Revision Analysis of Students' Position-Time Graphs

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Abstract: This research investigates the types of revisions students make to position-time graphs they construct. In our online graphing unit, students construct position-time graphs and then revise their graphs after receiving various forms of feedback. We examine how and why students attempt to revise their graphs, finding that students continue to have difficulty with constructing and revising position-time graphs. We then suggest areas for support in the future design of guidance for graph construction.

Objectives

Interpreting and constructing data visualizations is a skill necessary for scientific literacy since it allows for the elucidation of patterns and underlying processes and helps to reveal correlations between events (Friel et al., 2001; Wu & Krajcik, 2006). Construction and revision of graphs are important practices, however middle school students are rarely asked to interpret, let alone construct, graphs in science classes (Boote, 2012). Position-time graphs are particularly difficult for students, and many students interpret graphs as pictorial representations of an event rather than a relationship between the two variables on the axes (Brasell, 1987). This study looks at types of revisions students make to their position-time graphs after completion of our online graphing unit in order to determine where further guidance is needed.

This study employs a Web-based Inquiry Science Environment (WISE) unit, titled Graphing Stories, which was designed according to the Knowledge Integration (KI) framework, a constructivist framework that involves eliciting and building off of students' prior knowledge (Linn & Eylon, 2011). Students' issues with interpreting graphs often come from a difficulty in connecting the significance of graphical features, such as scale, slope, and direction of lines, to the thing they represent in reality. The KI framework encourages making these connections in our curriculum by eliciting students' prediction graphs (their initial ideas), giving them guidance that helps them to distinguish between ideas, and then prompting them to revise.

Methods

Two teachers from one middle school (62% non-white, 22% free/reduced lunch, 12% ELL) participated in this study, with a total of 10 classes of 8^{th} grade students (N=231). Students completed the 5-day Graphing Stories unit during 50 minute class periods. Students worked in collaborative workgroups assigned by their teachers, mostly pairs with a few students working individually. Students completed the pretest one day before beginning the unit, and the posttest one day after completing the unit. Both pre and posttest were completed individually.

The online Graphing Stories unit is designed as an introduction to interpreting and constructing data visualizations, addressing several NGSS science and engineering practices (NGSS Lead States, 2013). The curriculum focuses mainly on constructing and interpreting position-time graphs, and includes animations that match up to student-constructed graphs to give visual feedback. Students construct graphs with various graphing tools, and have several opportunities to revise their graphs after receiving various forms of feedback. For this study, we focus on the types of revisions students made on a posttest item that asks them to construct a position time graph and then revise their graph after receiving guidance. The prompt states: "Karim wanted to bike up a big hill in his neighborhood. He went slowly up the steep hill, then really fast on the way down the other side. Use the graph below to sketch his ride. Think about the different speeds he went during his ride." Students then examine and evaluate graphs created by two fictional students before revising their own graph. After making revisions, students are prompted to explain what they changed about their graph and why.

Results

Students' graph revisions for the assessment item were categorized into six different groups based on aspects of the graph that they changed (Figure 1). Only 15% of students (N=35) correctly drew the graph, and had no need to revise. Of those that did not correctly draw the graph, many (N=85, 36%) chose not to revise their graph, generally citing that they believe they were already correct despite their graphs going back to the starting position. About 20% of students (N=48) revised the slope of their graph, either correcting the speed or making difference between the two speeds more apparent. Many students needed to revise the direction of their line, but failed to recognize their error, keeping their "graph-as-picture" representation.

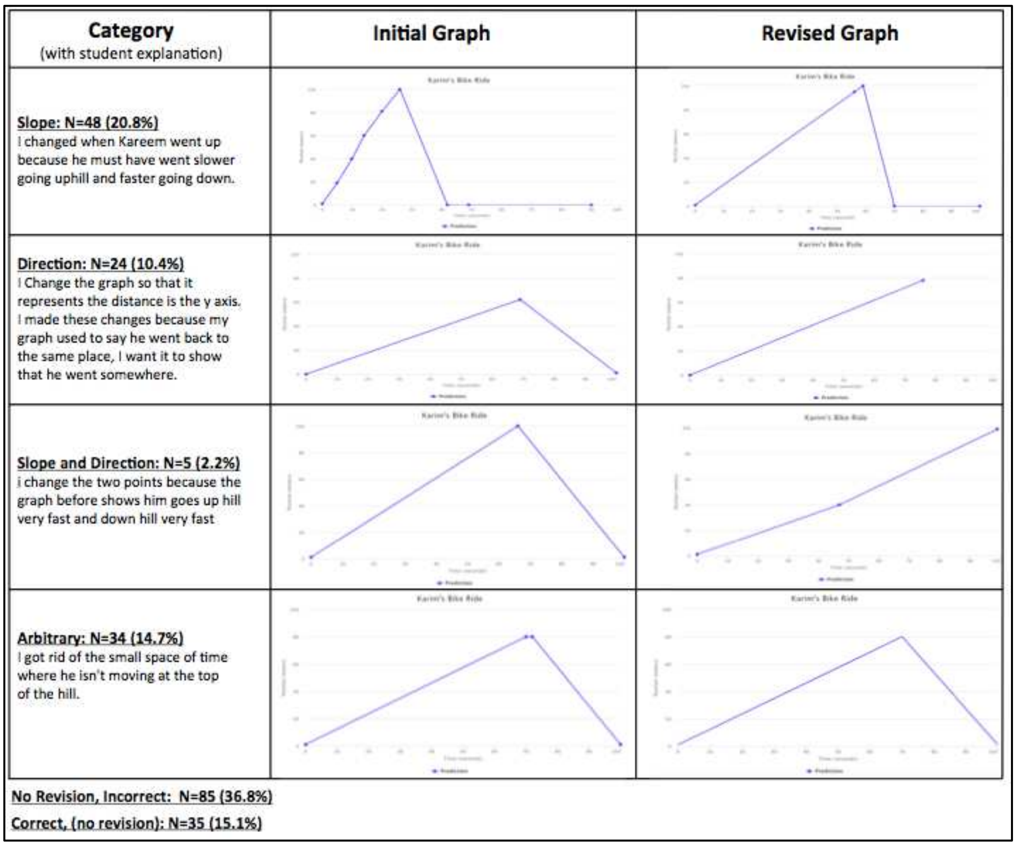

Figure 1. Graph revision categories with student examples about the reasoning behind their change and percentages (left column); one example for each category showing initial graph (center) and revised graph (right).

Significance of study

Graphing is an important skill, but students are rarely asked to construct, let alone revise, graphs. These results show that students need further guidance to recognize position-time graphs as a relationship between these two variables rather than a drawing of what is happening. Students also need practice evaluating their own work for correctness, in light of new information they have learned. In developing guidance, we should specifically target the relationship between line direction and position as a concept to emphasize.

References

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