Using Students' Speech to Characterize Group Collaboration Quality

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Abstract: Collaboration is a core teaching and learning process, as well as an important 21st-century skill that students must be able to master as they progress through school and into their careers. This project is investigating the feasibility and challenges of using the speech of small groups of students to determine the quality of each group's collaboration. Preliminary data analysis of this early-stage project will be presented.

Keywords: collaboration skills, learning analytics, discourse analysis

Introduction

Collaboration is a core teaching and learning process, as well as an important 21st-century skill that students must be able to master as they progress through school and into their careers (National Research Council [NRC], 2011). Collaboration is also an integral part of STEM learning.

Management and assessment of collaborative learning tasks is difficult in typical classrooms when teachers attempt to monitor 10-15 groups with 2-3 students in each group (Cohen, 1994). Ideally, teachers would listen to peer interactions in each group for long enough to understand how discourse is proceeding—and very few teachers can do this well for so many groups. This new project is working on building speech-based learning analytics for collaboration that could help teachers by identifying what is going on in groups and enabling teachers to target their interventions. For example, teachers could rearrange membership of a group when one student is too dominant, adjust roles if all students are not participating, explore further if the groups' rate of progress has slowed, or visit the group to debug frustration among the members. Thus, we see speech-based analytics not as replacing, but rather as informing the teacher's exploration of group dynamics, diagnosis of issues, and development of an intervention plan.

Therefore, this project is investigating the feasibility and challenges of using the speech of small groups of students to determine the quality of each group's collaboration. We are engaging human observers to code small-group collaboration while simultaneously collecting high quality speech data. We are developing feature detectors that can code the speech data automatically and are using machine-learning techniques to find ways to aggregate the signal from these detectors to agree with the judgments of human observers.

Methods

In fall 2013 we conducted a small pilot data collection in the classrooms of two middle school mathematics teachers. The teachers allowed us to visit their classroom for one class period (about 45 minutes) and have their students work collaboratively on some mathematics tasks delivered. We videotaped and audio recorded two groups from each class, for a total of 14 students.

The mathematics tasks had been developed in the context of another project, as discussed in more detail below. The tasks were a collaborative variation of the cloze task. In a cloze, students fill in blanks in a sentence in order to show their comprehension of material they have recently studied. In a *collaborative* cloze, three students each fill in one blank in a sentence (or short explanation) to express their mutual understanding. The tasks were embedded in an online delivery system and students worked in groups of three on a laptop together. Each student wore an individual microphone to pick up his or her contribution to the discussion.

Field notes were collected at the time of data collection to note times of particular collaboration indicators of interest, and video data was collected to aid the human coding of collaboration indicators.

A speech activity detection system was run on each student's audio channel and provided data on who was speaking when. Pairing this speech data with timing information from the software (e.g., which question the students are working on) enables us to analyze how much each student was speaking during each problem.

Findings

One of the collaboration indicators of interest was that of equality of participation. Researchers noted in field notes and video annotations that Group 3 members seemed to work well together during the beginning of the class period but that the collaboration quality decreased by the end, when the group had come to be dominated

mostly by Student 3-1. We looked for quantifiable evidence of this trend that could be extracted using automatic speech technology.

Figure 1 below shows, using the speech activity detection system, the amount of time that each student was speaking during the session, with each student represented by a different line. Each tick along the *x*-axis represents one task in the computer-based collaborative software. We can see that three students had relatively similar shares of speaking time for the beginning problems in the set. However, Student 3-1 (green) began to speak more and more in the later sessions, eventually dominating the floor. Speaker 3-3 (purple) dominated an early session (problem 6.5) but later was the least active participant.

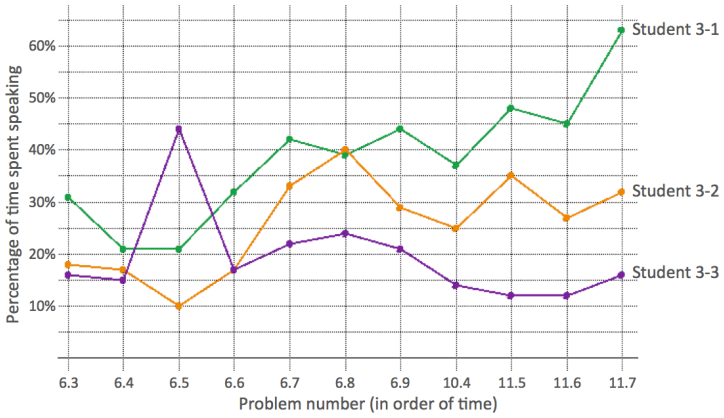

Figure 1. Speaking trends per problem over time for Group 3

The pilot data revealed over collaboration indicators of interest, including turn sharing and frustration. For turn sharing, we found a number of examples of both anticipatory completion (finishing another's sentence) and coproduction of turns (Lerner, 2002) (saying the same words at essentially the same time), indicating what Edelsky (1993) refers to as the "collaborative floor." This type of speech feature has been related to successful collaborative learning (Roschelle & Teasley, 1995) and automatically detecting it could thus be valuable.

Other collaboration indicators (such as suppressing off-task behavior, asking questions, and inviting others to talk/contribute to problem solving) will be included in the next phase of data analysis and will be discussed at the CSCL conference.

Conclusions and implications

Although this study is in early phases, it is a new approach to solving challenges with the management, assessment, and scaffolding of collaborative learning in classrooms. This approach has the potential to rapidly measure the quality of student collaborations, provide teachers with insights about their students' collaborative learning, and enable teachers to intervene based on the data.

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