THE ACTIVITY OF A
PRE-APPRENTICE
LEARNING TO MEASURE

ALM 17—Maths at work: Mathematics in
a changing world
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Overview

• The primary focus is a single pre-apprentice (C) learning to measure in fractions-of-an-inch during a 33 minute impromptu tutoring session. This took place within an eight week pre-apprenticeship training program in the pipe trades.
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My background

• I come to this project as an experienced secondary school mathematics teacher and mathematics teacher educator.
• I also bring considerable industrial work experience from a machine shop.
• As part of the UBC Workplace Numeracy Project, I spent 21 months in the field observing mathematics practices and learning within a wide variety of workplace training programs before I undertook the analysis of the data for the present study.
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Theoretical perspective

• This analysis is framed broadly by CHAT (Engestrom, 1987; Lenot’ev, 1978) as well as Radford’s (2008) recent elaboration, the theory of knowledge of objectification.

• Together, CHAT and the theory of knowledge objectification are particularly well suited for macro- and micro-analyses of mathematics activity and learning within various contexts as artifactually and socially mediated, goal oriented cultural activity.
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Engeström’s (1987, 2001) activity system model.
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Radford’s recent elaboration of activity theory, the theory of knowledge objectification (TO), foregrounds the deeply intimate and dialectical relationship between material culture and human thinking – including mathematical thinking – by introducing the concept of the *territory of artifactual thought*. 
Radford also emphasizes the central role of cultural-semiotic systems in mathematics thinking and learning by introducing the concept of *semiotic systems of cultural signification*. This concept positions beliefs about conceptual systems and conceptions about truth (ontology), knowability (epistemology), methods of inquiry (methodology), and legitimate knowledge representation (semiotic systems) as essential parts of the analysis of any mathematics activity.
Radford’s (2008) model of the theory of knowledge objectification
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Methodologically, the TO accounts for learning by calling attention to knowledge objectification i.e., the process in which one becomes progressively aware and conversant, through one’s actions and interpretations, of a cultural logic of mathematical objects.
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Analysis

The 33 minute activity of the tutoring session can be broken down into the following actions sets or foci that occur in sequence. These account for all of the mathematics activity that took place.
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1) Discovering C’s difficulty measuring with the measuring tape
2) Noticing the different division patterns on the measuring tape
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3) Exploring C’s understanding of the relative sizes of the fractions used on the measuring tape
4) Starting to read the different types of fractions on the measuring tape
5) Understanding fractions per inch and fractions as intervals
6) Using the smallest intervals on the measuring tape as benchmarks
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7) Using quarters as benchmark fraction intervals
8) Becoming more fluent with the number of unit fractions per inch
9) Using thirty-seconds and quarters as benchmarks to find other types of fractions
10) Becoming proficient identifying different kinds of fractions below and above 12 inches
11) Using the measuring tape in a new way
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The semiotic resources that serve as means of objectification during the entire session include:

• spoken and written language including fraction notation using digits
• a set of acetate rulers used as a teaching tool
• the particular pattern of fraction markings printed on the measuring tape and the set of transparency rulers …
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- counting
- a variety of different kinds of gestures
- other written indexical inscriptions
- the physical position, orientation, and alignment of artifacts
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The set of transparency rulers: Each row shows the fraction pattern inscribed on one of the rulers in the set.
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Video clip 1: Some of the actions that draw C’s awareness to measurements on the ruler as intervals.

1) Note the emphasis on fractions-of-an-inch as intervals or spaces using different words & sweeping gestures.

2) Also note L’s systematic explanation of the meaning of a fraction denominator using spoken words, written digits, indexical (pointing) gestures, and circle inscriptions.
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Other significant elements:

• **semiotic nodes** within learning activity are places where multiple semiotic resources are used in concert to promote knowledge objectification

• **cultural-historical semiotic contractions**

• the process of **semiotic extraction**
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A new teaching tool to draw the learners' attention to factions-of-an-inch as an intervals.
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Other features of this activity:

• it is a norm in the pipe trades that lengths are measured to the nearest sixteenth-of-an-inch

• linear measurement in the pipe-trades is a distinct form of practice in comparison with school mathematics in the following ways: it is based on a different sense of number, it has a different basis for establishing truth, and it serves an entirely different purpose, that being workplace production
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Video clip 2: L signals that he is crossing a cultural boundary when he describes a new approach to using the measuring tape as “cheating” (or breaking a rule).

Notice the continued emphasis on units of measure as intervals on the measuring tape.
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Some implications/conclusions:

- This research highlights the central role of workplace artifacts, workplace practice, and the role of body in mathematical thinking and the need to address these when designing mathematics training for the workplace.
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- This research highlights the need to examine various forms of cultural-historical semiotic contractions in workplace mathematics practices as sources of potential difficulty for learners.
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• This research highlights the importance of teaching methods and tools to help learners unpack the mathematical meaning embedded within problematic workplace practices.
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• This research highlights the need for the teaching of mathematics in workplace training to be informed in a coordinated way both by expert workplace practitioners who know the cultural ways of doing mathematics that are specific to their vocations as well as by mathematics educators who can help to recognize, unpack, and organize or reorganize the mathematics meaning embedded with these practices for novices.
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• This study also demonstrates the usefulness of adopting a cultural-semiotic activity theory perspective for examining the dimensions and dynamics of workplace mathematics.

• Further study is warranted to develop our understanding of mathematics practice and learning in the workplace using this type of an approach.
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*Tusen takk* — Thank-you

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Selected reference: