
			P-Val	0.000		0.000		0.000		0.000		0.000		0.000		0.013	

Fall 2020 Curiosity Scale (Pre and Post)

	Pretest % Agree, n=151	Posttest % Agree, n=106	% Change
Interest Epistemic Curiosity Scale			
I enjoy exploring new ideas	82.8	80.2	-2.6
I enjoy learning about subjects that are unfamiliar to me	71.5	74.5	3
I find it fascinating to learn new information	83.5	75.5	-8
When I learn something new, I would like to find out more about it	76.1	71.7	-4.4
I enjoy discussing abstract concepts	76.1	67	-9.1
Deprivation Epistemic Curiosity Scale			
Difficult conceptual problems can keep me awake all night thinking about solutions	59.6	59.4	-0.2
I can spend hours on a single problem because I just can't rest without knowing the answer	55	58.5	3.5
I feel frustrated if I can't figure out the solution to a problem, so I work even harder to solve it	63.5	57.5	-6
I brood for a long time in an attempt to solve some fundamental problems	60.3	58.5	-1.8
I work like a friend at problems that I feel must be solved	58.9	54.7	-4.2

% Agree= Always and Often with 4-Likert scale

Results of the Motivated Strategies for Learning Questionnaire Manual: Fall 2020
Curiosity Scale

				Interest Epistemic Curiosity Scale		Deprivation Epistemic Curiosity Scale	
Department	**PRE N**	**POST N**	**Constructs**	**Pre**	**Post**	**Pre**	**Post**
BIO	151	106	Mean	1.760	2.724	2.203	2.743
			SD	0.674	0.872	0.748	1.173
			Δ	0.964		0.540	
			P-Val	0.000		0.000	
ALL	259	169	Mean	1.734	2.589	2.181	2.661
			SD	0.658	0.956	0.735	1.214
			Δ	0.855		0.480	
			P-Val	0.000		0.000	

Spring 2021 Curiosity Scale (Pre and Post)

	Pretest % Agree, n=101	Posttest % Agree, n=68	% Change
Interest Epistemic Curiosity Scale			
I enjoy exploring new ideas	81.2	75	-6.2
I enjoy learning about subjects that are unfamiliar to me	76.3	70.6	-5.7
I find it fascinating to learn new information	83.2	79.4	-3.8
When I learn something new, I would like to find out more about it	76.2	73.5	-2.7
I enjoy discussing abstract concepts	69.3	64.7	-4.6
Deprivation Epistemic Curiosity Scale			
Difficult conceptual problems can keep me awake all night thinking about solutions	42.6	51.5	8.9
I can spend hours on a single problem because I just can't rest without knowing the answer	41.6	42.6	1
I feel frustrated if I can't figure out the solution to a problem, so I work even harder to solve it	59.4	58.8	-0.6
I brood for a long time in an attempt to solve some fundamental problems	52.5	47.1	-5.4
I work like a friend at problems that I feel must be solved	52.4	54.4	2

% Agree= Always and Often with 4-Likert scale

Results of the Motivated Strategies for Learning Questionnaire Manual: Spring 2021
Curiosity Scale

				Interest Epistemic Curiosity Scale		Deprivation Epistemic Curiosity Scale	
Department	**Pre N**	**Post N**	**Constructs**	**Pre**	**Post**	**Pre**	**Post**
BIO	101	68	Mean	1.762	2.392	2.401	2.276
			SD	0.682	1.124	0.755	1.557
			Δ	0.630		-0.125	
			P-Val	0.000		0.545	
ALL	264	162	Mean	1.803	2.421	2.339	2.425
			SD	0.706	0.956	0.753	1.287
			Δ	0.618		0.086	
			P-Val	0.000		0.448	

Fall 2020 Open-Ended Posttest Responses (n = 106)

Posttest Question: Please describe your class experience of using analog devices (Analog Devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone apps). It may be related to an experiment topic that you enjoyed, or your interest and curiosity/challenges, or something else)

- "It was fairly interesting and engaging to see how my heart fluctuates while performing different exercises"
- "It was interesting because it was my first time using it so it was cool to see the device in action."
- "Seem difficult but worth the effort to learn and try"
- "I love using the app to take my heart at anytime through out the day"
- "My class experience of using the analog devices was very difficult at first but me and my peers were able to explain things to each other and get it done so that we can understand and if we needed other help we'll ask our teacher but we'll ask each other first so that our knowledge can be put to the test a little before we ask for help from someone who actually 100 percent knows what's the answer."

