

Technology to Support Students' Learning Mathematics From Other Students Work

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Abstract: This poster reports on a study of a digital formative assessment tool designed to provide rich, formative information to both students and teachers during (and after) classroom instruction. Nine Algebra I teachers participated in a professional development series where they learned to use the tool in their classrooms. Results from student and teacher surveys suggest that the tool was effective for short-cycle formative assessments as well as facilitating mathematical classroom discourse. It also helped teachers display student work to build off their thinking and promote a growth mindset. This study has implications for the design technology and professional development that promote formative assessment, classroom discourse, and growth mindset thinking beyond a math classroom.

Introduction

In the K-12 mathematics progression, algebra presents a unique set of challenges to both students and teachers. It demands that students evolve their thinking from the strictly procedural patterns sufficient to master arithmetic to abstract reasoning needed for algebraic thinking (Vogel, 2008). Algebra interventions focusing on the development of conceptual understanding produce an average effect size almost double that of interventions focusing on procedural understanding (Rakes, Valentine, McGatha, & Ronau, 2010). One suggested approach is that students should be afforded the opportunity to develop conceptual knowledge by modeling their thinking using graphs, tables, and manipulatives (Brenner et al., 1997). Teaching representational fluency is more challenging than teaching elementary procedures because it requires that students apply multiple procedures and connect them to abstract concepts. The platform investigated in this study, "Woot Math Polls," enables teachers to construct rich interactive tasks from an array of digital manipulatives (graphs, tables, algebraic expressions, etc.). It is designed to lower the barriers for teachers to build conceptual understanding using a wide variety of representations and to facilitate richer and more productive interactions between students and teachers.

Leahy and Wiliam (2012) report that the use of 'short-cycle' formative assessments can positively impact student achievement. In general, despite widespread awareness among practitioners of the benefits of formative assessment, there are significant challenges that limit the extent and quality of implementations. Yin et al. (2015) report some evidence that middle school math teachers may find PD on formative assessment more desirable when it is combined with training on a tool that supports the formative assessment activity. In a meta-analysis, Kingston and Nash (2011) report that "Two types of implementation of formative assessment, one based on professional development and the other on the use of computer-based formative systems, appeared to be more effective than other approaches." (p. 28). Woot Math Polls simultaneously turns student devices into clickers and digital notebooks. Students select or enter a response and show their work on a digital scratchpad. Then teachers can project student work for discussion or review it privately after the poll is finished. The tool was designed to support teachers' formative assessment practices and also to promote productive discussions about mathematics in the classroom. This study seeks to understand the affordances and limitations of Woot Math Polls, through the context of professional development seminars with nine algebra teachers.

Study design

Nine mathematics teachers who were teaching one or more Algebra I classes (in 8th or 9th grade) in the fall of 2017 were recruited and enrolled in the study. Teachers participated in four 1-2 hour PD sessions with expectations for use of 5 formative assessment tools (presented at each PD) with their students during the 3 weeks between sessions. The first PD was on offline formative assessments. Before the second session but after exposure to these assessments, students took a pre survey which includes prompts on self-assessment of algebraic reasoning and attitudes towards their mathematics class. During the second and third PD sessions, teachers were trained in the use of Woot Math Polls and its application to formative assessment. At the conclusion of the study, students and teachers took a post survey, teachers participated in a one-hour PD.

Findings

Findings from the teacher survey suggest that the teachers found the prototype for Woot Math Polls to be particularly effective for formative assessment and facilitating classroom discussions about mathematics.

Teachers answered the question “To what extent were you able to use Woot Math Polls effectively for formative assessment purposes in your classroom?” with an average response of 4.1 where 5 is “very effectively” and 1 is “not at all effectively”. They also responded to the question, “To what extent were you able to use it effectively for the purpose of having classroom discussions about mathematics?” with an average of 4.0 on the same scale.

In the qualitative responses, it was also clear that teachers found the tool helpful for formative assessment. Coding was used to identify the next most common affordances of the tool. Figure 1 in the poster shows a histogram of code frequency to the 6 qualitative item responses that were coded for each of the 9 teachers. The table shows that teachers most frequently identified being able to promote a growth mindset and changes in student attitudes as an affordance of Woot Math Polls. They also identified using student work and promoting mathematics discourse as frequent benefits of the tool.

Although subtler in their connections to the research questions, student responses still provide helpful insights. Analysis of the 252 student responses to the post survey question “Please describe your thoughts about Woot Math Polls. Was it helpful? If so, why? If not, why not”, the code of productive discussions only came up twice (1% of all codes) and, although formative assessment was never mentioned, “provides helpful feedback” and “helpful to see student work” were coded 3 and 10 times respectively for a total of 5%. Even though it is rare that students mention the value of the tool for formative assessment and promoting discourse, the fact that some of them notice this at all is strongly suggestive that it was happening in the classroom and was a change brought about by Woot Math Polls.

Codes also emerged relating to the perceived benefit of seeing student work (4%), promoting growth mindset (3%), and providing helpful feedback (1%) were observed. Although low in frequency, this does show that some students identified benefits of Woot Math Polls that were similar to those the teachers identified.

From the student responses on all Likert-type items on the survey, we also calculated the correlation matrix after correcting for base response style (Javaras and Ripley 2007). We then identified the survey items that most strongly correlated with students attributing greater learning gains to Woot Math Polls. We found that students were more likely to report higher scores for: how much other digital resources helped their learning, how much seeing how peers answered a question helped their learning and how much participating in class discussions helped their learning. The first of these correlations could indicate that some students rank digital tools in general with similar levels of helpfulness. The next two most highly correlated items highlight a connection between Woot Math Polls and mathematical discourse in the classroom and learning from visibility into the work of peers. The latter was, in turn, most strongly correlated with reported gains in “willingness to seek help from others (teacher, peers) when working on math problems.”

Conclusion

The findings from this pilot study with Woot Math Polls indicate that approaches that link appropriate technology, manipulatives, and teaching strategies to existing curricula and practices could have promise for improving student outcomes in algebra. Responses from both teachers and students provide evidence that there are opportunities for technology to effectively support and encourage formative assessment and mathematical discourse in the classroom. A follow up randomized controlled trial study is planned in which differences in teaching practices, student attitudes, and student learning are measured as primary and secondary outcomes.

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