Chapter 10
The Mediating Role of Context in an Urban After-School Robotics Program:
Using Activity Systems to Analyze and Design Robust STEM Learning Environments

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ABSTRACT

The purpose of this chapter is to illustrate the usefulness of cultural-historical activity theory in understanding how context mediates youth activity in a successful urban after-school robotics program. Youth activity is analyzed using activity systems, uncovering the role of tools, rules, community, and division of labor in youth engagement with a set of open-ended engineering tasks. The program supported the youth in making sense of the engineering tasks using their own intuitive methods, and it also helped them to see a purpose for disciplinary practices. The author illustrates that the social context, made up of elements from in and out of school, supported youth in drawing on knowledge from across different settings. A use of activity systems is proposed for practitioners in the design of out-of-school-time educational programs.

INTRODUCTION

The Beech Hill High School[1] robotics team was successful when I first started working with them in the fall of 2006. Beech Hill robotics was an after-school program in an urban comprehensive neighborhood high school. The success of the robotics team is contrasted by the low academic performance of the school. In the robotics competitions, Beech Hill competed against, and outperformed, teams from selective-admissions schools and technology-based vocational schools. Much of this success was related to the design of the program and the resulting activity of the team. The

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purpose of this chapter is to illustrate how youth drew from and took part in the social context in which the robotics program was situated, and to show the utility of using this type of analysis in the design and enactment of robotics programs.

From the first year the team was formed, they created inventive robots and excelled across the various subcomponents of competitions. The robots they designed and built worked well, but tended to be a step behind the top robots in competitions. Their overall success came from their attention to the entire competition. In particular, they created well-structured engineering notebooks, and informative and professional marketing presentations. Moreover, their success can be attributed to a supportive coach and the autonomy of the youth to solve problems on their own in the designing, building, and refining of their robot, creating an environment in which the youth were motivated and engaged. The design and workings of the robotics program are explored throughout the chapter.

The data presented in this chapter comes from a mostly qualitative study of the mathematics use of the Beech Hill robotics team in the fall of 2008, including participant-observation through a 12-week competition cycle and two sets of interviews with youth participants. The project came out of an NSF-funded study, through the MetroMath Center for Learning and Teaching, investigating how youth used mathematics out of school across three different youth development programs. The research design matched the methods of those who previously researched out-of-school mathematics use (Scribner, 1984; Lave, 1988; Saxe, 1988; Nunes, Schliemann, & Carraher, 1993; Nasir, 2000; Hoyles, Noss, & Pozzi, 2001). Coming out of the sociocultural tradition (Vygotsky, 1978), this field of research thoroughly privileges the role of social context in mediating mathematics use. A focus on context was thus built into my study and is utilized in the present work to identify the role context played in youth activity more broadly.

In the chapter, I use a cultural-historical activity theory (CHAT) lens to understand how context mediated youth activity. It should be noted that the coach did not make use of this theoretical perspective when designing the program. Instead, I am using this theory as an outsider who observed and participated in the program. The result is two-fold. First, I am able to illustrate the usefulness of the CHAT perspective in uncovering the way in which different components of a social context impact group activity. My analysis examines the social context using *activity systems* (Engeström, 1993), showcasing how youth drew from, interacted with, and modified the social context in which they were engaged. By separating out the context into six components—subject, object, tools, rules, community, and division of labor— I show how each impact activity, and how they operate together as a complex system. I use what I have learned from applying this theory to the Beech Hill setting to propose a process for using CHAT in the design of STEM learning environments in out-of-school time. Second, the analysis leads to a number of findings about the role of the context. In particular, I illustrate how the social context was comprised of elements from both in and out of school, and that the youth drew seamlessly from across these resources. These findings are used to introduce a new conception of the way in which we think about learning environments, a topic discussed elsewhere more fully (Baker, 2011).

The chapter is separated into five sections. I first identify the literature that informs this work. Second, I more fully identify the team and the engineering task with which they were engaged. Third, I describe my research methods. Fourth, I analyze the activity of the robotics team using activity systems from two vantage points: at one particular meeting and then more generally. Finally, I introduce a process by which out-of-school-time educational practitioners can utilize activity systems to design successful programs.