

## **FIRE: Exploring Visual Cueing to Facilitate Problem Solving in Physics**

### **PROJECT SUMMARY**

Vision is a critically important medium of communication. Students are continuously bombarded with images on television, cell phones and during instruction. Research has shown that although well-designed images can facilitate learning, poorly designed ones can increase cognitive load (Ayers & Paas, 2007). Recent research (e.g. de Koning, et. al. 2009) has explored using visual cues to focus learners' attention on relevant areas of instructional imagery. Other research (Thomas & Lleras, 2007; 2009) has shown that using visual cues to influence eye movements can facilitate problem solving. These results illustrate how cognition is embodied such that bodily movements associated with attention can affect higher order cognitive activities such as problem solving. Furthermore, such results suggest that by having learners attend to the correct visual elements in a problem, they begin to think about those elements, leading them to formulate the correct solution to the problem.

Visual cueing has been shown to facilitate solving problems in which the visuospatial component is central to the problem (e.g. Grant & Spivey, 2003; Thomas & Lleras, 2007; 2009). Numerous physics problems fit this description, yet visual cueing has not been researched with physics problems.

We therefore propose our **overarching hypothesis**: *Visual cueing in physics problems with a strong visuospatial component can facilitate correct problem solving.*

This FIRE proposal will strengthen an existing partnership between a cognitive psychologist mentor (co-P.I. Loschky) and physics education researcher mentee (P.I. Rebello) to test the above hypothesis through a sequence of two studies with a total of 150 participants enrolled in introductory algebra-based physics courses. The studies build on our ongoing work over the past two years.

- Study 1 identifies differences in the eye movements of experts and novices while solving physics problems with diagrams.
- Study 2 determines whether manipulating novices' eye movements on training problems using visual cueing can facilitate solving transfer problems.

An expert panel of two cognitive psychologists (Brian Ross and David Irwin) and a physics education researcher who also works in cognitive psychology (Jose Mestre) will serve as the Advisory Board and evaluators for this project.

#### **Intellectual Merit:**

- (i) The main intellectual merit lies in its novelty and potential to transform research on the use of images in physics problem solving. This project is one of the first of its kind to explore and exploit the link between cognition and eye movements in the context of physics problem solving.
- (ii) Further, the project enables the mentee (Rebello) and his research group to expand their knowledge of the field of cognitive psychology, specifically visual cognition, thus promoting future collaborations between mentor (Loschky) and mentee (Rebello).

**Broader Impact:** Beyond its immediate scope, the project will:

- (i) benefit the field of physics education research by infusing ideas from cognitive psychology regarding visual cueing into physics education research,
- (ii) potentially change the ways visual media are used in physics instruction to more effectively facilitate students' learning, and
- (iii) build human capital in the field of physics education research by training faculty and graduate students in the knowledge and skills of cognitive psychology applied to their field.