Making Mathematical Thinking Visible Through Technology

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Abstract: At this session, we will discuss new and evolving technology that helps students make their thinking about mathematics visible to their peers and teachers. Building on prototypes that have been successful in algebra and pre-algebra classrooms, we will illustrate how technology may afford new opportunities for collaborative learning and mathematical discourse that exceed what is possible when supports are limited to written artifacts. Opportunities for automated analysis of digital artifacts will be discussed.

Introduction

In a mathematics class, student work provides insight into students' thinking as well as how teachers can best support them in improving their understanding of the content (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997). Reviewing student work in whole class or small group settings can be an effective way to show students that the process of doing mathematics is valuable and that the correct answer is just one component of mathematics. By building off of student thinking and highlighting things that students do well, discussions of student work can be an encouraging and formative process (Carpenter, Fennema, & Franke, 1996). It also acts as a formative assessment by making the expectations and path forward clear to the student and by providing information to the teacher that can inform instruction (Black & Wiliam, 2009). This process helps clarify the learning goals and improves both teaching and learning (Penuel & Shepard, 2008; Shepard, 2005). Student work also provides an opportunity for mathematical discourse, a practice that has been suggested to promote equitable classroom environments where traditional power structures can be disrupted (Nasir, Hand, & Taylor, 2008). In this sense, learning mathematics is viewed as a byproduct of classroom activity and participation in discourse (Cobb, Wood, & Yackel, 1993).

Description of relevant features of Woot Math Polls

Woot Math Polls is a math-specific digital formative assessment tool where students complete tasks on a cloud-connected device (e.g., laptop, tablet, mobile device, etc.). These tasks can involve various formats such as multiple choice, gesture-based graphing, select a point or region of an image, fill in the blank or other constructed response. Students show work using a mouse or touch screen on a scratch pad that includes a function editor, a graphing environment, a drawing tool, a calculator and a table feature. One of the features of Woot Math Polls is that after students respond, the teacher can choose to display individual responses or an aggregate of the class' responses. The teacher may also choose to display the work that the student did on the digital scratchpad. Figure 1 shows an example of hypothetical student work where they showed their work but did not get the question right. The teacher could display the work and highlight what the student did well and allow the class to suggest where they went astray.

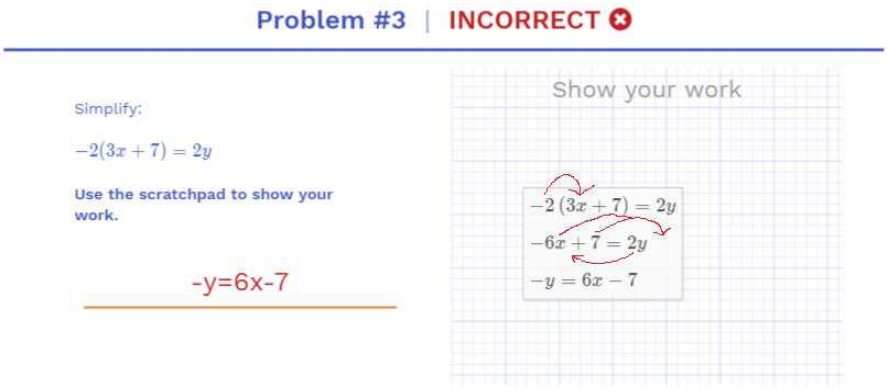

Figure 1. A screen shot of hypothetical student work displayed using Woot Math Polls.

Teacher perspective

A recent professional development study that used Woot Math Polls found that teachers highly value the displaying student work feature of the tool. In a post survey, an Algebra I teacher described how she used the display student work feature.

> It allows me to see their understanding and examples of student work (not just answers). Sometimes students are really close to getting the correct understanding and I really liked how I could pull of examples for the whole class to see and have them help pinpoint mistakes. There were a lot of 'a-ha' moments where the students could totally see what they did wrong and make a positive connection to fixing a misconception. (Teacher A, 2017)

This teacher pointed out how the students seemed to gain from being able to see examples of work that were close to correct and identify the errors. Beyond identifying errors, another teacher remarked about how the feature promoted discussion and comfort with talking about mistakes and how to address them.

> I think it started to make students feel more comfortable about talking about common mistakes and why/how they are made especially when reviewing student work. I also think that it made students excited about sharing what they understood and interested in sharing it with each other. (Teacher B, 2017)

This teacher claimed that the tool helped promote mathematical discourse in the classroom in ways that influenced students' interest in having their solution strategy contribute to the mathematics being discussed. That is, students wanted to position their mathematical activity as part of the lesson in ways that were not observed without Woot Math Polls. This teacher also talked about how she could use the tool to move towards more mathematical discourse, once she became more familiar with using student understandings. The tool supported teachers' promotion of a classroom culture that was supportive of mistakes, positioning students' own products as opportunities to learn (De Corte, 1995). It also shows how the tool has potential in helping the teacher facilitate productive student dispositions and discussions about mathematics.

Future directions and final thoughts

Digital technology affords new opportunities for collaborative learning by automatically recognizing students' work that is proximal to valid solutions. Such tools facilitate the display and analysis of student work in a classroom setting allowing the analysis to be more efficient and more immediate compared to the use of written artifacts of student work that must be analyzed by hand.

In addition to discussing the implications of this tool for teachers and classrooms, this poster also hopes to suggest future directions for how Woot Math Polls and similar technology can help use examples of student work to support mathematical discourse and growth-oriented classroom norms. Other applications include having the tool automatically display discussion questions, pre-determined by the teacher or task designer, that would help support teachers in facilitating these types of discussions. Another idea is to have the tool automatically analyze student work and learn patterns of common errors or misconceptions. Then this could be used to categorize student responses and provide examples that would afford productive classroom discussions.

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