Development of Rubric to Characterize Introductory Physics for the Life Sciences Curricula

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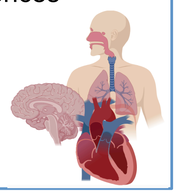
INTRODUCTION

IPLS: Introductory Physics for the Life Sciences

Physics courses designed for undergraduates with the intention of pursuing research in the life sciences, or of pursuing medicine and other health fields.[1]



→ ILPLS courses are intended to foster competency and understanding of relevant physics knowledge for life science students[1].

→ IPLS courses are distinct and better suited to this demographic than the standard of either calculus-based or algebra-based physics courses.

In contrast to traditional physics classes, IPLS courses have content that is immediately relevant to life science students.

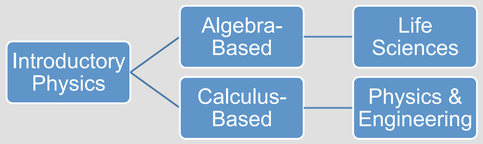


Figure 1. Standard physics course pathway. Determined by level of math competency.

Emphasized	De-emphasized
Dynamics	Projectile Motion
Fluids	Relative Motion
Diffusion	Statics
Waves	Magnetism

Table 1. Selection of topic emphasis in an IPLS course. Topics have biologically important applications and are essential to a "coherent physics narrative."[2]

For departments offering IPLS courses, there's currently no standard for what constitutes an ideal course. Curriculum developers and instructors would be best served with a **metric** by which to compare the authentic biology material of their course with other IPLS courses.

Biological Authenticity

We're interested biological authenticity- wherein solving physics problems contextualized to biology results in a deeper understanding of the biological system[3].

Research Question

To what extent can a rubric interpret the authenticity of content in an Introductory Physics for the Life Science course?

CURRICULA

Biomedical Physics, Portland State University[4]

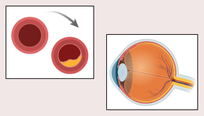
Focus: Biomedical Equipment and the Physics Involved in Their Use

Motivation: In response to the exponential growth in medical technologies, future medical students must have an understanding of the physics behind modern biomedicine diagnostic and treatment applications.

Course: Engages students by emphasizing practical applications of physics principles in biomedical field, and demonstrates how these concepts are integrated into technologies used in their chosen profession

Fluids	Biomechanics	Radiation Therapy	Ultrasound
LASIK	Microscopy	Pulse Oximetry	Endoscopy

Table 2. Selection of course topics.



NEXUS Physics, University of Maryland[5]

Focus: Cellular Biology – Atoms, Molecules, and Chemical Energy

Motivation: Students who complete this course will appreciate physics as relevant to their current academic studies, and to their future careers in research or medicine.

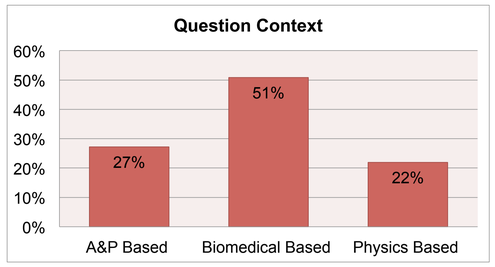
Course: Encourages the development of strong scientific skills, such as modeling, experimental design and analysis, and the representation of physical relationships in multiple forms.

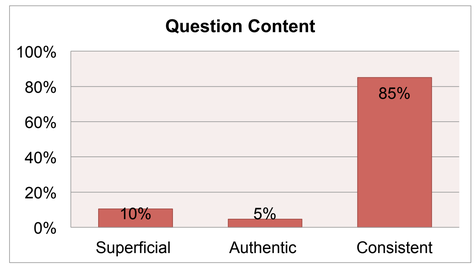
Thermodynamics	Oscillation	Brownian Motion	Diffusion
Dissipative Forces	Fluids	Chemical Energy	Pressure

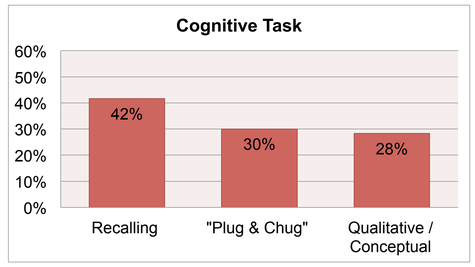
Table 3. Selection of course topics.