Spring 2021 Open-Ended Posttest Responses (n = 68)

Posttest Question: Please describe your class experience of using analog devices (Analog Devices (M1k- ADALM 1000 or M2K- ADALM 2000 or phone apps). It may be related to an experiment topic that you enjoyed, or your interest and curiosity/challenges, or something else)

- "My experience with the app was good. It really help with the experiment we did in class and helped my understanding."
- "I enjoyed doing the experiment because it was interactive and a great learning experience."
- "The experiment was very good the phone app was easy to use. I used the phone heart rate app. The instructor was very clear and it was an overall informative experiment."
- "My experience was fine using the analog device."
- "I thought it was was a new way and a great visual lab"

The Classroom Observation Protocol for Undergraduate STEM (COPUS)

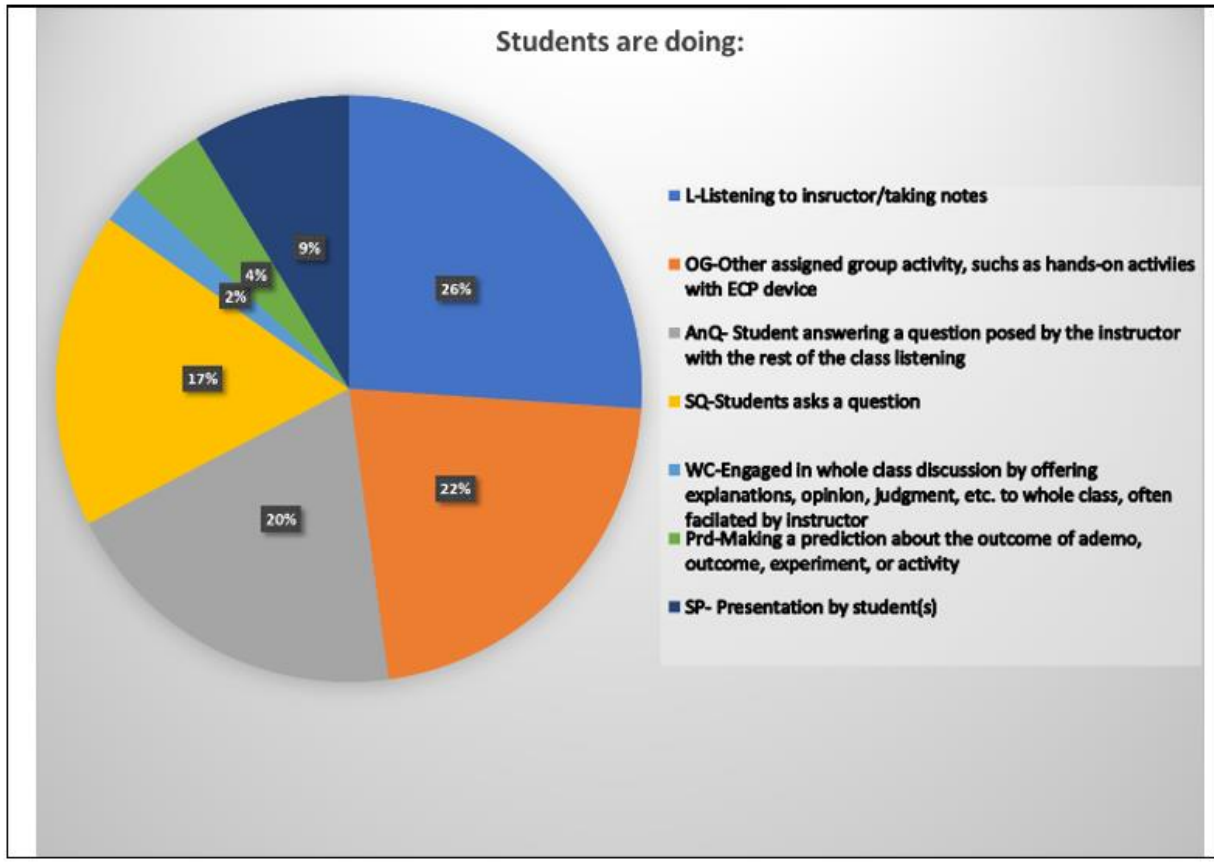
Faculty Effectiveness Rubrics virtual and face to face

