UBC Vantage College Science & Applied Science

Speaking and Writing Physics 101: The Language of Solving First-year Physics Problems

OER Supplementary Textbook

Alfredo Ferreira (UBC), Wucheng Zhang (Princeton University), David LeBlanc (UBC)

Textbook unpacks language & learning in 1st year physics

Combining perspectives of physics and language to help physics students understand and solve first-year problems more consciously and effectively.

Addresses gaps in tertiary science education:

- The perspectives and experiences of multilingual students; novel approaches also benefit native speakers' insights
- Explicitly addresses the mediating role of language systems in constructing valued physics knowledge across high-stakes genres.
- Data-based learning using authentic, recorded solutions by student groups and subject-area specialists, data exploited pedagogically for variation in:
  - **spoken and written problem-solving**
  - **novice and expert problem-solving**

Teaching & Learning Contexts

An **open educational resource (OER)** available on Pressbooks, the textbook available for self-study, group study, or instructor facilitated contexts of

1. tutorial sections of the physics courses focusing on problem-solving competencies and communicating solutions
2. linked content-and-language syllabi such as an English for First-Year Physics course.
3. advanced placement high-school science programs
4. pre-sessional university preparation programs.
5. refresher courses for first-year physics

The Physics Perspective

The textbook opens with instruction in **effective strategies for solving word problems in physics**. The units then present physics problems linked to the set of physics concepts typically taught in first year – from linear motion to fluids – focusing on how students and experts solve problems in groups and report their solutions with rationale formally in writing.

By exploring the **diverse competencies of students and experts in speaking and writing physics solutions**, the textbook aims to help students understand and develop their own competencies.

Organization

Unit	Physics Topics	Language Features
1	Motion Along a Straight Line	Units and Scales of Language as a Meaning-making Resource
2	Constant Acceleration	Doing and Being
3	Motion in 2 & 3 Dimensions	Entities Involved in Doing & Being
4	Newton's Law	Circumstances of Doing and Being
5	Application of Newton's Law	Logical Connection & Progression
6	Work & Kinetic Energy	The Concrete – Abstract Spectrum
7	Potential energy, Conservation of Energy	Information Density

The Language Perspective

Across the 13 units, the three main functions of language in shaping physics knowledge are illustrated, unpacked, and practiced:

Units 2-6: **Representing** experience & ideas
Units 7-9: **Organizing** meaning in language, figures, mathematical symbolism
Units10-13: **Negotiating interpersonal relations in** knowledge claims

For example, we explore the functional structures of English that physicists typically use when a problem requires **re-interpreting the concrete, physical world in terms of abstract concepts**, such as when modelling a running person (concrete) as a point mass (concept). How is such a shift in perspective realized in language?

FAQs answered

- What are the functions of language in solving physics problems?
- How does language help us to shift perspectives between a problem's dynamic, physical situation and the stable, theoretical concepts involved?
- What are the roles of visual figures and mathematical symbolism relative to language in solving physics problems?
- What language choices are involved in effectively solving a physics problem in group dialogue and writing?
- Can we distinguish between reporting and explaining our solution? If so, how?
- What does it mean for a solution to be effectively communicated?

Strategies for Engagement

Task-based learning

Task-based syllabus with little fronted instruction. Learning occurs as users engage with tasks. Units typically lead with tasks linked to audio/ transcripts of spoken solutions by students and experts; users input their task responses, and receive feedback, which is where much of the explicit instruction occurs.

Gamification

Advancement between textbook units is gated with a learning game involving a single Rube Goldberg machine comprising of 12 phases

Contact

Dr. Alfredo A. Ferreira, Lecturer UBC Vantage College
alfredo.ferreira@ubc.ca

Acknowledgement

We gratefully acknowledge the financial support for this project provided by UBC Vancouver via Teaching and Learning Enhancement Fund (TLEF): Small TLEF Innovation Project Grant (Year 3): ID: 2024-TLEF-SP-0000000268 .