Assessing the impact of IPLS on physical reasoning

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Research Question

Compared to their peers with traditional introductory physics, are IPLS students better equipped to flexibly apply physical models in novel biological contexts?

IPLS

Introductory **P**hysics for **L**ife **S**ciences (IPLS) is **designed to prepare and motivate life science students to use physics in biological and medical contexts.**[1]

- Same topics as traditional introductory physics,
- Explicit instruction in and emphasis on modeling biological phenomena.

Methods

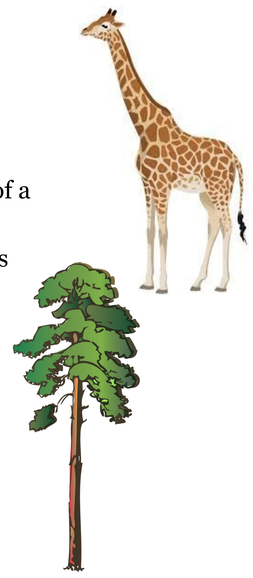
We analyzed life science students' work on an end-of-semester task given in IPLS (N = 61) and traditional (N = 37) mechanics. (Some life science students take the traditional course for scheduling reasons.)

Task:

(a) Finding the blood pressure in a giraffe's brain, by using simple hydrostatics

(b) Finding the pressure at the top of a tree, requiring them to identify whether to model flow as viscous or non-viscous, and incorporate gravity.

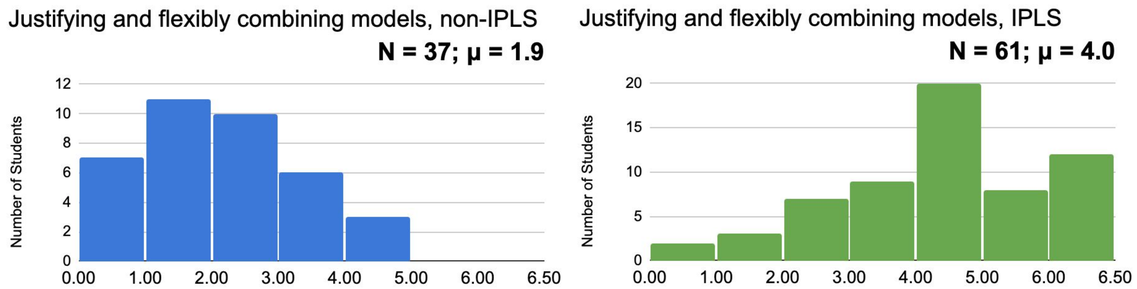
(c) Interpreting the evolutionary implications of these two results, using the idea of negative pressure, introduced for the first time in the task.[2]



Coding

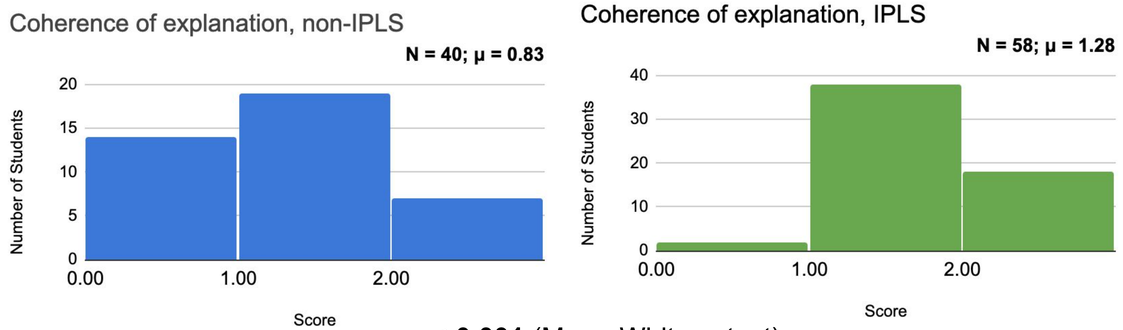
MT, BG, and CHC **iteratively** developed an emergent **code** for modeling and problem-solving competencies (parts (a) and (b)), and accuracy and coherence (c). Inter-rater reliability: 0.94 (a, b), 0.89 (c)

IPLS students demonstrate more skill **justifying and flexibly combining models** in novel biological contexts…



***p* < 0.001** (unpaired t-test)

…and more frequently **offer coherent explanations** when reasoning with *new physical ideas*.



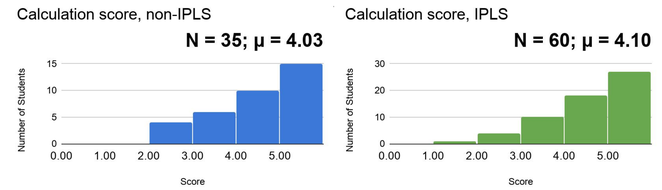
***p* < 0.001** (Mann-Whitney test)

Research Question

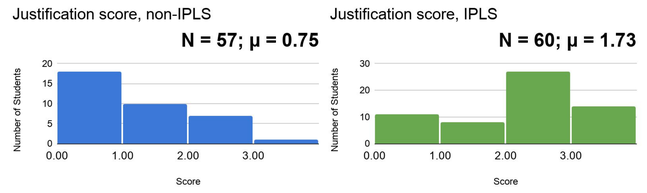
When applying a simple model, **IPLS and non-IPLS students exhibit similar modeling and problem-solving competencies.**
(Δμ = 6.8%; p = 0.20, unpaired t-test)

When choosing a model and flexibly combining models in a novel biological context,

- **IPLS and non-IPLS students demonstrate comparable numerical skill once a model is selected.**



- **IPLS students are more likely to justify their modeling choices when prompted.**
(p < 0.001, Mann-Whitney test)



When reasoning with physical ideas that are introduced for the first time in the task, **IPLS and non-IPLS students correctly interpret the physical consequences of a new concept at similar rates.**
(Δμ = 12%; p = 0.70, Mann-Whitney test)

References

[1] C. H. Crouch & K. Heller (2014)
[2] Inspired by J. D. Bransford & D. L. Schwartz (2001)

Acknowledgements

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