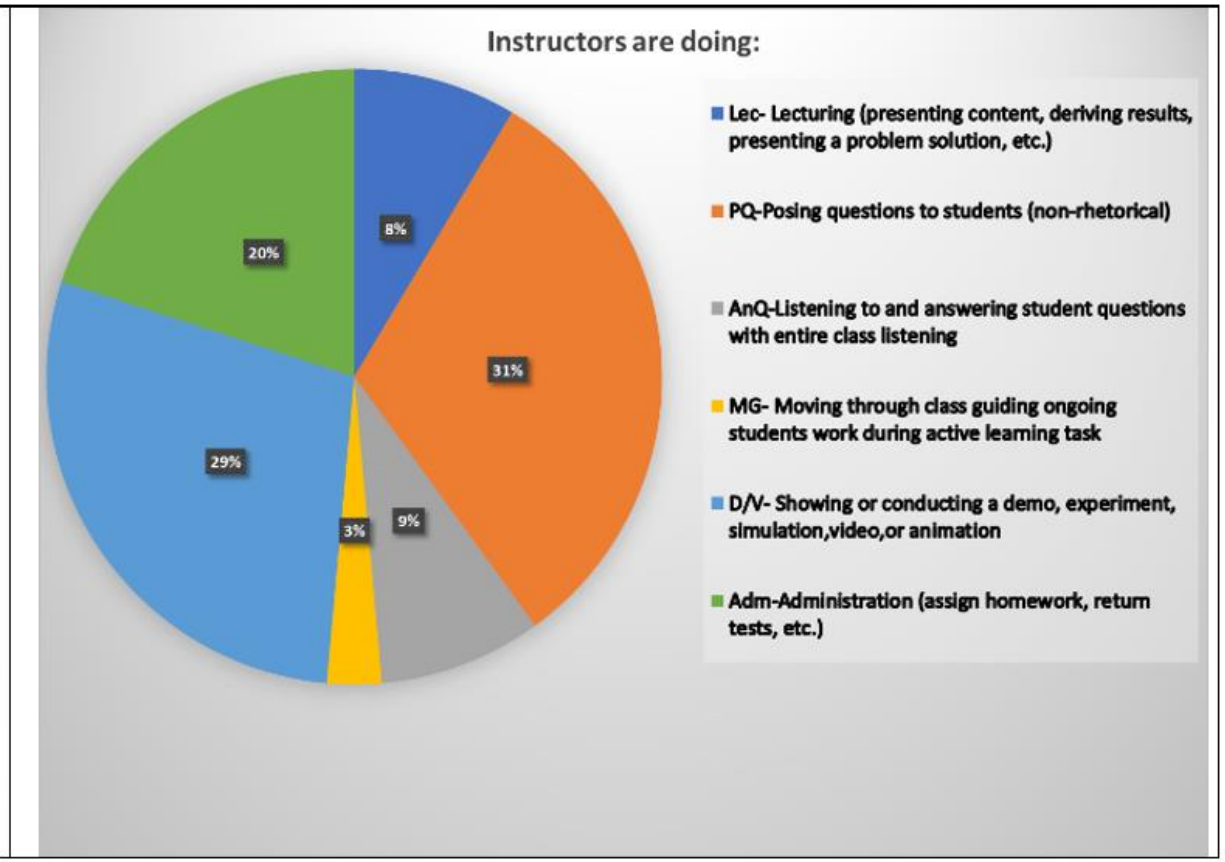
Descriptions of the COPUS Student and Instructor Codes (Smith et al 2013

Students are Doing	
L	Listening to instructor/taking notes, etc.
AnQ	Student answering a question posed by the instructor with the rest of the class listening
SQ	Student asks a question
WC	Engaged in whole class discussion by offering explanations, opinion, judgment, etc
Ind	Individual thinking/problem solving.
CG	Discuss clicker question in groups of 2 or more students
WG	Working in groups on worksheet activity
OG	Other assigned group activity, such as responding to instructor question
Prd	Making a prediction about the outcome of demo or experiment
SP	Presentation by student(s)
TQ	Test or quiz
W	Waiting
O	Other – explain in comments
Instructor is Doing	
Lec	Lecturing
RtW	Real-time writing on board, doc. projector, etc.
Fup	Follow-up/feedback on clicker question or activity to entire class
PQ	Posing non-clicker question to students (non-rhetorical)
CQ	Asking a clicker question
AnQ	Listening to and answering student questions with entire class listening
MG	Moving through class guiding ongoing student work during active learning task
1o1	One-on-one extended discussion with one or a few individuals
D/V	Showing or conducting a demo, experiment, simulation, video, or animation
Adm	Administration (assign homework, return tests, etc.)
W	Waiting when there is an opportunity for an instructor
O	Other – explain in comments

