Science Teachers' Communities of Practice and Policy Implementation

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Abstract: Science education is impacted by messages from multiple sources including national, state, and local policies as well as teachers' communities of practice. National level policies like the Next Generation Science Standards and local instructional polices such as the use of Project-Based Learning require sensemaking by teachers, an inherently social process. As teachers engage with learning events and new tools they will use their network of communities of practice to make sense of these policies, creating assemblages as they play with the policy. In this data from an ethnographic study of school policy, four science teachers engage with tensions created as they make sense of school-based policies and optional national standards. Teachers with larger communities of practice engaged in more productive play with policies. We call for expanding teachers' networks of communities of practice and bringing policy makers and administrators into the design of learning events and tools for better implementation.

Keywords: science education, communities of practice, educational policy, taxonomy of learning

Major issues addressed

Educational policies enter schools from multiple layers of the educational system. From national policies like the *Every Student Succeeds Act (*ESSA, 2015), to state level standards, and local instructional policies in districts and even schools, teachers have to determine how best to implement these networks of policies in their classrooms in ways that most benefits their students. However, the messages sent at these different levels of the system are not always aligned, nor are the policies necessarily aligned with the teachers' personal stance on teaching and learning. In this paper, we ask how science teachers' communities of practice influence their interpretation and implementation of local instructional policy and their use of the NGSS Science and Engineering Practices. To address this question, we lay out a brief summary of work in implimentation research, the theoretical and conceptual framing used to look at this problem, as well as the methods of data collection. We conclude with claims regarding the effect of communities of practice on teachers' implementation of policy.

National and local policies in practice

At the national level, science education does not have mandated standards or curricula. However, in 2013, the Next Generation Science Standards (NGSS) were published, having been built through a collective of stakeholders from states using previous publication in science education research and policy. These standards are not currently adopted in all states, but some states have used them to draft their own state standards using the three-dimensional learning model of the NGSS. This three-dimensional model provides Performance Expectations rooted in Disciplinary Core Ideas, Cross Cutting Concepts and the Science and Engineering Practices (hereafter referred to as the Practices), which states use to create their own standards and curriculum aligned with the local contexts. Though national accountability models require state standards in science, there is no obligation to conform to the NGSS or a derivative of it. Therefore, states are free to create their own interpretation of the NGSS or choose another model altogether.

The school district represented in this study is situated in a state that has not currently adopted NGSS aligned standards, and the local district has not chosen to create an NGSS aligned curriculum. Implications for practice include that teachers must make sense of messages they receive from different layers of the education system – national, state, district, and local. Local implementation of state and national policy is often in combination with the implementation of other locale-specific policies that require or promote the use of highly specific pedagogical practices which can be in conflict. Teachers, then, must decide which policies should take precedent in their instructional practice.

Policy sensemaking and communities of practice

In addition to the policies in the educational system, a teacher's communities of practice (Wenger, 1999) also influences instructional practices relating to these policies. Sensemaking is a collective practice; teachers do not come to decisions on their own. Teachers' communities of practice, both within and beyond their individual

school, shape policy implementation. Looking at reading teachers, Coburn (2001) found communities of practice serve as gatekeepers, determining what policies to validate or veto, and eventually come to support the development of shared thinking. For science teachers, sense needs to be made around pedagogical practices. The values and beliefs of the communities of practice teachers engage in will therefore impact the way that they bring both teaching practices and science practices into their classroom.

Teachers involvement in multiple communities of practice can then result in multiple interpretations of a policy in different classrooms within the same school. To help inform this complexity, we take up Koyama and Varenne's (2012) idea of "policy as productive play" where policy implementation is assemblages of discourses, peoples, regulations, rewards and punishments. In this framework, policy implementation is a non-linear, non-consensus process in which there is room for "play" – negotiation, interpretation, and selective appropriation of the tenets of the policy (Koyama & Varenne, 2012, p. 157).

