

Just-in-time hints: What the eyes say

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Our commitment to continually improving our Cognitive Tutor means that we are always monitoring research on the way students solve mathematical problems. No system is ever perfect, but as we learn more and more about how students think, we find ways to make our systems even more effective. This article focuses on one of the most promising new methods for learning about how students work with our tutors.

Kevin Gluck's doctoral research at Carnegie Mellon University involved having students solve problems in a variant of the Algebra I Cognitive Tutor. Students in the study wore a headset which tracked their eye movements. In this way, Dr. Gluck was able to study information that students used when solving problems.

One of the areas that Dr. Gluck studied was how students used hints. It may not be surprising to learn that students do not always read the hints that the system gives, but the eye tracking data lets us quantify this information and understand it at a deeper level.

Dr. Gluck found that 41% of the time, when the tutor presented a just-in-time hint (one that responds to a specific type of student error), the student's eyes never even moved to the hint window.

That might lead you to believe that we need to think of a better way to attract students' attention, but a more careful analysis of the data tells us more about why students are ignoring some hint messages.

In 62% of the cases where students ignored a just-in-time hint, they were able to enter the correct answer on the next attempt. So, in those cases, the student did not need to read the hint. Furthermore, students are somewhat more likely to read just-in-time messages when they are completing more difficult parts of the problem. So (at least some of the time) students are choosing not to read the hint (as opposed to not noticing that the hint is there).

The challenge then, is to present these hints in a way that draws students' attention without distracting students who already know how to correct their mistake. Our answer (to be introduced into the tutors next year) is to use "tool-tip hints." Instead of putting just-in-time hints in a window, which might be out of the student's field of view, these hints are put in "tool tips" that appear next to the related item in the interface (e.g. a cell in the worksheet). Tool-tip hints appear only when the cursor is put in the worksheet cell and do not need to be explicitly closed, so students can easily change an answer without reading the hint. With this presentation, students will always know that a just-in-time hint exists, but they will be able to ignore it when they already know what they did wrong.

The eye tracker is a very powerful tool for understanding how students solve problems. Hint presentation is just one area where we are applying data from the eye tracker to improve the effectiveness of our systems.