

# Evidence of problem-solving transfer in web-based Socratic tutor

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**Abstract.** We demonstrate learning and problem-solving transfer within the web-based homework tutor MasteringPhysics by considering time to completion, the number of hints requested, and the number of incorrect responses given. The group of students who were prepared by a prior related problem solves a related follow-up problem in ~14% less time on average compared to an unprepared group on that problem. Furthermore, the prepared group requests ~15% fewer hints and makes about ~11% fewer errors on average than the unprepared group.

## INTRODUCTION

In this paper we provide evidence of learning and problem-solving transfer in physics using three variables that are available from students doing problems in an online Socratic homework tutor: time to completion, number of hints requested, and the number of incorrect responses. According to Mayer [1, pg. 19], “problem-solving transfer is the effect of previous learning on new problem solving.” Within this definition we measure transfer due to a preparatory exercise by the reduction in time, hints, and incorrect responses by a student on a subsequent problem relative to students of equal ability who have not been exposed to the preparatory exercise. Data on hints, time, and wrong answers are obtained from retrospective analysis of the Socratic dialogue where students are provided with hints and simpler sub-problems upon request, and are given feedback when wrong answers are proposed. This is mastery learning pedagogy [2] - the time on task expands due to the dialog, ultimately enabling over 93% of the students studied here to solve a given problem.

According to Smith [3], problem-solving must satisfy three conditions: a question, not knowing the immediate solution or how to answer the question, and the desire to solve the question. The first and the last conditions are satisfied by default: the first by the given homework questions and the last by the desire to complete the homework and obtain credit for the course. The second criterion is subjective in the sense

that what is a problem for one student may not be perceived as such by another. This is particularly challenging when no interviews are carried out or doing so is impractical as with our class of 400 students. Interestingly, however, the log files the tutor generates can be used in novel ways to identify students for whom the homework question poses a problem. In this paper we show that students who take more than 2.5 minutes to complete a given question can be regarded as problem-solvers.

## THE STUDY

The data in this study involve students from the fall 2003 semester taking the introductory Newtonian mechanics course at the Massachusetts Institute of Technology (MIT). The students (~ 430 in total) were divided into two equally skilled groups based on their MasteringPhysics<sup>1</sup> homework assignment grades for the first six weeks of the semester. Our study involves these two groups solving related problem pairs in the opposite order relative to each other with no intervening problems. That is, the “first” problem in a given pair to one group is the “second” to the other and vice versa. We will call the group that solves a given problem in a pair first, the *unprepared* group

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<sup>1</sup> David Pritchard founded the Effective Educational Technologies which makes MasteringPhysics with his son, and their family has a controlling interest in the company. Some of the IP for this company is licensed from MIT where it was developed under his direction.





