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Resources for Interdisciplinary Understanding of Energy

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Resources for Interdisciplinary Understanding in Science

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Overarching Question: *What tools and resources do students use when transferring energy concepts across disciplinary contexts?*

Motivation for Research:

- Develop instruction that fosters coherence in student learning.
- As both a core idea and a cross-cutting concept, energy can serve as a vehicle to promote coherence.

"If transfer is the standard used to justify the human and financial investment in education and training programs, then it must apply well beyond the environment of training – that is, far transfer is required. Finding evidence of transfer from today's math class to tomorrow's math class is not sufficient." **(Singer, et al., 2012, p. 619).**

SCED (Science Education) Curriculum

The SCED series is designed to support transfer by giving students tools for applying energy principles to new situations. Student use energy diagrams to represent the flow of energy through systems, an approach that can be used with energy problems of any type. This purposeful teaching method provides an idealized setting for the study of transfer

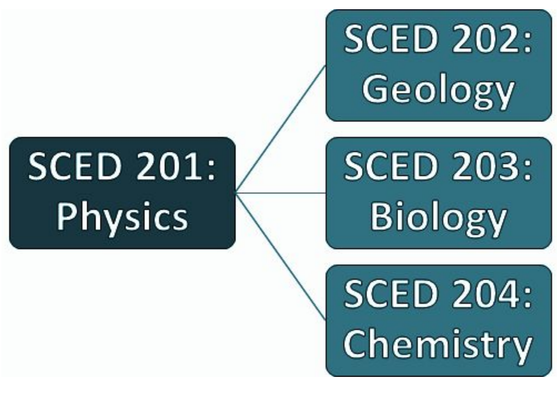


Figure 1. The order of courses in the SCED 20X series. Physics is always taken first.

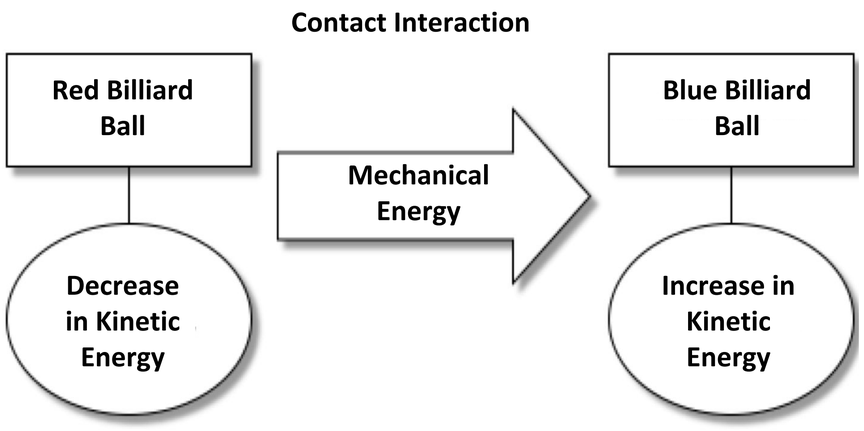
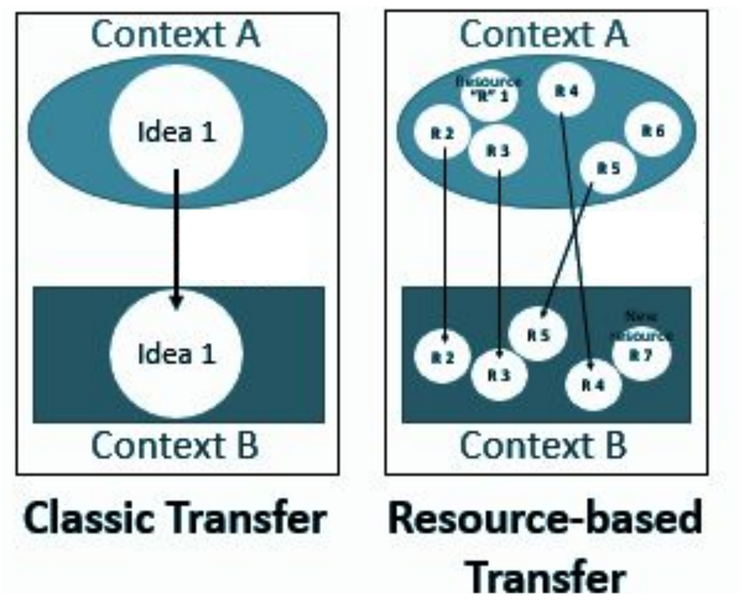


