Teaching and Teacher Education 51 (2015) 101–112

Contents lists available at ScienceDirect

Teaching and Teacher Education

journal homepage: www.elsevier.com/locate/tate

Learning at the nano-level: Accounting for complexity in the internalization of secondary STEM teacher professional development

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HIGHLIGHTS

- Case study design to explore the lived realities of STEM teacher development.
- Current learning models neglect the role of subjectivity and exogenous variables.
- Subjectivity provides a useful lens for analyzing processes of STEM teacher change.
- Consideration of exogenous variables deepens understanding of teacher PD outcomes.
- Understanding complexity could promote improvements in PD research and policy.

ARTICLE INFO

Article history:
Received 13 February 2015
Received in revised form
11 May 2015
Accepted 21 June 2015
Available online 3 July 2015

Keywords:
Professional development
Subjectivity
Exogenous variables
STEM education

ABSTRACT

Utilizing a case study research design, the factors that influence teacher learning and change, as well as the processes by which secondary STEM teachers internalize professional development (PD) content, are explored. The authors argue that conceptualizations of teacher learning often do not adequately account for teacher subjectivity and the role of exogenous variables in teacher development. The outcomes of PD are heavily influenced by teacher subjectivity, which includes perceptions, previous knowledge, and the internalization of the power and influence present in educational policy and socioeconomic realities. This complexity must be accounted for when planning, researching, or evaluating teacher PD.

1. Introduction

Teacher professional development (PD) is internationally recognized as a key component to contemporary education policy. Teacher education research from Scotland (Fenwick & Weir, 2010; Grieve & McGinley, 2010), Canada (Gibson & Brooks, 2012), China (Tang & Choi, 2009), Taiwan (Hung & Yeh, 2013), and Australia, Sweden, Finland, and Norway (Hardy, Rönnerman, Moksnes Furu, Salo, & Forsman, 2010) attests to the internationalization of teacher PD and its relevancy within the broader discourse on teacher education. Conducting localized studies is, therefore, essential for the expansion of knowledge on the idiosyncratic ways in which teacher PD policy and practice mirrors the milieu in which it operates and how it may influence teacher learning, praxis, satisfaction, retention, and effectiveness.

In the United States, science, technology, engineering, and mathematics (STEM) teacher PD continues to occupy a pivotal position in the discursive and pragmatic formulation of national education reform policy. National initiatives, such as Race to the Top and the No Child Left Behind Act before it, have emphasized PD as critical to U.S. educational and economic success (President's Council of Advisors on Science and Technology, 2010, 2012). In his 2011 State of the Union Address, President Obama announced the goal to prepare 100,000 excellent STEM teachers over the next

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http://dx.doi.org/10.1016/j.tate.2015.06.008
0742-051X/

decade. Answering his call to action, over 150 organizations led by the Carnegie Corporation of New York formed a coalition called *100Kin10*. Members of the coalition have made commitments to support STEM-Teacher preparation and professional development and raised over $30 million for this effort (Committee on STEM Education, 2013). Moreover, in conjunction with the federal reorganization of STEM-education programs to promote greater "coherence" and "efficiency", thereby reducing the number of programs spread across 14 federal agencies by nearly one-half, the Presidentially-approved FY2014 budget increased investment in STEM-education programs by six percent (Committee on STEM Education, 2013). With STEM teachers oftentimes distinguished as the primary subjects of the above policy and budgetary shifts, it has become increasingly necessary for thorough research to be conducted into the effects of such changes, not only on the development of teacher effectiveness, but on processes of teacher learning and professional change.

Furthermore, in the aftermath of these educational policies, and considering the fact that P-12 education is the responsibility of the states, not the federal government, it is apparent that STEM teacher preparation and professional development are in a state of metamorphosis. This is especially evident in Indiana, where educational reforms—operating according to the logics of neoliberal economics (i.e. privatization, vouchers, teacher pension restructuring, pay for performance, market-based approach to teacher licensure, etc.)—have changed the educational landscape of the state (Billick, Hiller, & Spradlin, 2011; Cole, Murphy, Rogan, & Eckes, 2013; Houser, 2012; Martin, 2014; Michael, Spradlin, & Carson, 2009) and have, in turn, placed professional and economic burdens upon schools and teachers, including PD, to stay abreast of content area and pedagogical changes. Such policy has contributed to an "exodus" amongst qualified educators from their chosen profession (Carroll, 2007; Heinz, 2014; Keigher, 2010). The sociocultural and political economic urgency placed upon STEM teacher development throughout the nation indicates the complexity of STEM teacher professional learning both within and beyond PD interventions.

