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Technology and Teacher Professional Development:

Promoting Teachers' Reflection on Orchestrating Classroom Discussions

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Abstract: *Teachers can reflect on their classroom discussions with students to inform their instructional practice. However, they often face difficulties regarding the data input, coding, visualization, and tracking and comparisons. This paper introduces an analytic tool called classroom discourse analyzer (CDA) to address these difficulties. By applying it to the analyses of classroom discourse from a fourth grade science class, the paper shows how CDA can be used by teachers to support their reflection on classroom discussions and how it can provide personalized, data-supported evidence to inform teachers' professional development and classroom practice.*

Keywords: classroom talk, learning analytics, teacher professional development, visualization

1. Introduction

Teachers' orchestration of student participations, argumentation and evaluations can affect students' learning processes and outcomes (Resnick, Asterhan, & Clarke, 2015). However, currently teachers' performance in helping student learn through discussion is far from satisfactory (Mercer, Dawes, & Staarman, 2009; McNeil & Pimentel, 2010). Given the large benefits of effective classroom talk on students' learning, teachers often find it difficult to engage students into productive discussions involving deep reasoning and argumentation (Clarke et al., 2013; Pimentel & McNeil, 2013). This raises the challenge of teacher education and professional development (PD) on orchestrating the classroom discussions with students.

This paper introduces a novel discourse analytic tool called Classroom Discourse Analyzer (CDA) for teachers. We explicate how CDA addresses the difficulties regarding data set, coding, visualization, and tracking and comparisons that teachers face in analyzing their classroom discourse data. Data set difficulties include data input, data transformation, and dealing with utterances by unknown speakers. Difficulties involving data coding include the coding of complex classroom discourse, coding reliability, and coding efficiency. The visualization issues include the visual representations of many things, synchronization of different displays, and adaptation to data/codes changes. Lastly, there are also difficulties regarding tracking and comparing teacher's and students' actions across multiple sessions.

We showcase CDA by applying it to the discourse data from a fourth grade science class. The data was first video recorded and transcribed by humans. The female teacher and 16 students (9 males, 7 females) contributed 1,939 teacher turns and 1,926 student turns in 30 discussion sessions (total duration: 8 hours and 51 minutes). The analyses and visual representations show how CDA can support teachers' reflection on their classroom discussions and how it can provide personalized, data-supported evidence to inform teachers' classroom practice.

2. Classroom Discourse Analyzer

When trying to reflect on and analyze classroom discourse, teachers often face analytic difficulties regarding the discourse data set, coding, visualization, and tracking and comparisons. CDA addresses the discourse data set issues (data input, data transformation, unknown speakers) with a simple input template, automated transformation, and a student

naming array. CDA addresses the coding issues (i.e., complexity of classroom discourse, coding reliability, coding efficiency) with multi-dimensional coding at the unit of conversational turn and the use of machine coding.

Visualization with the synchronized discourse transcripts is an important function in CDA because it supports teacher reflection of classroom interaction by providing an activating experience similar to that using video as a facilitator for reflection (which is very often referred to as a 'vivid secondhand" experience; Miller & Zhou, 2007; Seidel et al., 2011). CDA can visually display participants, turns, and codes by a variety of shapes and colors, in different frames of the same visible window, and more importantly with a real time update to the changes of data/codes. Lastly, to facilitate the tracking and comparisons, CDA allows a teacher to select any participants' (teacher and/or students) any actions in any sessions.

3. Showcasing Classroom Discourse Analyzer

In this section, we showcase CDA by applying it to the transcripts from a fourth-grade science class. After describing the data set and coding, we show in what ways that teachers may use CDA to analyze the discourse and thereby inform their classroom talk with students.

3.1. Data

The data set includes 1,939 teacher turns and 1,926 student turns transcribed from videotapes of 30 discussion sessions in a 4th grade science class. The participants were a female teacher and 16 students (9 males, 7 females). The total time of discussion was about 8 hours and 51 minutes. Sample discussion topics include: "what causes the water level to rise?"; "Same volume, same weight?"; and "How can we measure the volume of a liquid?". The format of the input data in CDA is presented in Table 1. Teachers only need to provide data along the following four columns: session, turn, speaker, and content.

