Towards Uncovering the Mysterious World of Math Homework

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ABSTRACT

Homework has been a mysterious world to educators due to the fact that it is hard to collect data with regard to homework behaviors. Little is known about when a student works on homework, how long it takes him to complete the homework, how much time he spends on a problem and whether and where he has struggled, etc. Such information not only have implications on a student's performance level on assigned skills, but also are potential indicator of his non-cognitive status, such as engagement with homework and whether he was persistent. In this paper, we present our initial effort to uncover the mysterious world through exploratory analyses of the system logs from the ASSISTments platform when 690 7th grade students in the state of Maine did their math homework in the system.

Keywords

Homework, math, online tutoring.

1. INTRODUCTION

Homework is a well-established practice in schools, despite all the controversial discussion regarding its influence on learning (Kohn, 2006), and the research knowledge base for the effectiveness of homework is also well established (Cooper et al., 2006). Yet, without explicit interventions, homework has been commonly underutilized for improving teaching and learning. Educational technologies have gained popularity in schools (e.g., Khan Academy, DreamBox, IXL.com), but not at home. Most of the computer programs for homework are for college-level populations (e.g., WebAssign, Mastering Physics, OWL), but not in K-12 settings. Homework has been a mysterious world to educators partly due to the fact that it is hard to collect data. However, information from homework, such as when a student works on homework, how long it takes him to complete the homework, how much time he spends on a problem and whether he has struggled, has not only implications on a student's performance level on assigned skills, but also is potential indicator of his non-cognitive status, such as engagement with homework and whether he was being persistent.

2. BACKGROUND

ASSISTments (www.assistments.org) is an online tutoring system that provides "formative assessments that assist." Teachers choose (or add) homework items in ASSISTments and students can complete their homework items online. As students do homework in ASSISTments, they receive feedback on the correctness of their answers. Some problem types also provide hints on how to improve their answers, or help decompose multistep problems into parts. Teachers receive reports on their students' homework and can use this information to organized more targeted homework reviews, to assign specific follow-up work to particular students, and to more generally adapt or differentiate their teaching.

Prior research also has established the promise of ASSISTments for improving student outcomes in middle school mathematics through homework support (Mendicino et al., 2009; Singh et al., 2011; Kelly et al., 2013). Building on this prior work, a large-scale efficacy study is being conducted with ASSISTments in the state of Maine where a one-to-one laptop program was well established, to evaluate the efficacy of ASSISTments for online homework support. This randomized controlled trial involves 45 middle school schools that were randomly assigned to treatment or control (i.e. "business as usual") conditions. The intervention is implemented in Grade 7 math classrooms in treatment schools over 2 consecutive years. In the treatment condition, teachers receive professional development and use ASSISTments to assign homework for their students during the school year.

3. METHOD

3.1 Data

For this study, we collected homework log of 690 7th grade students from classes of 17 teachers in 9 middle schools that participate in the efficacy study. The data set includes 779 homework assignments made by the teachers during January and February 2014. These students have been using ASSISTments to do their homework since the beginning of the school year and their teachers started using ASSISTments since September 2012. We excluded the problems that took students over 10 minutes to complete, considering students were likely to be off-task and thus the measure of completion time might not accurate. On average, each student solved 181 problems, and the number varies a lot among students (standard deviation = 163). In addition to student homework log, we also collected teacher's usage data, in particular, when they have opened a report provided by ASSISTments.

Based on the student log and teacher usage data, we calculated the following metrics

- %Correct—student's average percent correct on all problems in an assignment

- AvgAttempt—the average number of attempts [1] a student made on a problem in an assignment
- AvgFirstResponseTime—the average amount of time it took a student to respond to a problem in an assignment
- AvgTotalTime—the average total time it took a student to complete a problem in an assignment
- StartHour—the hour of the day when the student started working on an assignment
- CompletionIndicator—whether an assignment was completed on time, late or not completed.
- CompletionRate—a student's overall homework completion rate during the time period
- %ReportOpening—a teacher level metric, the percentage of assignments for which a teacher has opened related ASSISTments reports. For example, if a teacher has made 10 homework assignments to her students, but only looked at reports for 4 of the assignments, then %ReportOpening will be 40%.

3.2 Analysis and Findings

Our analysis was mostly exploratory. First, we plotted the data (see Figure 1) to see when students started working on homework, and if there is any association between when a student started and whether the assignment was completed on time or not. We observed that for the 8573 instances of assignments that were completed on time, most of the time students started around 11am, or 12pm, or early in the morning at 9am. The assignments that were not completed tended to start a bit later at 1pm or 10am.

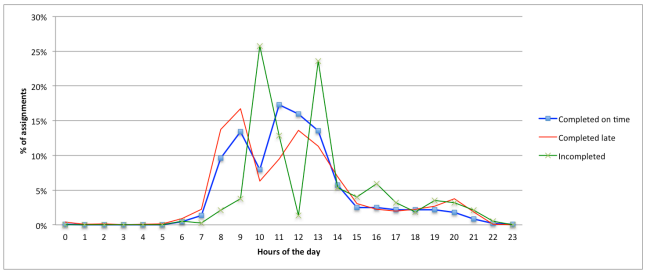

Figure 1. Time students start working on homework

Then we looked to see whether there was any difference in student's performance or behaviors when they completed homework assignments on time or not. We found that for assignments that were not completed, students were significantly (unpaired t-test, $p < .01$) low on %Correct metric, yet high on AvgFirstResponseTime, and AvgTotalTime, comparing to their performance on assignments that were completed on time, indicating students were struggling with the problems in those assignments. Meanwhile, students were also significantly low (upaired t-test, $p < .01$) on AvgAttempt, suggesting they were not as persistent when trying to solve the problems.

Teacher's review of homework performance report is a critical step in the ASSISTments logic model and teachers are encouraged to look at the reports to direct their homework review with students and adapt their instructions. During the interviews (another data collection activity of the efficacy study), teachers indicated homework review time has been largely reduced because of that the ASSISTments reports have made the review more targeted. While we don't have the classroom observation data yet, we consider %ReportOpening as an indicator of how often the homework review was done. We discretized %ReportOpening into 3 bins: low, medium and high, and aggregated other metrics across students within each bin. We found in the bin where %ReportOpening was low, students' average %Correct and CompletionRate were significantly higher yet AvgFirstResponseTime and AvgTotalTime were all significantly lower, comparing to those for the "high" bin. While this finding was against our initial instinct, it is too early to draw any conclusion regarding a casual relationship between teacher's review practices and student's homework performance from this, given that the analysis wasn't tracking changes in the same teacher's classes longitudinally, and didn't account for any incoming homework performance data of the students (e.g. homework completion rate, %Correct, etc). Teachers who knew their students had problems with completing homework may choose to look at reports more often to monitor student's progress.

[1] In ASSISTments, students are allowed to make multiple attempts at problems until they solve the problem correctly.

4. CONCLUSION

In this paper, we presented some initial results from analyzing student homework logs and teacher's usage of an online homework support program as a part of an efficacy study. The analyses here represent the beginning of our efforts to understand the world of homework. In the future, we plan to link student's homework log data with their unit test scores (as proximal measure of their knowledge) and end of year standardized test scores to investigate the relationship between homework and learning outcomes. We also plan to analyze student homework log data, teacher's report usage data and test scores together longitudinally and triangulate the results with findings from field classroom observations to further investigate the impact of teacher's review practices on student's learning outcome and on how students do their homework.

5. ACKNOWLEDGMENTS

The research reported here was supported by the Institute of Educational Sciences, U.S. Department of Education, through Grant R305A120125 to SRI International. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

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