

Measuring Mathematics Discourse in Technology-Supported Collaborative Activities

Ken Rafanan, Jeremy Roschelle, Ruchi Bhanot, Torie Gorges, William R. Penuel
SRI International, 333 Ravenswood Avenue, Menlo Park, CA, USA
Email: ken.rafanan@sri.com, jeremy.roschelle@sri.com, ruchi.bhanot@sri.com,
torie.gorges@sri.com william.penuel@sri.com

Abstract: This paper presents a classroom observation protocol and analysis method that efficiently capture key student and teacher discursive moves. We developed this protocol for use in a study comparing classrooms using Eduinnova, handheld computer-supported collaborative learning software, with classrooms using a popular, non-collaborative software application aimed at the same topic. Analysis of data from the observations clearly shows differences between student discourse in these classrooms but also reveal some challenges in the CSCL classroom.

Introduction

Discourse analysts study text and talk that can be represented and contextualized both in terms of features of the setting and in light of the cultural tools and practices participants engage in the setting (Fairclough, 1992; Gee, 2005). While discourse analysis has proven essential for theory building, it is overly time- and resource-intensive for intervention studies. Nonetheless, in studying an intervention that relies on discourse as a learning mechanism, it is important to measure both how much and which type of discourse is actually occurring. An alternative to discourse analysis for larger-scale intervention research is a structured observation protocol. In conjunction with our research on enhancing student discourse in mathematics classrooms, we set out to design an observation protocol and see how useful it could be in our design and intervention research.

We integrated the Eduinnova software (Zurita & Nussbaum, 2004) into an intervention called TechPALS, which includes mathematics content, teacher professional development, and peer to peer learning activities to address the particularly important topic of rational number (fractions) at the elementary school level. Our research goal is to test whether TechPALS results in better learning than Larson Intermediate Math (LIM), a popular, non-collaborative fractions software. Overall, our study hypothesizes that when students ask mathematical questions and explain their answers to each other and rely less on the teacher as a source of authoritative knowledge, they learn better. Hence, we wanted to construct an efficient instrument to detect any changes in classroom discourse patterns within the context of our study.

TechPALS Intervention

The Eduinnova software, the foundation for the TechPALS intervention, builds upon scientific principles for motivating and structuring peer-assisted learning (Johnson & Johnson 1987; Slavin 1990). In TechPALS activities, students work in triads on tasks that require each student to answer a question and for the student group to agree upon an answer. The technology coordinates tasks to provide individual students with problems to solve (“individual accountability”) and also requires that students work together to complete the task (“positive interdependence”). The system provides the teacher with a display of summary feedback on both the progress of groups through problem sets and the success rate across groups on mathematical tasks.

Observation Protocol Design

We created an observation protocol with specific categories for student discourse to differentiate between particular discursive moves that have been found in prior research to support student mathematical learning, such as giving mathematical explanations, and moves that do not, such as giving answers without explanations (Webb, 1991). A primary design goal was for the protocol to allow high reliabilities. Toward this goal, we focused on just 11 different conversational moves that a student might make. A key feature that we revised after piloting the protocol was to focus observations on one individual student instead of asking the observers to record all the key discourse markers for a small group, a difficult task in real-time. Because the TechPALS intervention theoretically restructures not just student-student interactions but student-teacher interactions, it was also important for us to capture the key discourse markers of the teacher.

Observation Data Analysis

Sample

A total of 38 students were randomly assigned to and observed across two classes, one representing the control condition (LIM class) and the other the intervention condition (TechPALS class). Pre-intervention

mathematics achievement measures revealed no significant differences between these two experimental groups. There were 21 students in the TechPALS class (including 9 boys and 12 girls) and 17 students in the LIM class (including 9 boys and 8 girls). There were four observers observing the two conditions.

Plan of analysis

Analyses were conducted on the Student Activity Codes (including the Student-Student Discussion and Other Work categories) and the Teacher Activity codes (including those for the Teacher's Activities with the Small Groups/Individuals and with the Whole Class categories). Within each coding category, we calculated the sum of the observations captured during the observation period spanning six minutes. This was repeated for each of the behaviors in the above 4 coding categories for the entire sample. Mann-Whitney U tests with Bonferroni corrections for multiple comparisons were conducted to compare the observed codes between the two conditions.

Results

The findings indicated that students in the TechPALS class gave answers significantly more often than students in the LIM class ($U = 43.0, p < .005$). Students in the TechPALS class also directed their peers significantly more often than students in the LIM class ($U = 100.0, p < .005$). Data on the Other Work category of Student Activity codes indicated that students in the TechPALS class read problems aloud more often than students in the LIM class ($U = 79.0, p < .0125$). We found a trend for students in the TechPALS class to give more explanations to their peers ($U = 105.0, p < .05$), but the finding was not significant when Bonferroni-correction was used. The observations for the Teacher Activity category indicated teachers in the LIM class gave more math explanations or answers to students than teachers in the TechPALS class ($U = 45.0, p < .00625$). There were no significant differences in the number of observations on teachers' behaviors with the whole class.

Discussion

Overall, the results clearly distinguish between the TechPALS and the LIM classroom; students are talking more in the TechPALS classroom. However, not all the talk fit our desired pattern. Students directed their peers and gave answers without explanations to their peers more often than students in the LIM group. Based on prior research it would be desirable for students instead to ask for help and give explanations. There was a non-significant trend for students giving more explanations. Students in the TechPALS classroom also read problems aloud more often than those in the LIM classroom, an important opening move in any group problem-solving activity.

Conclusion

Our experience with the TechPALS observation instrument shows that this more efficient form of data collection can yield valuable insights. We would recommend continuing with discourse analysis where the primary research objective is theory development or detailed explanation of the mechanisms of learning. As researchers transition to designing and studying new classroom interventions, discourse analysis may be impractical. While our study constraints rule out discourse analysis, we must continue to attend to and measure the discourse, and our observation protocol allows us to capture essential elements of classroom discourse.

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Acknowledgments

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305K060011. The opinions expressed are those of the authors and do not represent views of the U.S. Department of Education. Hewlett-Packard through its Global Philanthropy program, provided vital support with a generous donation of four classroom sets of iPAQ Pocket PCs. Eduinova® has provided key support for all aspects of the study.