BIO 103: Introduction to Biology for Nursing Students

10/20/2020 | Number of Students: 25





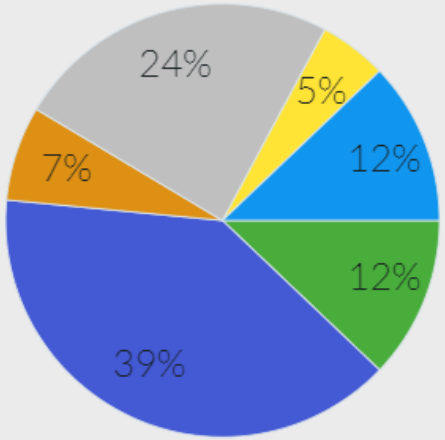
Link to the Class recording

Class: BIOL 109.004

Date:02/05/2021

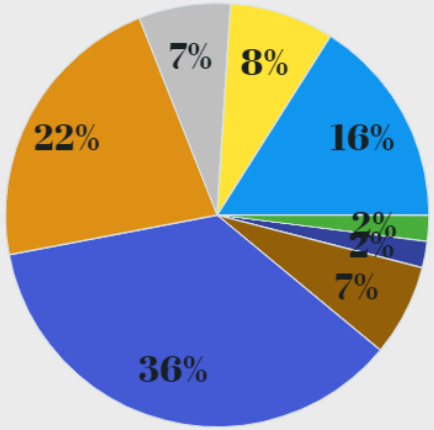
Number of Students: 30

Student Doing



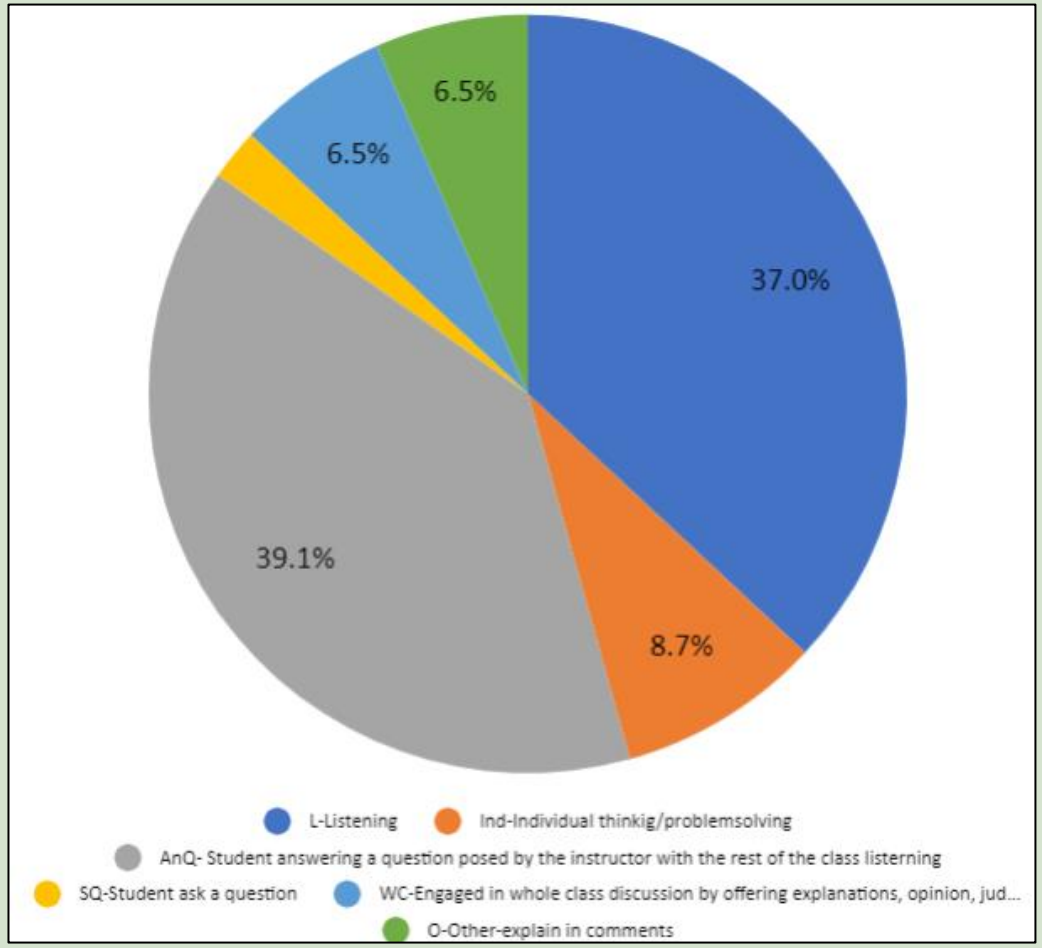
- L - Listening
- OG - Other assigned group activity such as hands-on activities with ECP device (students must have the device)
- AnQ - Student answering questions posted by the instructor with the rest of the class listening
- SQ - Student ask a question
- WC - Engaged in whole class discussion by offering explanations, opinion, judgement, etc to the whole class. often facilitated by instructor
- O - Other - explain in comments

