# Student Understanding of the Inverse-square Law in Multiple Representations

Author: Mianqing Yang
Faculty Mentor: Dr. Rabindra Bajracharya
Department: Chemical and Physical Sciences
Competition Category: Education

We investigated how students understand the inverse-square law in multiple representations. Our hypothesis is that students in physics have difficulties with the inverse-square-law in multiple representations, in particular the numerical and the graphical representations. We modeled student responses to explain the potential causes for their difficulties. In the study, we designed two versions of written surveys, one with a physics context and the other without any physical context. The questions in the surveys were based on the inverse-square law and were asked in multiple representations: words, algebraic equations, numerical tables, and graphs. We administered the versions with and without physical contexts in various physics and mathematics classes respectively. We chose the classes because the students had already learned the inverse-square function in their previous mathematics class.

We found that although the prevalence of correct responses in both mathematics and physics classes was less than 50%, the students in physics classes performed better than the students in mathematics classes in general. For example, 38% students in calculus-based physics II answered the graphical questions correctly, whereas only 19% students in calculus II answered the question correctly. More than half of the students who responded the questions incorrectly seemed to be confused between the inverse-square relation and the inversely proportional relation. Student used various salient features without engaging in genuine conceptual thinking to answer the questions. The results clearly show that students lack deep conceptual understanding of the inverse-square law.

The teaching implication of this study is that more emphasis needs to be put on multiple representations while teaching the inverse-square function in mathematics and the inverse-square law in physics. Our results suggest that various features in a question affect how student perceive the question, so instructors should pay attention to the features in questions that may invoke incorrect concepts.