A Feel for Physics: A Study of the Affective Dimensions of Professional Physics Practice

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Abstract: Research exploring cognitive processes involved in science learning generally focuses upon the mechanisms that bring about conceptual change; however, relatively little work has investigated the role of emotion in learning. Studies exploring the affective dimensions of learning have drawn mainly upon data collected in classroom contexts but have not investigated scientists' emotion within professional disciplinary practice. We seek to address this gap by exploring how research physicists' emotions sustain their practice.

Introduction

Historically, research in the learning sciences has focused primarily upon cognitive processes with little attention directed toward understanding affective dimensions of learning. Given this gap, scholars have undergirded the importance of considering learners' emotions and their relationship to reasoning and learning when researching cognition; however, this work typically explores affect in classroom contexts (or towards educational tasks) rather than affect within professional disciplinary practice (Gupta et al., 2018; Jaber & Hammer, 2016; Odden & Russ, 2019). While first-hand accounts that describe the affective experiences of professional scientists exist, there is a dearth of research empirically investigating the affective dimensions of professional practice in science.

We begin to address this gap in the literature through an ethnographic study of a laser physics research group and their lab practices. Specifically, we seek to elucidate the affective dimensions of physics practice by characterizing the ways in which affect is embedded within and constitutes professional physics practice. We foreground the perspectives and lived experiences of professional physicists by attending to their verbal exchanges within and talk about their practice with the eventual goal of informing how science instruction and curricula might authentically nurture students' affective engagement in scientific practice.

Theoretical framework

To frame our analysis of physicists' engagement in professional practice, we draw upon *epistemic affect*: individuals' "feelings…connected to epistemic experience and objectives in the doing of science" (Jaber & Hammer, 2016). Using this construct, we attend to physicists' dialogic interactions, including verbal and symbolic exchanges, as they engage in the daily conduct of lab work. We analyze participants' interactions during research endeavors (e.g., research meetings and laboratory experimentation) and trace the affective dimensions salient in these activities.

In addition, following a socio-cultural perspective on learning, we pay particular attention to how material artifacts mediate physicists' research practice (e.g., instruments and graphic displays) and consider the ways in which these artifacts are both central to physics practice and "objects of affect" that elicit emotional responses (Arnold et al., 2012). We assume that these affective ways of "feeling physics" are socialized within the daily practice of professional physicists and constitute important dimensions of reasoning and learning in professional scientific communities (Lave & Wenger, 1991).

Methods

We draw upon data collected during an ethnographic study (Emerson, 2001) of a laser physics research group at a large, public research university in the Southwestern United States. The broader objective of this study is to investigate how physicists collaboratively reason when planning and subsequently running experiments and when analyzing experimental results. To evaluate these aspects of physics practice, we observed a professional physics research group during planning meetings and laboratory sessions, collecting over 12 hours of video data in addition to field notes documenting salient episodes that occurred during observations.

Results and implications

The affective dimensions of professional physics practice are complex and varied. Here we describe episodes that highlight the ways in which epistemic affect emerges in professional physicists' practices.

In one episode from the group's research meeting, physicist Ralph shared plots he generated using

physical simulation software. Worried that the plots were imprecise, Ralph described them as "pessimistic." Professor Dawson, the group's leader, disagreed with Ralph's assessment, instead describing the plots as "beautiful" because "there's a lot of physics there." The interaction between Ralph and Professor Dawson exemplifies how physicists' talk might draw upon words, which—when paired with a context—acquire affectively charged meanings, both positive and negative. Ralph was initially disappointed that the plots defied what he expected and, in describing them as "pessimistic," exhibits negative affect toward scientific meaning that had eluded him. By contrast, Professor Dawson was happy with the physics displayed in Ralph's results, and he attends particularly to the aesthetically pleasing "beauty" of the underlying physics highlighted within the plots. In addition to assuaging Ralph's initial disappointment, Professor Dawson's positive affective response is an invitation for Ralph to look differently at his results and focus on the phenomena displayed. This episode demonstrates how affect is embedded within professional physicists' reasoning and how affective language tunes physicists' perspectives toward their content.

In another episode from an experimental session date, physicists Lou and Amber inspected an image to assess the amount of energy generated during a trial. Lou exclaimed, "This is an absolutely disgusting amount of energy—if [radiation] is making it all the way through the scintillator, that's absurd!" In this moment, the epistemic work of precise quantification was superseded by the positive affective response toward the successful run and the sheer magnitude of the ("disgusting amount of") energy produced. Later, Amber waited for another file to open in order to see if she had successfully imaged optical transition radiation (OTR), a phenomenon she had unsuccessfully tried to image for a week. "Alright, OTR," she said in anticipation of the image loading. Then erupting with excitement, she yelled, "YES, I GOT FUCKING OTR!" Amber's affective response toward a successful result, after many unsuccessful attempts, reveals joy and the release of tension that are characteristic of cycles of experimentation in physics labs. In professional practice, the stakes are authentically high, and individuals become affectively and emotionally entangled with the objects of pursuit. Amber expressed pleasure at imaging a phenomenon that had previously eluded capture, and her colleagues shared in her excitement, gathering around the monitor to view the result and enthusiastically discussing the image produced during the experimental trial. In the laboratory setting, affectively charged terms convey reasoning as professional physicists make-sense of incoming data and are also artifacts of their emotional entanglement with their work.

Physicists participate in disciplinary communities of practice and develop ways of knowing and reasoning within the cultural-historical contexts of these communities (Traweek, 1992). Affectively charged language conveys disciplinary meaning, and affective responses emerge within physicists' epistemic work. Physicists may experience frustration at having to prioritize research aims and allocate limited time and resources towards these aims at the expense of others, but they may also exhibit elation after successful experimental runs in which useful data are captured. Affect within and towards their work is embedded within physicists' disciplinary ways of knowing and learning; however, such affective development is not typically encouraged in schools, where students engage in well-defined units of study that culminate in an assessment of knowledge. The authentic talk encountered in professional physics laboratories is often prohibited in classrooms, despite being part of the repertoire of high-school and college students.

It is important for the learning sciences community to expand understanding of the affective dimensions of scientific practice and the ways in which affect is experienced and expressed by professional scientists. Understanding affect in professional practice can inform how to nurture students' affective engagement—an important aspect of disciplinary reasoning—with science in schools.

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