Figure 2. An energy diagram, a tool students use to model energy transfers in all courses.[2]

Transfer



Classic Transfer: Knowledge consists of fully compiled units that a student learns in one context and deploys in another

Resources: Small grain size ideas a student builds through experience and activates in response to a learning challenge

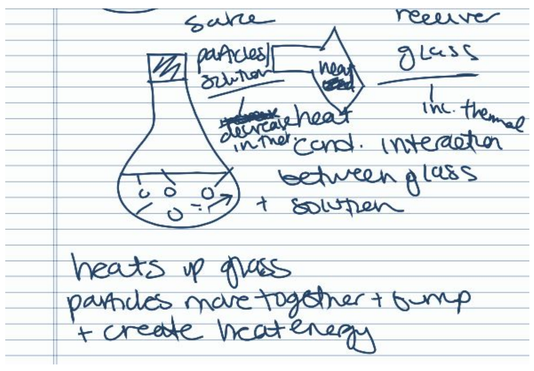
We view transfer as the activation of *new* combinations of *existing* resources that occurs when a learner confronts a novel challenge (e.g., a problem in an unfamiliar science discipline).[1]

References:
(1) Hammer, D., Elby, A., Scherr, R., and Redish, E. "Resources, Framing, and Transfer." *Transfer of Learning: Research and Perspectives*, 2004.
(2) Goldberg, F., S. Robinson, and V. Otero. *Physics and Everyday Thinking*. Armonk, NY, It's About Time: Herff Jones Education Division, 2005.
(3) Braun, V., and Clarke, V. "Using Thematic Analysis in Psychology." *Qualitative Research in Psychology*, vol. 3, no. 2, 2006, pp. 77-101.
(4) Singer, S.R., N.R. Nielsen, and H.A. Schweingruber, (2012), National Academies Press: Washington, D.C.

Methods

Interviews were conducted with students who had completed the physics course and were enrolled in the chemistry course. Interviews occurred *before* energy was introduced in the chemistry context. Students were asked to create scientific explanations for real-world phenomena.

Sample Interview Task: A powder is placed in a room-temperature flask. A liquid is added to the powder and the flask is sealed with a stopper. You observe fizzing in the mixture. After a few minutes, the stopper pops off the flask. *Create a scientific explanation for why the stopper popped off the flask.*



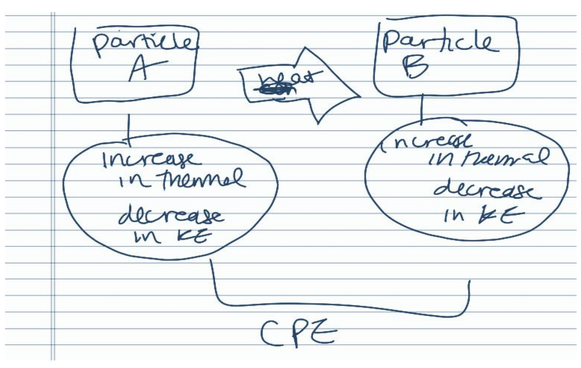


Figure 4. Sample diagrams from a think-aloud interview using the chemistry protocol.

Data Analysis

We use thematic analysis[3] to code the interview transcripts, identifying the resources students draw on when faced with a transfer task. We are currently working to determine what combinations of resources are activated, and investigate which combinations tend to occur in which specific contexts.

Energy Resource Codes		
Form	Indicator	Change
Transfer	Transform	Quantity
With Object	Accounting	Mechanism

*"There would have to be a **transfer of energy** to the stopper which would make it move with **kinetic energy**, so there would have to be a **transfer of energy** from basically the reaction as kind of the starting point to the stopper, and it would **change into kinetic energy** in the stopper.*

*There would be **an energy transfer**. So it would be more so like we have the reaction which would **transfer energy to kinetic**, air/gas I guess, and that would **transfer energy to the stopper which would increase in KE** and this would be an increase in what might be KE. I'm not sure. And then this would be maybe, **chemical potential**? Not sure. But that would be **energy transferred**."*

Transfer, Transform, Forms

TRANSFORM: Statements that energy converts from one form to another.

Transform, Forms

FORMS: Statements that indicate that energy takes on different forms and has identifiable types.

Change, Transfer, Forms

CHANGE: Statements that the amount of energy associated with an object can increase or decrease.

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