Students take Sketch Worksheets for a spin during in-class group activity

Maria Chang, Ken Forbus

Northwestern University

Sketching is an excellent tool for communicating ideas and teaching concepts in spatial domains. For this reason, sketching is heavily used in many STEM disciplines. What if we could build software that understood student sketches in the same way a teacher would? What if sketch-understanding software could help students learn? At SILC, we are working toward these goals, by developing CogSketch and Sketch Worksheets.

Last year, we showcased the first launch of Sketch Worksheets in classrooms (http://www.silccenter.org/archives/showcase_archive/2010_showcase/Showcase10.html#May). Our work continues, and last Spring quarter (2011) Sketch Worksheets were field tested in college geoscience courses at Northwestern University and Carleton College. Since the initial launch of worksheets, we have developed several new features to improve the way the software understands student sketches. We have forged collaborations with UW Madison and Carleton College to develop geoscience sketching exercises that are designed by field experts. To teach students the ins and outs of using CogSketch, we developed built-in tutorials and how to videos that students can access via YouTube.

This year, Sketch Worksheets were used by over 70 students across both schools. At Northwestern University, students used worksheets to complete homework assignments about faults, geological processes and the Earth's carbon cycle. At Carleton College, students used worksheets to complete an in-class activity on plate tectonics. The plate tectonics exercises were completed in groups, with 2-3 students sharing a laptop, sketching interactively and bouncing ideas off of each other. In less than one hour, students in the group activity were able to learn how to use CogSketch and complete an average of 3 worksheets on plate tectonics, despite having never heard of or seen CogSketch before that day.

In both activities, students made use of the Sketch Worksheets tutor, which uses artificial intelligence techniques to provide students with feedback about their sketches. The Sketch Worksheets tutor can be used to let students know if they've made predictable errors in their sketches, so the instructors and TAs can dedicate their time to students who need more complex coaching. With students outnumbering instructors, it is impossible for instructors coach every student all the time. Software tutoring has the potential provide students with some of the on-demand feedback they need, while freeing up time for teachers. The field tests we are conducting and the feedback we are receiving from students, educators and domain experts bring us one step closer to reaching this potential.

CogSketch is publicly available through SILC's website (www.spatiallearning.org). For peer-reviewed publications on CogSketch and Sketch Worksheets, see the following:

- Forbus, K., Usher, J., Lovett, A., Lockwood, K. and Wetzel, J. (2011), CogSketch: Sketch Understanding for Cognitive Science Research and for Education. Topics in Cognitive Science. doi: 10.1111/j.1756-8765.2011.01149.x (http://onlinelibrary.wiley.com/doi/10.1111/j.1756-8765.2011.01149.x/full)
- Yin, P., Forbus, K., Usher, J., Sageman, B. & Jee, B. (2010). Sketch Worksheets: A Sketch-based Educational Software System. Proceedings of the 22nd Annual Conference on Innovative Applications of Artificial Intelligence. (http://www.qrg.northwestern.edu/papers/Files/QRG_Dist_Files/QRG_2010/Yin_Worksheets%20IAAI10%20Final.pdf)

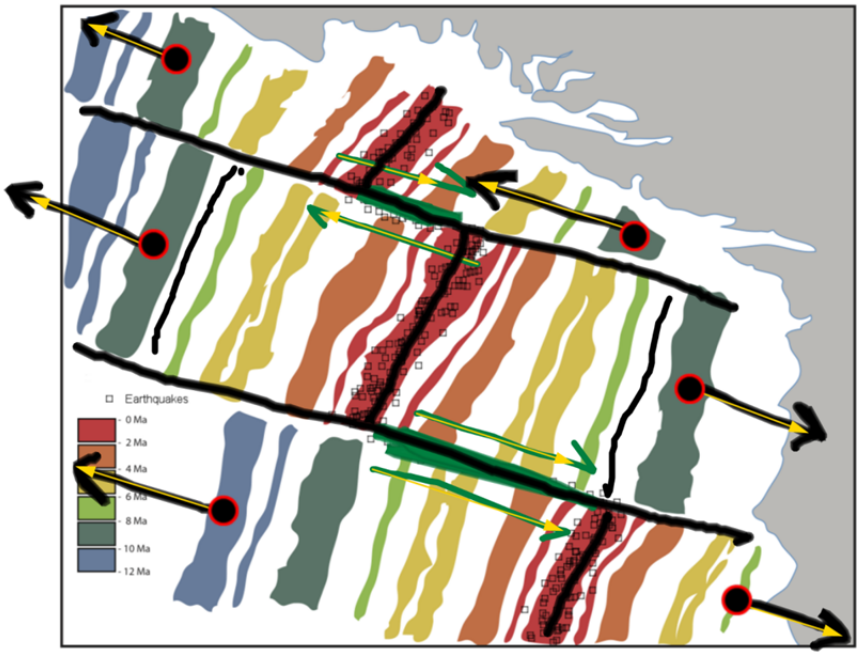

Figure 1: Example plate tectonics exercise

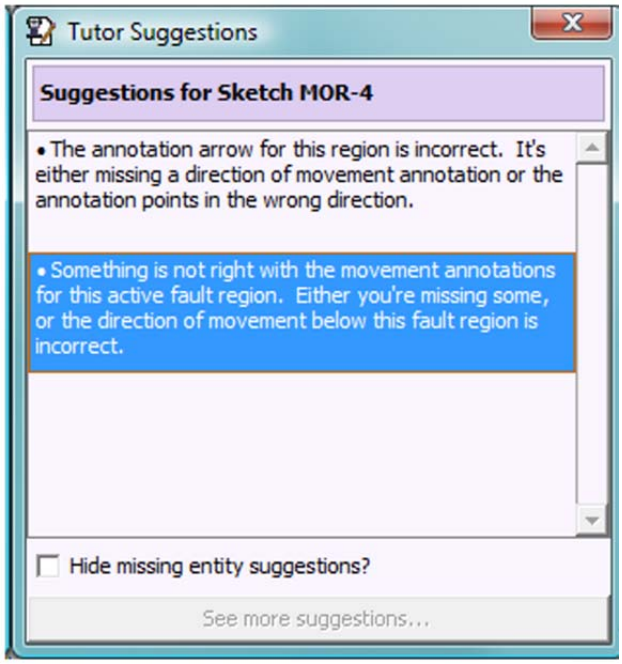

Figure 2: Example of feedback given by the tutor