High School Students' Science Learning in a University Internship: A Cultural-Historical Activity Theory Perspective

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DRL1322600

Introduction

The Next Generation Science Standards (NGSS Lead States, 2013) emphasize that K–12 science education should reflect real-world interconnections in science and focus on deeper understanding and application of content. One effective way to help students learn to apply science is to invite them to work with scientists on authentic scientific projects. Internship programs designed for students to work with scientists have been suggested as one of the most productive activities for helping students to engage in open-inquiry activities (National Research Council, 1996) and to experience diverse aspects of science practice in problem-solving contexts with a high degree of complexity (Lee & Songer, 2003). The purpose of this study is to provide empirical data regarding science learning in authentic contexts and to illustrate the unique features of dynamic interactions and activities involved in an internship program for high school students.

Theoretical Framework

Cultural-historical activity theory (CHAT) is a theory to comprehend the practices of meaning making through interactions among the collaborators and variables within a system (Engeström, 1987).

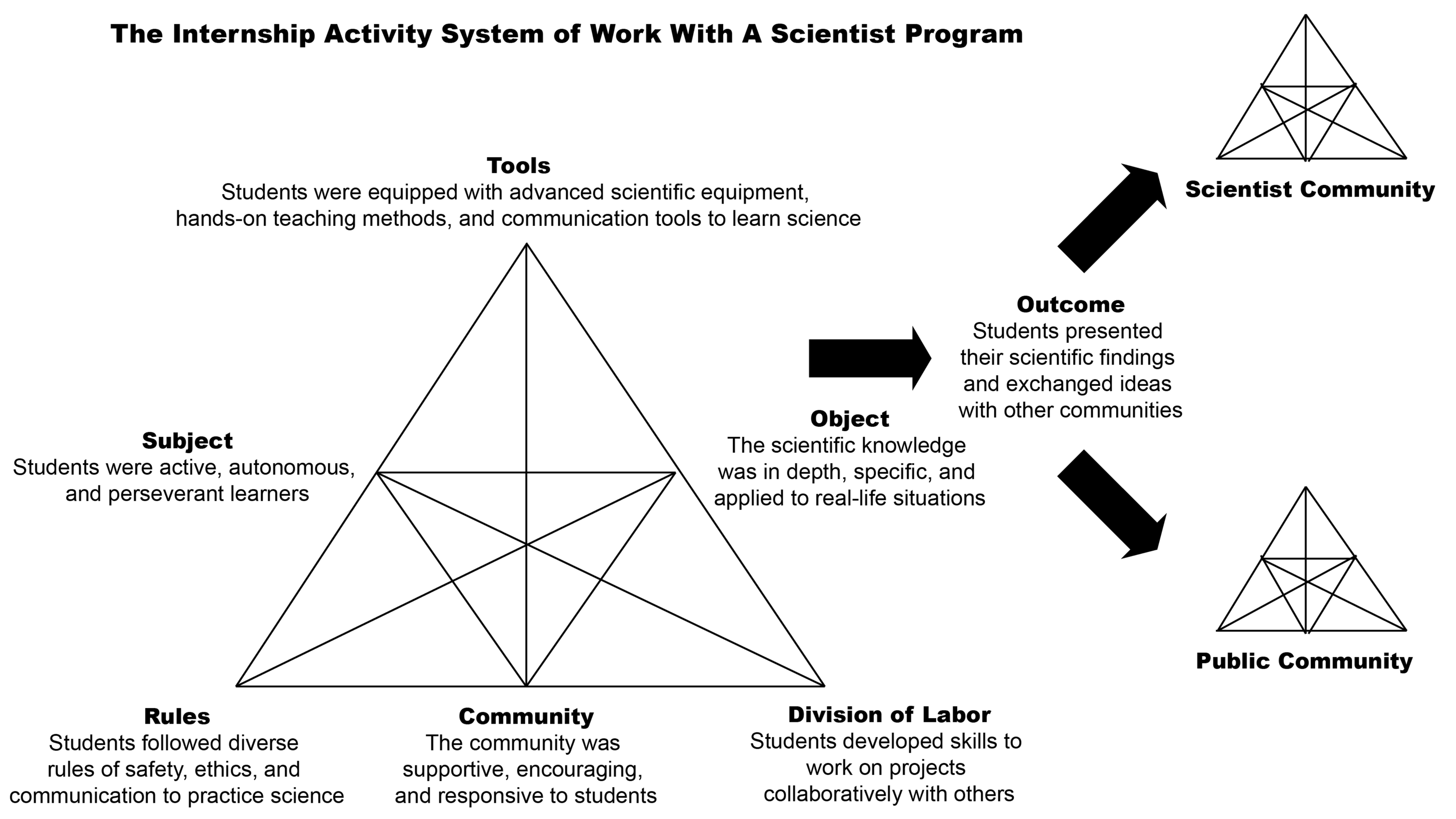
- The *subject* is the individual/group whose agency is chosen as the point of view in the analysis.
- The *object* is the primary target the subject acts upon and is transformed into outcomes.
- The *tools* serve as the mediating instruments for the *subject* to act upon the *object*.
- *Rules* are the guidelines through which the interactions among the system components occur, establishing normative behaviors for the activity between and within the groups.
- The *community* includes individuals or groups who share the same general object.
- *Division of labor* refers to how the work of the activity is divided within the community and facilitates identification of roles, responsibilities, and tasks; the division of labor is continually negotiated based on the positions of power within the community.
- The *outcome* reflects the products and results of the subject's mediation of the components of the activity system (Hsu, van Eijck, & Roth, 2010).