As teachers engage in sensemaking around a policy, local communities provide resources to support sensemaking and implementation of the policy. Cobb and Jackson (2012) developed a taxonomy of learning supports to describe the potential that different types of resources have in supporting implementation of policy in schools and classrooms. There are four parts of the taxonomy: new positions, learning events, new organizational routines, and new tools. In this paper, we focus on the learning events and new tools provided to the science teachers in one school district to support their implementation of the local policy of Problem-Based Learning (PBL) and the Practices found in the NGSS. Learning events happen within formal professional development and communications, as well as teacher's informal talk. Formal, or intentional learning events might look like single day workshops, meetings of Professional Learning Communities, or presentations by colleagues in a department meeting. Incidental learning events might take place in hallway conversations, lunch room discussions, or as part of small group side conversations in other meetings. New tools to engage with the policies might be the texts teachers use with students, technology aids, and written policy messages. The opportunities teachers have to engage with these learning events and tools will influence their play with policy.

Theoretical and conceptual framing

Each community of practice a teacher engages with will influence their implementation of a policy in their classroom practice and may introduce different learning events or new tools. What does and does not get taken up is influenced by multiple boundary interactions teachers have in each community (Wenger, 1999). The interpretation of policy that teachers create will be unique to each of them, based on the assemblage of messages from each of their communities of practice about the policy and its peripheral factors. As part of a larger ethnographic study of middle school culture, this study takes a sociocultural approach to teacher learning, drawing on situated cognition (Lave & Wenger, 1991) and communities of practices (Wenger, 1999) as means of sensemaking (Coburn, 2001). A conceptual framework has been designed to incorporate Cobb and Jackson's (2012) taxonomy of learning supports with policy as productive play (Koyama & Varenne, 2012) to critically examine the ways that four science teachers incorporate two different policies (PBL and the Practices) into their classrooms.

Methodological approach

Using ethnographic methods, data was collected through semi-structured interviews, participant observation, and artifact collection (Spradley, 1979, 1980). Though interviews with multiple disciplines in the school community influenced the study, we focus our findings on four science teachers within two middle schools of Brighton School District. Participating teachers' classroom instruction was observed over the span of 2-5 days on multiple occasions throughout the school year (see Table 1.) In addition to teacher interviews, Wilson's (3) and Aldrin's (2) principal, Aldrin's vice principal (1), and two teacher leaders (1) were interviewed.

Table 1: Teacher data collected

Teacher	School	Subject and Grade	Number of Interviews	Number of Observed Class Periods
Talia	Aldrin	7th grade science	17	26
Kasey	Wilson	8th grade science	10	17
Rory	Wilson	8th grade science	10	8
Maggie	Wilson	7th grade science	11	12

Analysis was conducted using a constant comparative method and open coding (Emerson, Fretz, & Shaw, 2011; Lincoln & Guba, 1985) iteratively to create more cohesive codes. Within axial coding, emergent themes (Maxwell, 2012) were used to find patterns in classroom practice and teacher thinking in terms of how

they were playing with policy in their teaching decisions. The resulting analysis led to a focus on PBL and the Practices, which was examined through further analytic iterations.

Findings

Analysis of this data is still preliminary, but several working claims are backed with evidence from the interviews, observations and artifacts. Brighton School District provided teachers with broad scope professional development opportunities in homogenous settings that minimized teachers productive play with policy as these fail to account for variations on the taxonomies of learning put forth by Cobb and Jackson (2012.) The homogenized approach to broad professional development, lack of administrative knowledge of science, and misaligned communities of practice each contribute to the level of productive policy play in which each teacher engages. Within their productive play with the local policy of PBL and the national level NGSS Practices, the four participating science teachers engaged in play along a continuum for each policy. Maggie, a veteran teacher chose to ignore the policies of PBL and the Practices, incorporating neither. Talia embraced both PBL and the Practices, but struggled to implement both to a level she believed successful. Rory and Kasey each put together a patchwork of instructional practices in their classroom that attempted use of PBL alongside other tools and practices of the district. Rory, midway through the study, began to implement the NGSS, but did not quite get to incorporation of the Practices during the study's scope.

