

Material Agency: questioning both its role and meditational significance in mathematics learning.

Sean Chorney
Simon Fraser University

Abstract

Tools in the mathematics classroom are often not given the credence or the attention they warrant. Considering Vygotsky's view of mediation, tools may play a larger role in mathematics than originally thought. This preliminary report presents a framework for attempting to identify the implications of tools in student learning. Using Pickering's analytic framework (1995) distinguishing individual, disciplinary and material agencies, I am interested in how material agency takes form in the interaction of students with tools. While teaching an education class of pre-service mathematics teachers I will analyze their interactions with a Dynamic Geometric software, specifically Geometer's Sketchpad. In the process of solving a problem I will analyze students' engagement with the tool in terms of the different types of agencies, based on their spoken words and their actions in using the program.

Key words: agency, disciplinary agency, material agency, mediation, dynamic geometry software, Geometer's Sketchpad

Introduction

A tension has always existed between the advocates of mathematics as being more of a mental discipline and, both academics and pedagogues, who consider the physical role of objects, materials or machines playing a formative role in the learning of mathematics. While both sides recognize that tools play their role in the practice of mathematics, the mental mathematicians may consider that tools or machines play a small role to either simplify a calculation to arrive at a particular theorem or merely serve as a vessel that serves the sole purpose of "getting" to the mathematics. This attitude is not so much explicitly stated as it is practiced. Whether stemming from Plato's vision of mathematics as a separate, distinct and pure discipline, that is accessible solely through contemplation (Tarnas, p. 6), mathematical production acts often state no reference to materials or tools

used in the process. While mental discipline advocates argue tools can cloud the very nature of mathematics, advocates for an object-oriented inquiry argue that tools or machines influence how we learn mathematics (Turkle, 2007) and are consequently worthy of study.

Analytic Framework

The implementation of tools or machines into mathematics classrooms and how they are used is a topic of interest: if mathematics learning is to be fully understood, the tools used in mathematical activity are not to be reduced to an avoidable step. Wertsch claims that one of Vygotsky's major themes in his theoretical approach was "...that an adequate account of human mental functioning must be grounded in an analysis of the tools and signs that mediate it" (in Daniels, 2008, p. 4). The framework that I would like to propose for analyzing tools in mathematics education is based on Pickering's distinction of agencies. Pickering (1995) has classified 3 types of agency: individual, disciplinary and material. While one would not usually think of materials or disciplines as having agency, Pickering describes the individual engagement with either of these agencies as a "...dialectic of resistance and accommodation" (p. 52). Pickering has referred to this interplay of resistance and accommodation as a "dance of agency". His view is that mathematics is a product of human activity and therefore individual agency plays a major role in any conceptual and/or material advancement. However, engagement with materials or conceptual systems is not a one-sided affair. In his argument for disciplinary agency Pickering describes how a conceptual system can "...carry human conceptual practices along...independently of individual wishes and intents" (p. 115). So although individuals exercise their agency in their intentions and actions, they are often met with

resistance or an obstacle . This resistance is the agency of the material or conceptual system. The dance of agency is then enacted by having the individual accommodate their actions to appropriate the resistance. This dialectical interaction is the framework from which I would begin. When a student of mathematics is interacting with an object and an attempt is made by the individual to achieve a goal, any resistance to that goal is an example of material agency.

Boaler uses this framework to argue that disciplinary agency dominates the practices in a traditional classroom. Pickering sees this disciplinary agency as the negotiated rules and algorithms of mathematics. Thus if student are not given the chance to act, the math is given the status to direct and determine the practices of math classroom activity. Boaler argues that good classroom teaching would entertain a balance between the two agencies for both are important and essential. Both Pickering and Boaler however do not refer to material agency in mathematics. Pickering offers material agency as only being evident in scientific advancements. So while Pickering is focusing on the emergence of new ideas, theories, and practices I hypothesize that material agency does have significance in the practices of mathematics. Wagner also uses Pickering's framework by acknowledging disciplinary agency but appeals to material agency in mathematics and poses the question: "What is the nature of material agency in mathematics?" (Wagner, p. 43). I borrow from Wagner and ask the question: what is the nature and implication of material agency when students of mathematics are engaged in using a tool.

Proposed Study

While there are many tools and/or artifacts that have found themselves in different ways into the mathematical community I am choosing what could be termed a technological artifact. A dynamic geometry software (DGS) can be said to have been made to elicit determined geometrical principles. DGS's options and many features such as built in tools offer many choices for students to engage with. It is the choices they have that allows for them to exercise their own agency. This dialectic engagement is what I choose to focus on. While teaching an education class of pre-service mathematics teachers I will analyze their interactions in solving a problem by analyzing the data in terms of the different types of agencies, based mainly on their spoken words as well as their actions in using the program. Informal, ad hoc studies using Jing as a way of capturing both their dialogue as well as their activity within the program show evidence of material agency.

Questions

What does this framework offer that appropriation does not?

Is this a viable framework in mathematics education? How best to capture data for material agency? Does a DGS afford the opportunity to observe individual agency alongside material agency? How can one distinguish between disciplinary and material agency in the context of a DGS?

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