Research Context & Methods

The study is part of a four-year research project, which invited high school students to work alongside scientists in an internship partnership between the university and three local high schools.

- Research Context
  - ✓ Work With A Scientist Program
  - ✓ Seven months (every other Saturday in Spring Semester and 30 days in summer)
  - ✓ Four lead scientists (chemistry, neuroscience, immunology, biology) with their research teams
  - ✓ 36 high school students from Title 1 schools
  - ✓ Open inquiry projects with cogenerative dialogues
  - ✓ Proposal and final presentations to the public
- Methods:
  - ✓ Ethnography
  - ✓ Interviews with students, assistants, scientists and teachers
  - ✓ Student journals on internship experiences

Results



Key Features of the Internship Activity System

Subject: Students were active, autonomous, and perseverant learners.

- "My learning experience this week was very well. I learned a lot through trial and error. Recently we had been having some technical difficulties, but after this week, we got our concentration levels of our DNA up and got back on track. We have been working more independently and confidently with chemicals such as buffers. We have been working a lot more individually as opposed to relying on the scientist or the science research assistants all the time."

Object: The scientific knowledge was in depth, specific, and applied to real-life situations

- "There is a lot of work that has to be done when it comes to neurology, from cutting up mice to researching for hours on end. This internship has made me realize that neurology is a hard job and not everyone is cut out for it, but the job can also be very rewarding. The experiments that are conducted can potentially help many people in the world."

Tools: Students were equipped with advanced scientific equipment, hands-on teaching methods, and communication tools to learn science.

- "It was fun working with chemicals and learning how to use different scientific tools. It amazed me how many different things are in the laboratory, from scientific equipment to chemicals. I felt so professional working in a university laboratory. "
- "The learning experience was enjoyable, because last week in cogenerative dialogue we discussed that most of us are visual learners and would like to try to see items used in this week's internship and we saw that the RAs took in some of our opinions into consideration."

Community: The community was supportive, encouraging, and responsive to students.

- "I also learned something I've never encountered by an educator before, and that's that our voices actually do matter. Almost every teacher (with the exception of about 3 of my past teachers) has tried to hush students. Dr. MacDonald is the first that I've ever met to say that we have a voice, and also practice what he preaches. With everything we do, Dr. Moore makes sure to ask our feedback in order to provide better learning and even just to get to know us. My teachers don't really care what we have to say and some even act like they hate the mere sounds of our voices. Having opened my mind to the possibility that not all educators are selfish, I now feel more confident about voicing my thoughts."

Rules: Students followed diverse rules of safety, ethics, and communication to practice science.

- "We were given training in the laboratory by Garry and what to do in case of an emergency. This was useful information especially that we will be given the opportunity to actually work in a laboratory setting. On Saturday we were also introduced to cogen dialogue, meaning that this program will have a huge sense of equality and a family feel!"

Division of labor: Students developed skills to work on projects collaboratively with others.

- "My learning experience this week was instrumental to the commencement of my team's productivity in formulating our project. We were able to start on good ground. All of us agreed on how we wanted to approach the problem of pollutants in the air."

Outcome: Students presented their scientific findings and exchanged ideas with other communities.

- "In our final presentation, I learned that my partner and I really have impacted the science community. I realized that because of the great success of our research project, we have the capability of making a breakthrough in cancer research. I learned that because we have come so far, my partner and I have the chance to get our names in a published paper. This is very exciting because I had no idea that this program would lead to such amazing opportunities like this for me."

		Students (36, 100%)	Scientists (4, 100%)	Assistants (8, 100%)	School teachers (3, 100%)
Subject	Students were active, autonomous, and perseverant learners	**83%** (30/36)	**100%** (4/4)	**88%** (7/8)	**100%** (3/3)
Object	The scientific knowledge was in depth, specific, and applied to real-life situations	**78%** (28/36)	**75%** (3/4)	**50%** (4/8)	**67%** (2/3)
Tool	Students were equipped with advanced scientific equipment, hands-on teaching methods, and communication tools to learn science	**67%** (24/36)	**100%** (4/4)	**88%** (7/8)	**67%** (2/3)
Community	The community was supportive, encouraging, and responsive to students	**69%** (25/36)	**100%** (4/4)	38% (3/8)	33% (1/3)
Rules	Students followed diverse rules of safety, ethics, and communication to practice science	47% (17/36)	**75%** (3/4)	**50%** (4/8)	0%
Division of Labor	Students developed skills to work on projects collaboratively with others	42% (15/36)	**75%** (3/4)	50% (4/8)	33% (1/3)
Outcome	Students presented their scientific findings and exchanged ideas with other communities	19% (7/36)	**75%** (3/4)	13% (1/8)	**100%** (3/3)

Conclusion & Discussion

This study was designed to investigate the unique features of science internship activities in the Work With A Scientist program from a cultural-historical activity theory perspective. In the internship, students view themselves as active, competent, perseverant and independent learners. Their scientific knowledge gained from the internships is in-depth, specific and applicable to real-life situations making students well equipped to learn science with advanced scientific equipment, hands-on practices and communication tools to be successful in the internship environment. The community of scientists, assistants and peers are supportive, encouraging and responsive to the students. Rules of safety, ethics and communication are expected to followed to learn and practice science. All students are expected to contribute to the project by sharing their expertise and working collaboratively with others. Students in the internship present and share their findings with other communities to exchange ideas and possibly influence change. Our findings provide important insights and implications to improve current K–12 science education, especially for schools that still embrace traditional teaching practices.

References

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