Instructor Doing

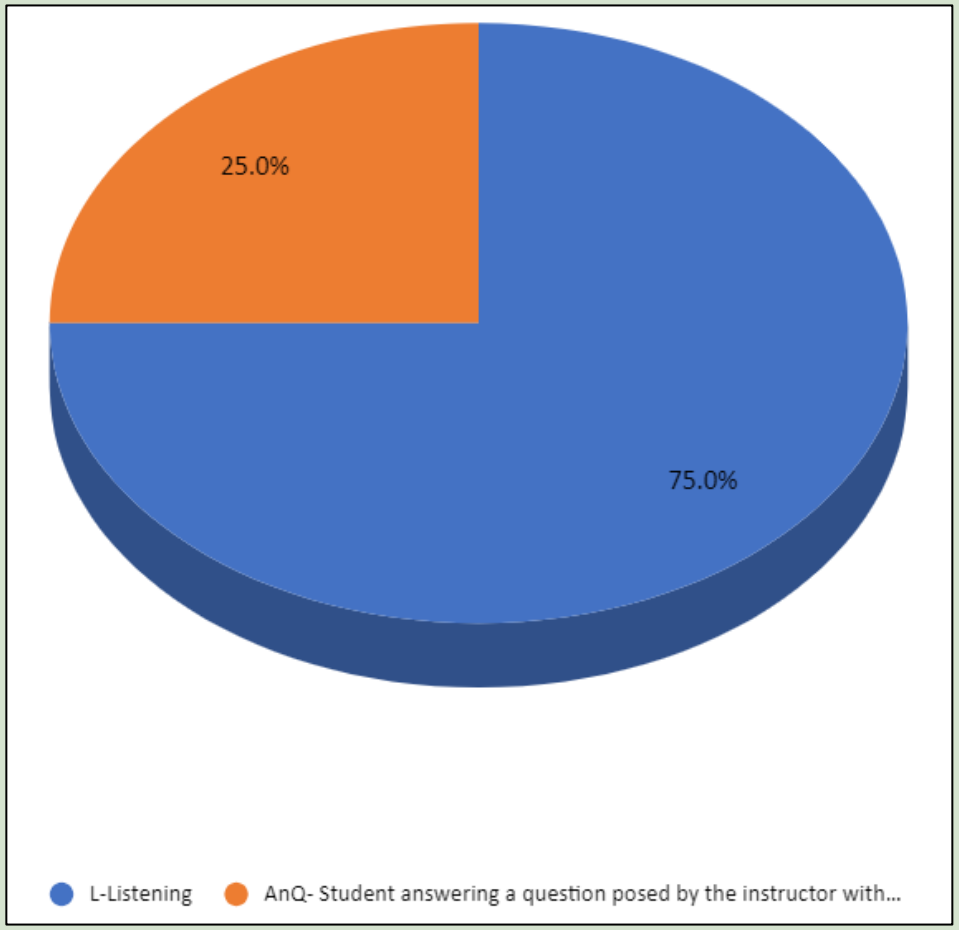


- Lec - Lecturing (presenting content, deriving results, presenting a problem solution, etc.)
- PQ - Posting questions to students (non-rhetorical)
- AnQ - Listening to and answering student questions with entire class listening
- MG - Moving through class guiding ongoing student work during active learning task
- D/V - Showing or conducting a demo, experiment, simulation, video, or animation
- Adm - Administration (assign homework, return tests, etc.)
- W - Waiting when there is an opportunity for an instructor to be interacting with or observing/listening to student or group activities and the instructor is not doing so
- O - Other - Explain in comments

