Implementation and Adaptation of Evidence-Based IPLS Laboratories

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Project Motivation

- Calls to modify physics laboratory courses to focus on student implementation of authentic scientific inquiry rather than results verification[1,2]
- Topics of traditional physics labs are often not applicable to pre-medical or life science students
- Traditional physics lab manuals are typically overly prescriptive in methods and procedures; students typically conduct prescribed experiments to verify previously determined results

Project NEXUS Overview

- Created to reform science courses offered to Life Science students[3,4,5]
- Central goals of IPLS lab include[3,4,5]:
  - ➢ a focus on Physics relevant to microscopic and living systems
  - ➢ the use of 21st century tools and software
  - ➢ the ability to engage with data-rich environments
  - ➢ preparation for future contributions to biomedical research

IPLS Implementation at University of Utah

Course Information:

- 3 hours per week, 1 credit-hour
- Pre-lab assignments designed to prepare students for upcoming lab topics and tasks
- 5 multi-week labs per semester
- Roles-based groups of 3-4 (Manager, Data Interpreter, Recorder, Skeptic), two group changes per semester based on student identity, attitudes, content knowledge, etc.
- Demographics below:

	Course	University
Male	43%	53%
Female	48%	47%
Transgender	2%	N.R.
Non-binary	2%	N.R.
Prefer not to say/Other (Gender)	5%	N.R.
White	58%	68.5%
Hispanic/Latinx	14.5%	12%
Asian	13%	5.8%
Black/African American	4%	1.4%
Native American/Pacific Islander	1.6%	0.5%
Prefer not to say/Other (Race)	8%	12.5%

N.R. – Not reported

Reform IPLS Lab Topics

Lab	Title	Topics
	1st Semester IPLS Lab	
1	**Kinematic Analysis of Zebrafish**	Students use pre-recorded videos and tracking software to study kinematics of zebrafish.
2	**Study of Macroscopic Flow Patterns**	Students analyze two experimental systems to investigate turbulent and laminar flow patterns of macroscopic objects.
3	**Study of Microscopic Brownian Motion**	Students analyze how Brownian motion of microscopic particles in solution is impacted by mass, fluid viscosity, and particle concentration.
4	**Comparison of Microscopic Brownian and Directed Motion**	Students investigate how addition of directed forces impacts Brownian motion in a microscopic system.
5	**Biological Motor Systems of Vesicles in Onion Cells**	Students utilize skills and knowledge from previous labs to study motor protein transport in onion cells.
	2nd Semester IPLS Lab	
6	**Hemodynamics (ongoing adaptation)**	Students analyze capillary systems to investigate hemodynamics, specifically blood pressure, cardiac output, cardiovascular flow patterns, etc.
7	**Electrophoresis and Debye Screening**	Students use electrophoresis to measure charge screening effects of synthetic microspheres in saline solutions.
8	**Investigative Spectroscopy**	Students explore emission and absorption of multiple light sources with filters, are introduced to various models of the Hydrogen atom, and explore how evolution impacted humans' visible spectrum.
9	**Biological Fluorescence**	Students explore fluorescence by observing absorption and emission of light in a chlorophyll sample.
10	**Modeling Neural Axon Signaling**	Students utilize passive circuitry to model neural axon transmission of electric signals in the body.

TA Training and Support

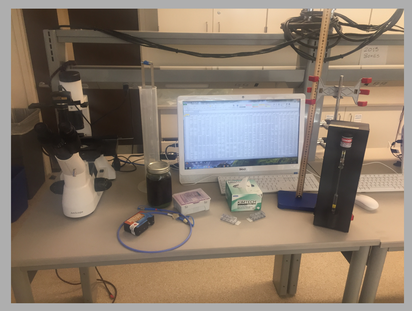
Changes in course structure and rigor have required implementation of TA Training and Support:

- Weekly meetings with course instructors, head teaching assistants, teaching assistants (TAs), and learning assistants (LAs) to discuss content, instructional techniques, course logistics, etc.
- Weekly meetings with head TAs, TAs, and LAs to preview lab manual, equipment, and experimentation to be familiar with equipment troubleshooting, common student struggles, and practice instructional techniques.
- Restructuring of departmental Mentor TA Program to provide observational support to TAs and LAs.

Adaptations and Revisions

Adaptation from Project NEXUS, including:

- Weekly PRE-LAB ASSIGNMENTS to introduce new scientific content and practices prior to experimentation
- Reducing explicit requirements for lab experiments to allow students more independence in experimental design, analysis, and communication
- Development of pedagogical training techniques as necessary for Physics and Life Science Teaching and Learning Assistants
- Restructuring of group role designations to provide opportunities for students to develop natural research-oriented communication and group work skills
- Drafting of new lab report guidelines to incorporate argumentation as central component of students' scientific writing (ongoing adaptation)
- Promoting a course focus on community building and promoting effective group work (e.g. Intro lab week with Group Activity, establishing group norms)
- Fostering peer learning and communication through discussion and presentations



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