In this paper, multiple conceptual models relevant to teacher professional learning (Clarke & Hollingsworth, 2002; Fore, 2013; Guskey, 1986; Ostrom, 2011) are examined and critiqued through empirically-derived evidence in an attempt to contribute to the existing body of knowledge and to new conceptualizations of teacher professional learning. Due to the unique characteristics of STEM education, there is a need for models of professional learning that fully account for the bigger picture of education that teachers, especially those in urban environments, must negotiate. Areas that impact this study include: 1) the ubiquity and concomitant pressures of STEM education discourse and practice; 2) the costliness and lack of STEM education materials in schools during a time of recession, privatization, and austerity; and 3) the frustrations of shifting and/or contradicting policy reforms. The aim of this study is to move toward a dynamic model of STEM PD through an evolving understanding of how outcomes are affected by both emerging teacher subjectivities and the milieu in which these subjectivities are and will be enacted.

2. Theoretical framework

Data gathered were analyzed through a particular theoretical lens, which foregrounds the importance of subjectivity theory, equates the logic of teacher PD with the vast body of literature on international development, and stresses the importance of politics and economics in the functioning of the milieu in which a teacher operates. Data was also weighed and compared against current teacher conceptual learning models (discussed further in Section 2.2). To ensure clarity, several relevant terms should be defined according to their use in this study. Subjectivity refers to "the relation of self—comprising one's emergent truths, desires, practices, and perspectives—to itself, to others, and to the influence [i.e. power] present in a variety of encounters, whether social, political, economic, or religious" (Fore, 2013, p. 82). The French term *subjectivation* denotes the process of an individual subject's becoming. Central to both of these terms is a concern with the ordinary governance operating within everyday life. As teachers act in a variety of contexts, their experiences open them up to the political power of the judgment of others, the influence of discourse and discipline, and the potential for self-fashioning.

2.1. Subjectivity and tactics

Oftentimes, research involving STEM teacher PD interventions is less concerned with the processes of teacher professional learning than PD "best practices," which tend to be more evaluative and/or prescriptive without venturing deeply into a political economic, socio-cultural critique sensitive to issues of discourse and power (for exceptions, see Hardy, 2012; Kemmis, Heikkinen, Fransson, Aspfors, & Edwards-Groves, 2014; Mulcahy, 2011). While research into best practices is a necessary applied dimension of educational research (see, Ball, 1996; Garet, Porter, Desimone, Birman, & Yoon, 2001; Hadar & Brody, 2013; Hollingsworth, 1999; Putnam & Borko, 1997; Sparks & Loucks-Horsley, 1989), exclusively evaluative or prescriptive PD research may identify desired program outcomes with little regard for the procedural complexity and sociocultural embeddedness of teacher learning (Opfer & Pedder, 2011). As a result, PD research can be conducted in ways that naturalize and (re)produce hegemonic representations of teachers-as-cause of educational and economic entropy and, therefore, deemed in need of development and systematic subjection/*subjectivation*.

Such ideology is arguably related to the interventionist philosophy of international development, which often operates according to the paternalistic, neocolonial assumptions within economic neoliberalism and modernization, while perpetuating articulations of the "underdeveloped" subject as deficient and, therefore, burdensome to well-functioning society and in need of development (Edelman & Haugerud, 2005; Escobar, 1992; Ferguson, 1990; Frank, 1966; Rahnema & Bawtree, 1997; Ziai, 2004). Moreover, similar to international development recipients, teachers themselves are increasingly portrayed (see Kumashiro, 2012; Wagner, 2014) as the "technical problem" that must be "technically fixed" through the expertise of knowledge-power brokers (Escobar, 1992; Ferguson, 1990; Foucault, 1977). In such a model, the logic of progress acts upon the level of the individual, who must change to ensure development. By blaming the individual and concealing the role of the political economy, the reality of education is depoliticized, similar to Ferguson's (1990) representation of international development in Lesotho as an *anti-politics machine*. It should be unsurprising that such a status quo would influence learning and perception as teachers encounter PD interventions (Clarke & Hollingsworth, 2002; Hardy, 2012; Opfer & Pedder, 2011; Ostrom, 2011).

Acknowledging the complexity within national PD strategies demands that the gaze of a critical eye be directed at the relations of power within teacher PD policy and implementation, and the "tactics" (de Certeau, 1984) employed by participant educators in response, as the learning process unfolds. While conceptual models of teacher professional learning and change have been adjusting to concerns over complexity (Clarke & Hollingsworth, 2002; Opfer & Pedder, 2011), PD learning models continue to downplay the role of the wider milieu and teacher subjectivity and *subjectivation*, which can lead to misrepresentations of teacher learning and change (Opfer & Pedder, 2011).