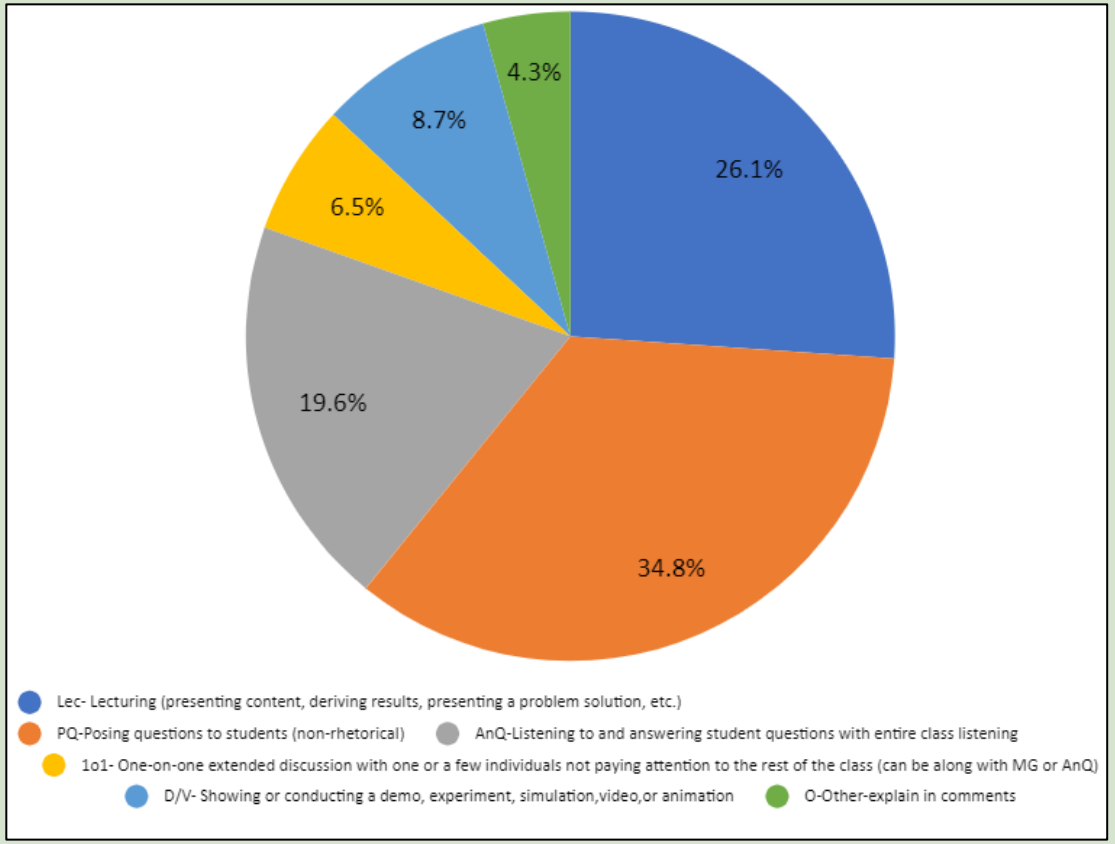
Students' Learning Engagement with ECP



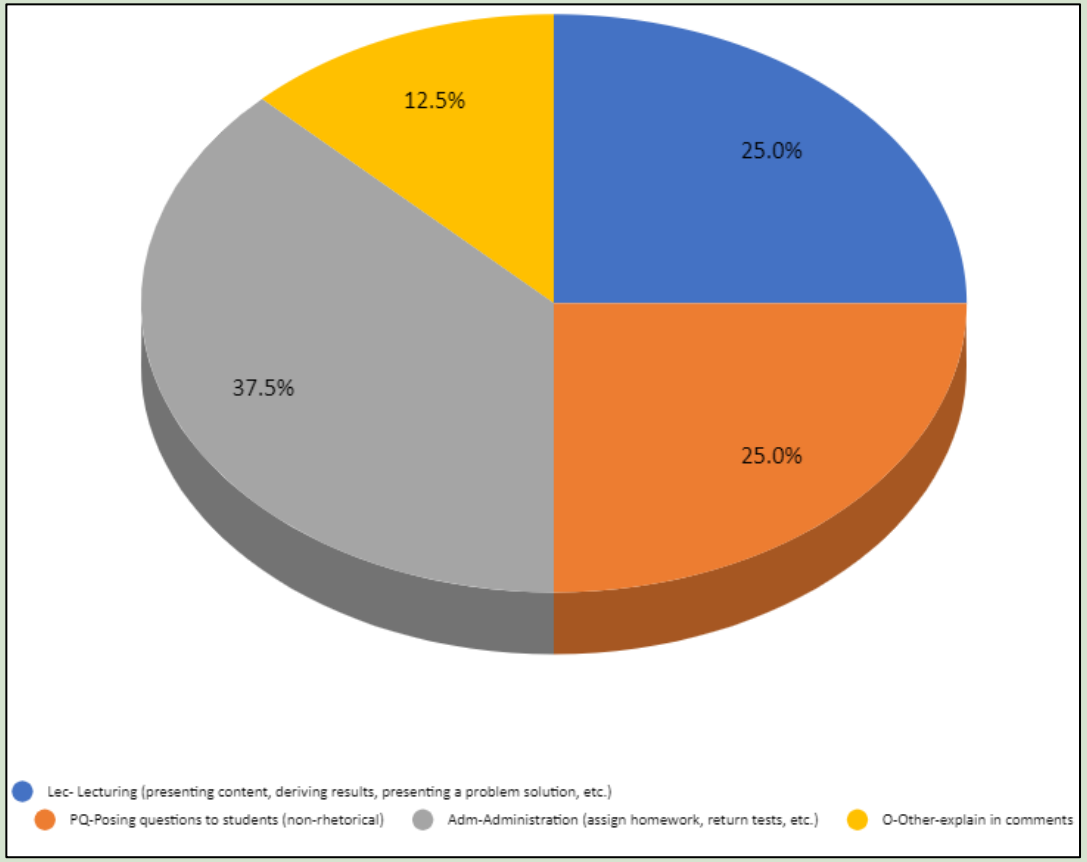
Students' Learning Engagement without ECP



