Analyzing the interdisciplinary nature of tasks in a physics course for life science majors

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Designing Interdisciplinary Tasks

Recent increase calls[1] for interdisciplinary science education reform raise the practical challenge of designing interdisciplinary tasks.

"We are caught between demands to transcend the boundaries and perspectives of the separate disciplines, in order to obtain more complete understanding, and demands to ground inquiry in the disciplines...".[2]

We designed and analyzed a series of tasks in our physics for life sciences course[3] and developed a framework that examines how tasks vary in both the *type* and *degree* of integration between the disciplines.

Task Analysis Framework

Less Integrated	Dimensions	More Integrated
Bringing in phenomena from another discipline	**Phenomenological Context**	Integrated phenomena
Question from one discipline in the context of the other	**Question/ aim**	Integrated question
Ideas applied from one discipline to the other	**Conceptual framework**	Reconciliation of conceptual frameworks
Tools from one discipline used in the other	**Reasoning strategies / tools**	Shared reasoning strategies

Questions for Discussion

- **In what ways do we want the disciplines to interact with one another in learning environments, how deeply, and for what purpose?**
- In the course(s) you teach, which disciplines are represented?
- Along which of these dimensions is integration important to you?
- What is the level of integration between disciplines that is important to you?

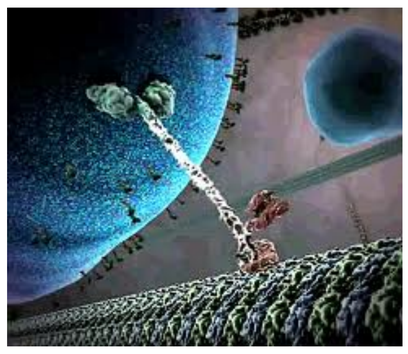


image credit: XVIVO
http://www.studiodaily.com/2006/07/cellular-visions-the-inner-life-of-a-cell/

Task Analysis Example: Energy and Molecular Motors

We began with the phenomenon of the molecular motor movement in a cell as a context in which to develop an interdisciplinary task. Below we compare our initial and refined versions of the task.

less integrated → more integrated

Kinesins are able to transport large and heavy cargo like vesicles. Let's consider the energetics driving this process.

Kinesin used as a context in which to explore energy transformations.

We know a lot of movement takes place within cells. The question is what drives this movement and what are the tradeoffs among different mechanisms?

Question examines both the physical mechanisms that underlie biologial movement as well as the implications of these mechanisms for organisms.

Create energy bar charts accounting for all energy in the system for each frame in the kinesin walking process.

Focus is on physics concepts of energy.

Use your understanding of energy transformations to explain what it means to say that a cell "uses ATP to fuel molecular movement".

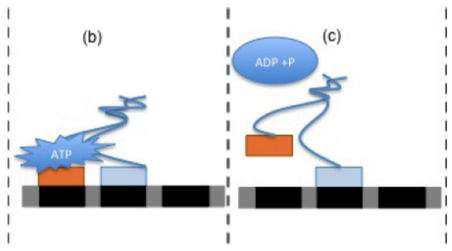
Task emphasizes integrated understanding of energy that combines physical and biological conceptualizations of energy.

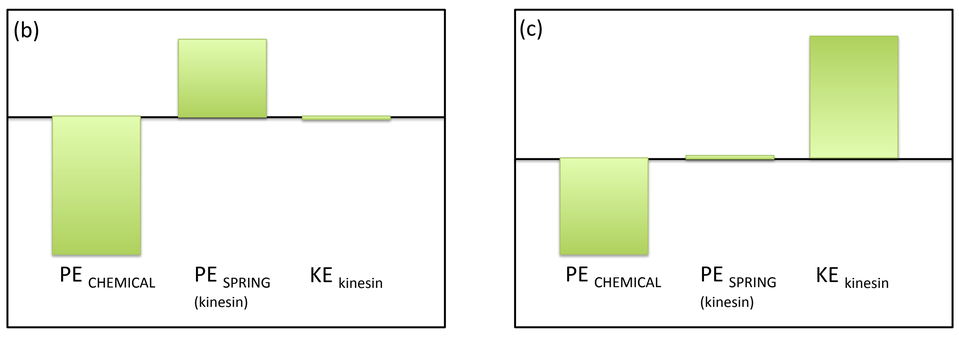
Has the principle of energy conservation been satisfied? If not, how can you modify the system to ensure that it has?

