Assessment Analytics in CSCL: Activity Theory Based Method

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Abstract: In this exploratory study, we present and apply an automated student participation analysis method derived from activity theory. We show how it can be used in a specific computer supported collaborative learning (CSCL) environment (Virtual Math Teams with Geogrebra—VMTwG), and provide holistic analysis of individual student participation according to aggregate behavior, in order to inform teaching and assessment practices.

Introduction

Automated assessment of student performance is a long hoped for, often strived for and probably distant objective for learning sciences research. A more pressing and achievable objective for learning analytics is to provide teachers with insights into student interactions. This work provides an activity theory-informed method for producing a holistic view of individual student participation in CSCL activities.

Theoretical Framework: Activity theory

Activity theory is a social psychological and multidisciplinary theory that seeks to be naturalistic and offers a holistic framework for describing activities in practice while linking together individual and social behavior (Leont'ev & Aleksei, 1974). Engeström's (1999) model of the structure of an activity system includes the interacting components of subject, object, tools, division of labor, community, rules, and outcome (see Fig. 2).

The activity of learning is "the joint activity of a student, physical/symbolic tool(s), and another person(s) performing together as a working social system to achieve some outcome under constraints such as rules" (Basharina, 2007). Learning is reframed as social practice (rather than as merely the product of practice) (Engeström, 1999). In our CSCL learning assessment context, the outcome and process of this transformation may both be seen as learning. It is the sum of the system components and the tensions among them that make up the learning and influence the learning outcomes.

Current participation analysis methods only address part of the activity of the learning system. Activity theory helps us to address complex interactions in the environment, and to see into individual student interactions in a socio-technical environment. The activity system can be thought of as being built for each student, which allows us to highlight the learning of an individual student in collaborative group work.

Case Description

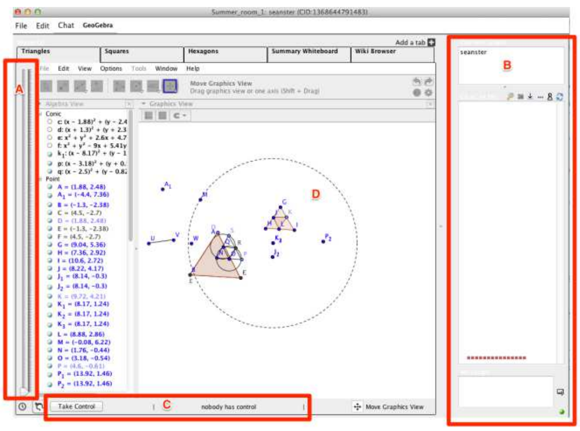

Figure 1. VMTwG of an Analytical Tool for collaborative Math Discourse.

In this study, we operationalize activity theory as a lens for making sense of electronic trace data from the synchronous math discourse software Virtual Math Teams (VMT). There are four main ways to participate in collaborative activities in VMT (see Figure 1). The time dimension (A in Figure 1) is provided by the VMT replayer bar (each action within VMT is logged with a timestamp). In the chat window (B), text is entered for direct textual communication among students. C and D are related to Geogebra actions. C is the "Take Control" button, while D is the GeoGebra window itself. In this figure, students are working to create an equilateral triangle within an equilateral triangle, and many approaches are being tried. This is an ordinary part of how VMT facilitates interactive problem solving discourse among teams. We collected log data in .txt format from five modules in a single course. The data centers on specific event types from the CSCL environment (VMT):

Awareness, Geogebra, System, Chat, and WhiteBoard (Wb). We process each event into four dimensions: individual, group, action constraints, and module set to facilitate measure construction.

Measure Construction

Subject: When mapped to our log data, it represents all actions one student makes during the whole training under the individual modules, and is the sum of all actions under individual tasks (Figure 2).

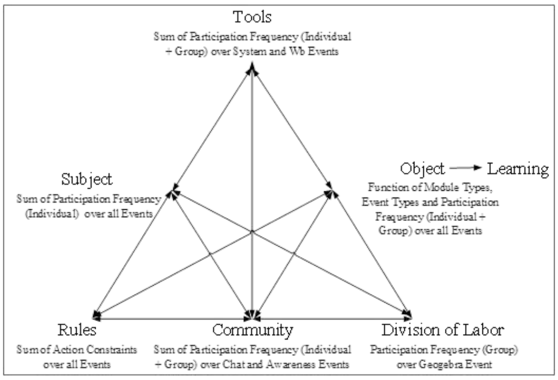

Figure 2. VMT data analysis using activity theory

Rules: Students have to perform actions that the VMT environment offers. Therefore, the Rules are reflected by the sum of actions the student uses across all the modules.

Tools: The tools are the System and Wb event types where the student's action for tool usage is registered. Thus, Tools are presented as the sum of participation frequency in System and Wb events.

Community: All the communications that help maintain the community structure. Community is presented as the sum of chat messages and awareness.

Division of labor: Contributions of the student made to the collaborative learning modules. The only concrete contribution to the geometry object construction is from the Geogebra dimension. Therefore, we use the student's participation in Geogebra events to represent the student's Division of Labor aspect.

Object: The CSCL activity is to achieve the object of a student's active involvement in the whole class. We incorporate the total of module types involved, frequency of participation and the number of event types.

Results and Conclusion

Individual student participation in the course is represented as six dimension sets (after standardization) (see Table 1 as a *sample*). By investigation into those numbers, the teacher can provide specific advice to individual students. For example, if the value of a student in the Community dimension is very low, the teacher could suggest for the student to communicate more in the group. This methodology can be totally automated to be time efficient for teachers to use, and represents a unique, holistic, and theoretically informed approach to analyzing participation in group work.

Table 1: Sample Individual student participation model based on Activity Theory

Name	Subject	Rules	Tools	Community	Div. of Labor	Object
A	0.67	0.45	2.17	1.63	0.56	1.71
Q	1.14	0.06	0.42	1.62	0.12	2.35
⋮	⋮	⋮	⋮	⋮	⋮	⋮

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