Instructor Pedagogical Approach with ECP



Instructor Pedagogical Approach without ECP



Observation

• The professor was able to keep all students actively participating in class activities.
• The professor engaged with students using the chat box to answer questions and comments.
• The students continuously followed the professors instructions.
• The professor kindly showed the connection between the theory and the experiment at the end of the session.
• The students accumulated an increased interest in the experiment and class activities.
• With the increased use of ECP, the laboratory session was very interactive between students and the instructor.

Notes: Students were selected at random to present the slides provided by the instructor. For the most part of the class the students presented while the instructor explained aspects of the slides that were not clear to the students in the form of lecturing as they present. This approach of teaching kept the student at alert as they could be called to present at any point during the class period.

Figure 2 below is an illustration of a course that utilizes several active learning instructional practices with a lecture-based course. Comparing figure 1 to figure 2 the instructor seems to have engage students actively, by engaging them with questions that kept them active throughout the duration of the class.

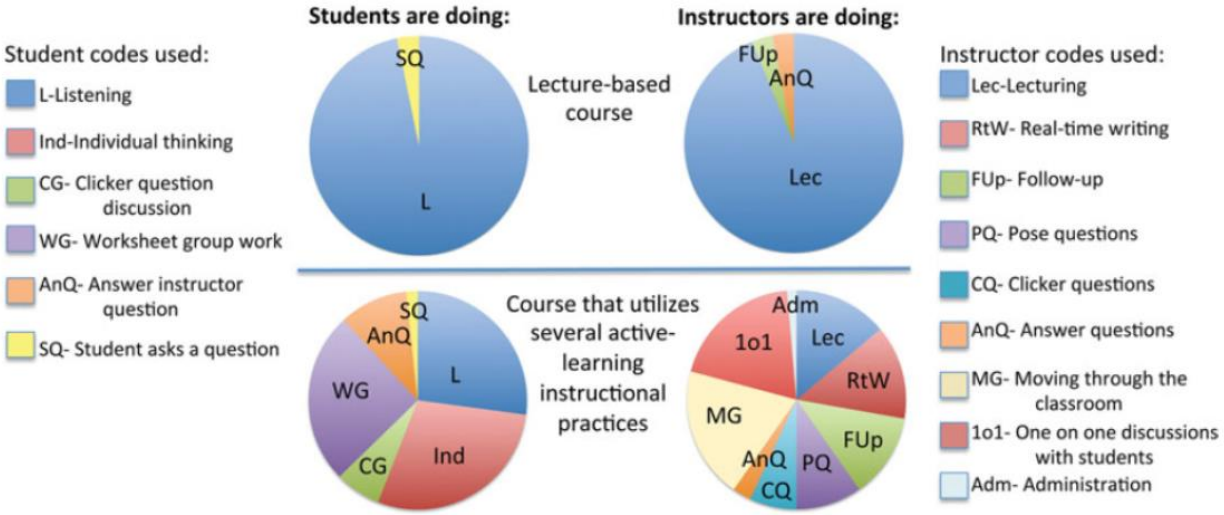


Figure 2:A comparison of COPUS results from two courses that have different instructional approaches, (Smith et al, 2013).