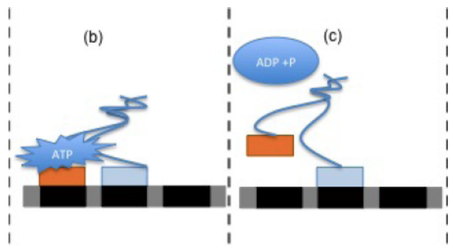
Energy bar charts used as a tool for tracking energy transformations and checking for consistency with the principle of energy conservation.

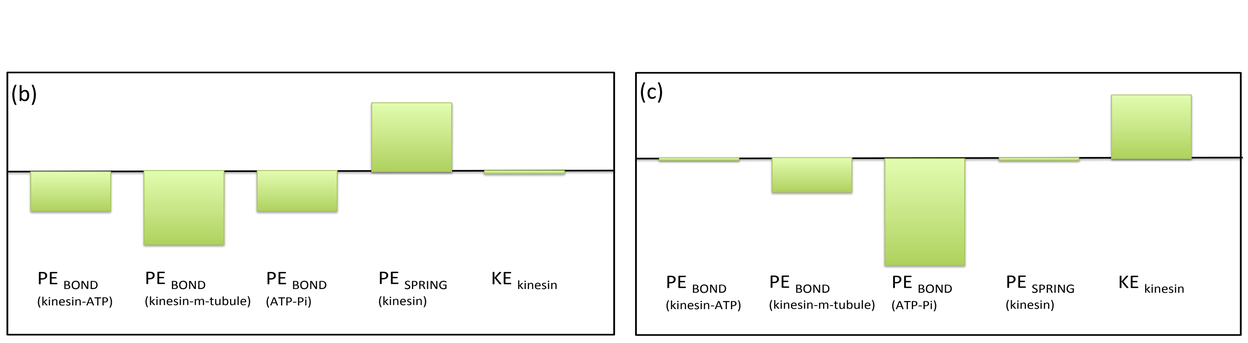
Use energy bar charts and the principle of conservation of energy to keep track of changes in energy and to explain where the kinetic energy comes from.

Energy bar charts used to unpack concept of chemical energy and explore implications for the biological mechanism of kinesin walking.

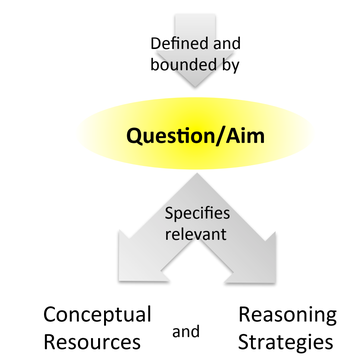








Entry points for Interdisciplinarity



Summary and Future Work

- Changing the degree of integration of the driving question was central to task revision. A more integrated question led to the need for a more integrated set of conceptual resources and reasoning strategies.
- In future research, we will investigate the impact that different interdisciplinary tasks have on students' engagement and learning.

References

1. *Scientific Foundations for Future* Physicians (AAMC/HHMI, 2009), Vision *and Change in Undergraduate Biology Education* (AAAS/NSF, 2011)
2. Paxson, T. D. (1996). Modes of interaction between disciplines. *The Journal of General Education*, *45*(2), 79-94.
3. http://www.hhmi.org/news/nexus20110608.html

Acknowledgements

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