Table 1. Format of the input data in CDA.

Session	Turn	Speaker	Content
1	1	T[a]	What is an earth material? Amalia, what's an earth material?
1	2	Amalia[b]	Materia- Material is like, um, like well, you could say like what's under our feet, you could say like um, maybe like soil and rocks.
1	3	T	OK. What's another way you would describe earth materials? What does that word or that term mean to you? Louie?

[a] Teacher. [b] Student name was pseudonym.

3.2. Coding

CDA used multi-dimensional frameworks for coding the teacher and student turns. The teacher turns were coded based on the scheme of teacher Accountable Talk® during the discussion, which includes eight categories of Accountable Talk moves (i.e., "say more", "revoice", "press for reasoning", "challenge", "restate", "add on", "agree/disagree", and "explain other"; Resnick, Michaels, & O'Connor, 2010). Machine coding software (lightSIDE; Mayfield & Rosé, 2013) was used to facilitate the coding of teacher turns. The student turns were coded using a multi-dimensional framework: a) knowledge content (new idea [with justification or not], repetition, or no academic content), b) evaluation of previous turns (agree, disagree, or being neutral), and c) invitation to participate (statement, question, or command; Chen & Chiu, 2008; Chen, Chiu, & Wang, 2012).

3.3. Analyses

We first introduce the overall interface of CDA. We then show how the various displays in CDA help visualize the discourse processes and how they can inform teachers about their talk with students in the classroom.

3.3.1. CDA interface

Figure 1 shows an overview of the classroom discourse from the 30 sessions. The user interface of CDA includes 8

frames for visualization (see Figure 1). Frame 1 is the place that visualizes the distributions of the teacher and student turns. Frame 2 represents teacher-student turn-taking patterns automatically generated by CDA. Frame 3 shows summary statistics for each row of data. The transcripts are displayed in frame 4 and the coding frameworks for teacher and student turns are displayed in frames 5 and 6. The visual displays in different frames are always synchronized to facilitate viewing. Frames 7 and 8 are the controls for changing bubble sizes, zooming in/out the visual displays, and for sorting the speakers in various ways.

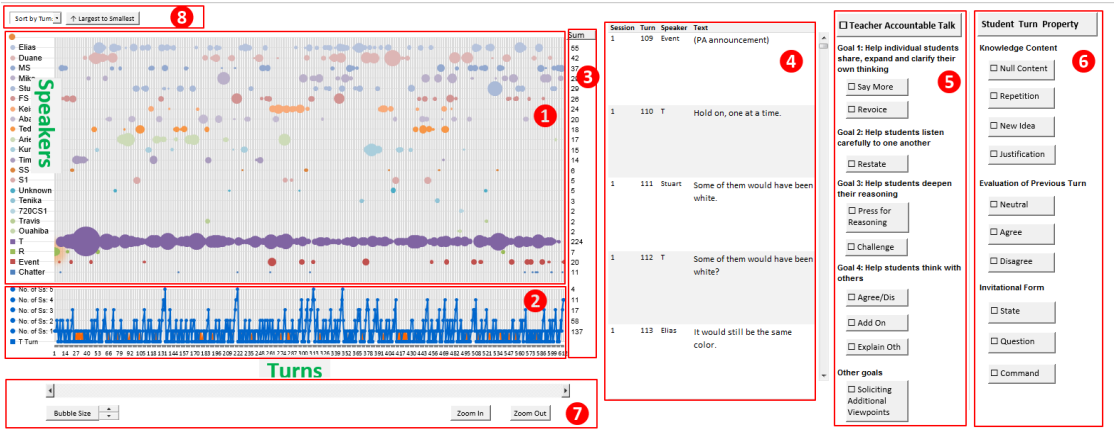

Figure 1. An overall interface of the CDA.