Prospective Fall 2021 Experiments

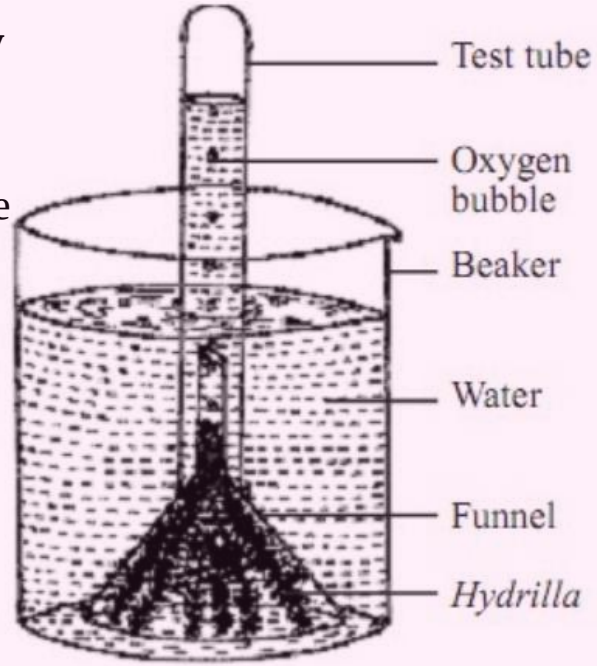
- Experiments that will be developed throughout the course of the summer:

1. **Varying light intensity with fast plants**

- Materials: standard fast plant seeds, CFL and LED bulbs, Arduino, light intensity sensor
- Arduino logs and displays the data in Excel.
- Light intensity sensor monitors light level.

2. **Varying light intensity with aquatic plants**

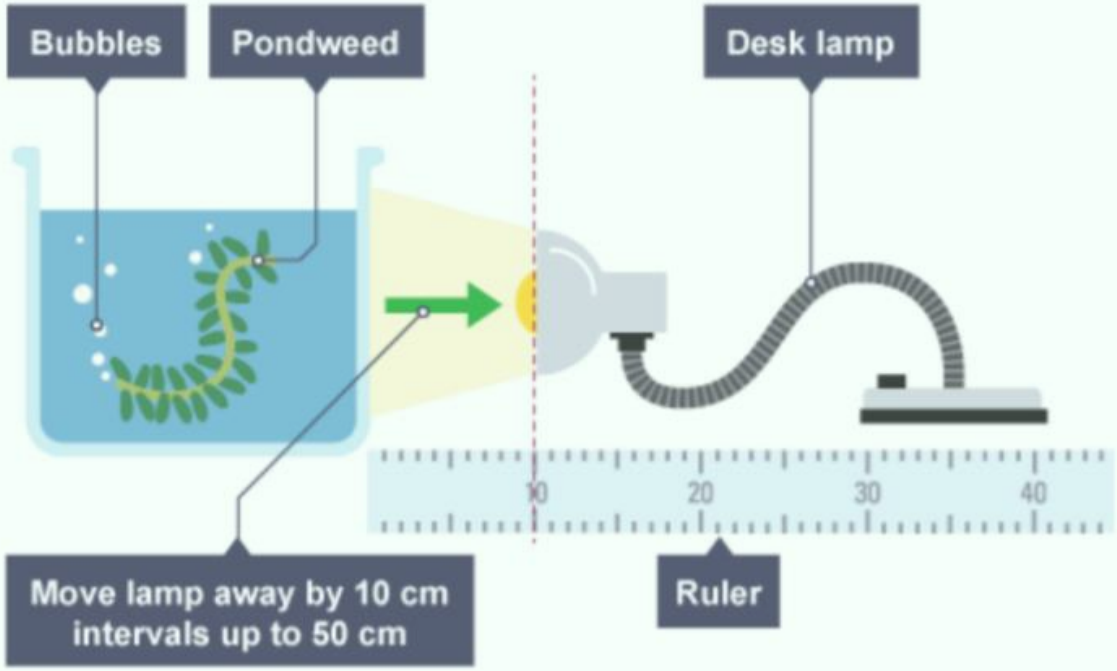
- Materials: Hydrilla, beaker, funnel, test tube, temperature sensor, oxygen sensor, light intensity sensor
- Two setups: one in an area with light exposure, one in an area with low light
- The number of bubbles are counted.
- Oxygen levels and temperatures are taken.



Prospective Fall 2021 Experiments

3. Varying light intensity with distance

- Materials: pondweed, ruler, lamp, 60 W bulb, light intensity sensor, oxygen level sensor, 500 ml beaker



Conclusion

- Remote hands-on laboratory was successfully conducted for biology during the Spring 2020 – Spring 2021 academic semesters.
- Student engagement gradually increased with the inclusion of ECP.
- Student-to-teacher, teacher-to-student, and student-to-student interaction increased as a result of the inclusion of ECP devices, along with learning aids like chatrooms and live demonstrations.
- Phone apps and analog devices helped to increase student engagement.
- The inclusion of ECP had a positive effect on students' interest in the course.

Thank you

Any Questions?