Learning in Real Time: How Understandings Emerge from Physics Students' Laboratory Activities

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Constructing an Explanation in Realtime

There are not only difficulties in determining the nature of physicists' intellectual and material practices, but there is also a dearth of studies about individuals' trajectories from their first encounter with school physics activities to competent practice as physicists; we know little about how any understanding of physics arises from students' hands-on activities (Nersessian, 1995); and we know even less how learning arises in realtime (Roth et al., 1997). This is the central concern of our research agenda and the work presented here. We focus on what students do in realtime in school physics laboratories to (a) understand the relationship between actions, knowing, and learning and (b) find more definitive answers about the pedagogic value of laboratory work. Situated cognition (Agre, 1993) and activity theoretic frameworks (Hutchins, 1995) served as referents in this study. The case study presented here is based on data collected during the teaching of an experimental curriculum on the limited predictability of non-linear systems in a German, academically-streamed Grade 10 physics class. The data corpus includes: videotapes of 3 student groups during 8 lessons, interviews with 12 students, a pretest, and students' notebook entries during the unit completed the data corpus. We conducted our data analsyis according to precepts of Interaction, discourse analysis, and Situation Theory

Our fundamental concern is with processes by means of which particular student explanations arise from activity. To understand how students came to know physics, we needed to understand the trajectories students' activities (and associated conversations) took in real time. While there were variations between the particulars of the explanations that various groups construct, there are some structural features common with other students and settings.

In the course of the events described, a group of five girls constructed an explanation why the magnetic pendulum could not move along the bisector between two magnets. According to the students, the magnetic pendulum could not indefinitely swing back and forth in the same plane, but was deflected of its path because of the earth's rotation. Our case study shows how this explanation emerged from the interaction of goal, drawings provided by the teacher, history of students' conversation, and students' prior embodied experience. Using the apparatus of Situation Theory (Devlin & Rosenberg, 1996), we provide a detailed description of students' activities and the learning which evolved from it.

We began this study by asking two questions, "What is the relationship between students' actions and their learning?" and "What is the pedagogic value of hands-on activities?" This case study documented how students structure their experience, how new descriptors arise from and are grounded in interactions with social and material worlds, and how students' observational and theoretical language develops from group activities and at the classroom level. Because students bring with them previous experiences, images, and discourses to structure new experiences, different structurings of the experiential and perceptual fields, and the related theoretical descriptions are different. From the interactions emerge new descriptions and understandings with sometimes surprising and unpredictable twists. We suggest that these kind of learning paths are the signals to be accounted for in theoretical models of real-time student activity rather than unwanted noise. Better understandings of the courses students' activities take in real time are needed before "better" curricula can be designed.

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