3.3.2. Distributions of teacher and student turns in a session

In addition to the overview of multiple sessions, teachers can use CDA to visualize the speakers' turns and words in a particular session. Figure 2 shows the teacher's and 14 students' turns and words in session 26. (Two students were absent from the session). The discussion topic is "what causes the water level to rise?" There were 71 teacher turns and 70 student turns in the session. The session lasted about 20 minutes and 47 seconds. As shown in Figure 2, the students were sorted by the amount of words this time. While *Mario* only spoke one word in one turn, *Marcel* spoke 233 words in two turns in the session. Based on the information the teacher may balance students' participations in subsequent discussions (e.g., inviting *Mario* to participate more in future sessions).

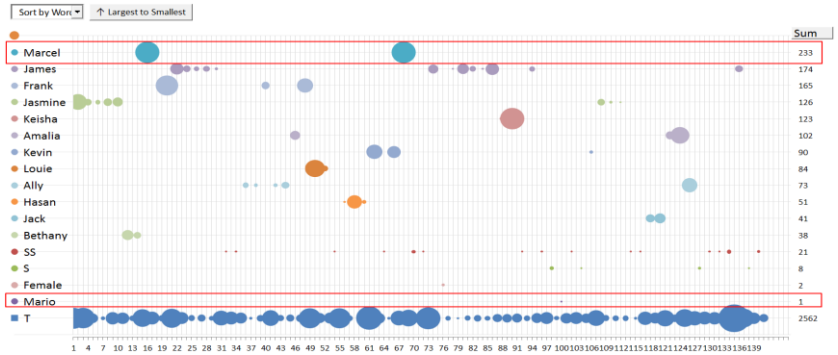

Figure 2. The visualization of students' turns and words in session 26.

3.3.3. Teacher-student turn-taking patterns in a session

CDA can automatically generate the visualization of teacher and students' turn-taking patterns during a discussion. There are three major patterns during classroom discussions. The first is teacher's talk with a particular student for two or more turns (or "T->S_1->T->S_1"). Another is teacher's talk with one student for one turn and then turn to another student (or "T->S_1->T->S_2"). The last one is that teacher allows two or more students to talk with each other before taking the turn (or "T->S_1->S_2->T").

3.3.4. Tracking teacher and student actions in a session

Teachers can use CDA to track teacher's or any individual students' particular actions during classroom discussions. The purpose was to track how students disagreed with one another during the discussion. Teachers may zoom in to reflect on why the students were having conflicting views and how the teacher moderated the disagreements in this episode.

4. Discussion and Conclusions

The CDA results of the above case showed that it can be used to visualize teacher and student talk over time. This allows teachers to track any participants' actions (e.g., students' disagreements with one another, new ideas, justifications) in a discussion session. The information can also be used to inform teacher's guidance and feedback in future discussions. CDA can also automatically visualize teacher and students' turn-taking patterns to reveal at a glance the social structure of a discussion. Moving beyond a single session, teachers can use CDA to compare students' behaviors in different sessions. Furthermore, a group of teachers can use CDA to view and compare the discourse from one another's classes, which would also help develop a learning community among teachers.

There are challenges that might limit the application of CDA in practice, which include data collection, transcribing, and coding. In a classroom discussion that involves a large number of students, it is sometimes difficult to capture the information of who speaks at what time. Alternative ways of recording classroom discussions, such as microphone-array systems (Sun & Canny, 2012), may help address this issue. The data in the above case were all transcribed manually from videotaped records. The process was often time and labor consuming. Whether computer transcribing is comparable to external human transcribing remains an open research area. Coding transcripts of classroom discussions also takes time and effort. It has been showed that computer coding was reasonably acceptable as it coded for some particular categories of classroom talk (Clarke et al., 2013; Mayfield, Laws, Wilson, & Rosé, 2013). Whether computer coding can be used to code complex categories remains an open research area.

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