RESULTS

"Biomed. Physics": IPLS Physics Course, PSU

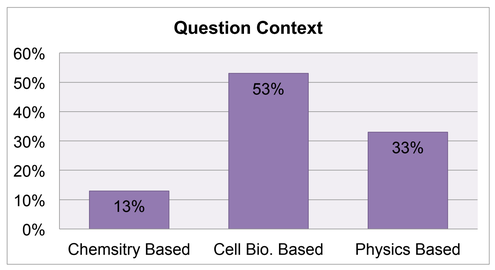


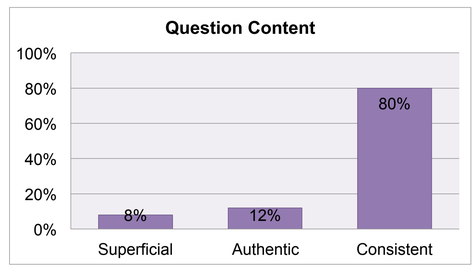


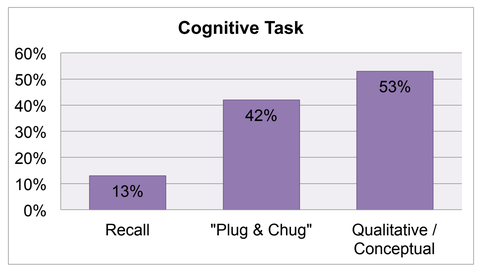


Graphs representing the context, cognitive task, and authenticity of material from the 'Fluids' module. Material analyzed consisted of pre-lecture questions, checkpoint questions, and homework questions; designed for flipped classroom.

"NEXUS": IPLS Physics Course, U.Md.







Graphs representing the context, cognitive task, and authenticity of material from the 'Diffusion & Random Motion' module. Material analyzed consisted of recitation questions and homework problems.

METHODS

biology & physics context → biology & physics content → authentic course

Our rubric will identify biologically authentic content across multiple courses and determine the proportion of context-content agreement. The intention is to differentiate between superficial & authentic, not the best fit of IPLS course content.

Rubric Development:

→ Redish et al., established question categories[5], but these alone were insufficient.

→ Inductive analysis was used to determine emergent categories, and then the coding rubric was used to differentiate between question context, type, and content.

→ Multiple coders from diverse backgrounds were used to determine IRR.

Course materials from two different universities were analyzed:
- Biomedical Physics, from Portland State University
- NEXUS Physics, from University of Maryland

DISCUSSION

→ The majority of the context for the analyzed sections were some sort of biology-based (78% Biomedical, 53% NEXUS).

→ Most questions were consistent between context and content (85% Biomedical, 80% NEXUS), with fewer questions being superficial (10% Biomedical, 8% NEXUS).

→ However, the proportion of questions that were physically valid and biologically relevant was low (5% Biomedical, 12% NEXUS). Ideally, an IPLS course would have a higher percentage of authentic questions – allowing students to use physics skills to make sense of biological phenomena[6].

→ The difficulty in creating a rubric to assess the authenticity of course context with content is compounded by the range of life science student backgrounds and course strategies.

FUTURE DIRECTIONS

→ **Currently**: Applying our rubric to Catherine Crouch's IPLS course material, assessing the Fluid Dynamics module[7].

→ **Planned**: Apply our rubric to a variety of other IPLS courses from other instructors, incorporating modifications as needed.

Ultimate Goal: Robust rubric that can effectively capture the authentic content of IPLS courses and be utilized as a tool for researchers and curriculum developers.

ACKNOWLEDGEMENTS

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