Visualizing Complex Classrooms Through Real Time Observations

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Abstract: Analyzing video data is a complex problem for social science researchers. This study explored the use of an analytical visualization method to support the process of narrowing a video data corpus—focusing on meaningful moments for further qualitative analysis. We used the real-time observational coding tool to examine students' activities and engineering design practices in a STEM curriculum. The findings suggest that using this tool supports time-efficient analyses of large corpuses of video data.

Keywords: visualization, video analysis, engineering design, human-centered robotics

Introduction

Video data is one of the most complex types of data in empirical social sciences research, making it challenging to work with (Mondada, 2006). Even a few minutes of recording includes a massive quantity of information, such as visual, acoustic, and gestural data that needs to be transcribed and coded for analysis. Video thus creates issues of data management, retrieval, and selection for researchers. In particular, methodological and practical questions arise when trying to balance micro and macro-levels of analysis (Knoblauch et al., 2006). Because video analysis is so time consuming, it may not be useful for timely feedback during instructional interventions.

To address issues of managing timeliness and balancing micro- and macro-analytic approaches to analyzing video data, this study investigated the use of a real-time observational coding tool called the Generalized Observation Reporting Protocol (GORP; UC Davis Center for Educational Effectiveness, 2016). GORP is a web-based system that allows observers to record data using a customizable interface (see Figure 1). The coded data are systematically stored and organized in the cloud for future analysis. GORP allows users to gain an overview of the class activities and track aspects of students' learning activities. We tested this in a human-centered robotics (HCR) curriculum that focuses on the design of robots to serve human needs, thus helping learners make connections between the social and technical aspects of science and engineering (Schaal, 2007; Gomoll et al., 2017). Specifically, we captured students' collaborative activities as they engaged in HCR design processes (Gomoll et al., 2016). This poster presents our use and analysis of GORP data to support iterative video analysis—moving from the high-level picture of group engagement to the finer-grained analysis of specific video segments that highlighted collaborative activities and engineering design practices.

Methods

Data were collected from public schools in two U.S. states. Participants included ten eighth graders and six seventh graders taking an elective science class in a public middle school. The inquiry-based HCR unit took place over five weeks with 35-50 minute daily class sessions. We videotaped and observed two focal groups with two males and two females per group. The coding scheme included two major categories and a total of ten codes (see Figure 1): 1) Student actions (e.g., solo work, hands on material, off-task) (purple codes), and 2) Engineering Design practices (e.g., ask questions, imagine, collection information) (green codes). One observer per focal group coded in three-minute increments. Within a three-minute increment, each code in Figure 1 could be applied once. All observers achieved inter-rater reliability above 85% on a 60-minute classroom video from a previous implementation before entering the classroom to code.

Using the output of the GORP coding, we constructed a visualization, the Chronologically-Ordered Representation of Discourse and Tool-Related Activity (CORDTRA) to help us move from macro- to micro-level of analysis (Hmelo-Silver et al., 2011). CORDTRA diagrams provided visual representations which can aid in interpreting complex patterns and analyzing students' activities in collaborative learning environments. CORDTRA analysis included the real-time codes that quantify different types of learning activities. This creates a chronological picture in which multiple processes were represented in parallel on one timeline (see Figure 2). We created the CORDTRA diagrams to provide macro-level visualizations of our GORP coding results.

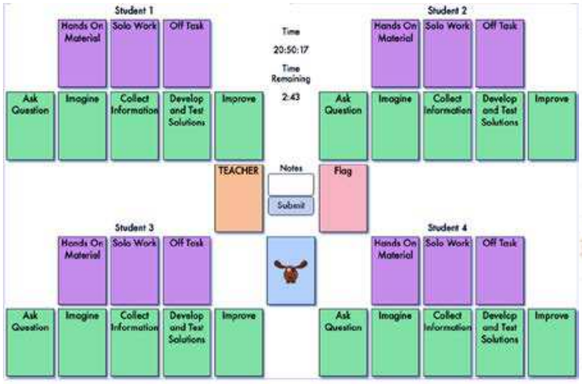

Figure 1. GORP interface displayed on a smartphone, tablet, or laptop (green codes: student actions; purple codes: engineering design practices).

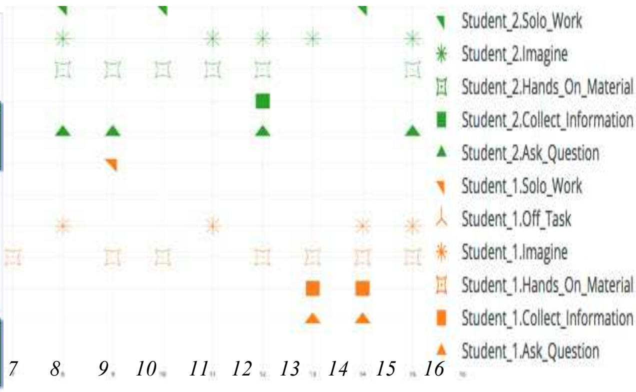

Figure 2. An excerpt of CORDTRA output (21 minutes period) of two students from Focus Group 1 at the Designing Robot Bodies class session.

Findings

Using CORDTRA visualizations to explore GORP data, we were able to highlight specific patterns of design practices across our robotics unit and to pinpoint moments for further exploration in video and interaction analysis data sessions. The CORDTRA diagrams were generated quickly via R programming software and provided a macro level picture of all engineering design codes occurring for each student group in small increments of time. Figure 2 shows an excerpt of two students' activities and engineering design practices in one class section in which we identified rich collaboration and use of engineering design practices while they built their robots. Through the analysis of the GORP coding, we were able to zoom in to deepen our exploration of patterns of students' collaborative engineering design practices throughout the HCR curriculum. For instance, if we are interested in understanding how the engineering design practices, such as collect information, were performed by students 1 and 2 in Figure 2 informed group activity, we could zoom in on segments (e.g. 12-14). Collaborative data analysis sessions informed by CORDTRA diagrams unpacked these interactions.

Discussion

Future work will explore how sharing real-time observational data with students and teachers can help them to develop engineering design practices *in situ*. Since GORP data can quickly generate CORDTRA diagrams, these have potential for formative evaluation. Adaptations of this real-time coding tool provide a time-efficient approach to analyzing data and have the potential to support creative examinations of learning in a variety of disciplines and contexts. In future work, CORDTRA visualization shows a promising approach for reducing large corpuses of video data. The visualization provides a high-level view of activity over time and help research teams to zoom in on intriguing moments and patterns.

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