Professional development offered within the district likely contributed to the lack of time for the district's science community of practice to collaboratively play with the policies of PBL and the Practices. Learning events within Brighton School District around PBL represented a broad, homogenized approach. All science teachers were offered formal learning opportunities around PBL by colleagues who hold leadership roles or who had been identified as successfully implementing PBL into their own classrooms; however, these were one-off workshop sessions, often only part of a larger day of activities. Informal learning opportunities happened between teachers within and across disciplines. Rory and Kasey reached out to two colleagues who had been informally identified as successful implementers of PBL, but were not science teachers. There were no observed formal or informal learning opportunities around the NGSS or other science content.

There was some variation between schools in terms of formal learning events, but, no formal learning events focused on science offered within the district professional development schedule. Administrators at Wilson and Aldrin were responsible for setting the schedule of professional development offerings. Neither principal had a science background, had taught science, or had heard of the NGSS. Both schools offered similar percentages of learning events for Writing (18% and 19%) and Technology (31 and 30%.) With their additional professional development time, Wilson provided learning events for Project Based Learning and note taking skills, whereas Aldrin used a large portion (31%) of its learning events for mathematics. Wilson's principal believed in developing "21st Century Skills" so students were able to collaborate, whereas Aldrin's principal was concerned with increasing scores on the state tests coming in the Spring. Without learning events, tools for science learning, administration established roles or organizational routines to discuss science formally, Brighton's science teachers were denied space to engage in social policy play.

Though pedagogical foci of the schools constricted the in-district productive policy play by science communities of practice, involvement with multiple communities of practice appears to increase teachers' level of productive policy play. Talia is highly involved with external communities of practice like national, state and local level science organizations, as well as a long-term project with a local university. She engaged the most fully with PBL, allowing students to drive the instruction throughout most of the year, but voiced concerned with the lack of "doing science" (Jiminez-Aleixandre, Rodriguez and Duschl, 2000). However, Maggie, a veteran science teacher in the school district, identified no external communities of practice, did not attempt implementation of PBL and claimed to use the NGSS as a check-in for her to see if she's "on track." She calls the NGSS "circles instead of squares," a phrase she uses to mean the same thing with a new name. Maggie does not see the NGSS as influencing her teaching. Rory and Kasey each fall on the continuum between Maggie and Talia. They are attempting to use new policies like PBL, and in Rory's case the NGSS, within their classroom.

Conclusions

Teachers' communities of practice, and the members within those communities, influenced how teachers play with policies in this context. Within the district community of practice, teacher learning support was provided from administration as formal learning opportunities and tools, and teachers crafted informal learning opportunities through their communities of practice. However, two other elements of Jackson and Cobb's (2012) taxonomy of leaning supports, new organizational positions and routines were not provided for teachers to engage with the Practices or PBL as a science-specific tool. Administrators need to be cognizant of the elements of the taxonomy of learning that are offered to teachers around policies. Because there was no data to

collect on new organizational positions or routines within this data set, we surmise that these pieces may have further influenced the ways in which teachers play with policy.

Communities of practice can enhance teachers' play with non-district policies. Because the NGSS was relatively unknown to the district and school level administrators, there was no professional development offered to the science teachers in the district. Subsequently, teachers and administrators who did not have external science education communities of practice were less aware of the NGSS and did not explicitly engage with the Practices in their classroom. External communities of practice, like those with which Talia engaged, can provide learning opportunities and tools not available in the district. Experiences with more heterogeneous groups of science teachers expose teachers to a broader perspective on science teaching and learning.

Significance

Findings from this study add to our understanding of how teachers make sense of conflicting policies as part of their negotiation across school and external communities of practice. It also adds to the limited amount of research on science education and policy that involves observations and thick descriptions of practice. Though there are studies using survey data (Anderson, 2012; Aydeniz & Southerland, 2012), there are few studies of teachers' enactment over longer periods of time. Barton (2001) does examine the political nature of education through critical ethnography but focuses specifically on the students' culture. Similarly, Kelly and Chen (1999) use ethnographic methods to examine student discourse, but do not situate the teacher in larger community of practice of the school system. Providing thick description of the practices of science teachers engaged in productive policy play adds to the research base and provides grounding for further intervention studies.

This research informs policy making at all layers of the educational system (national, state, and district), as well as how learning events and tools should be provided to teachers in order to implement policies with success. We provide administrators, professional development facilitators and teacher leaders with information on how policies get interpreted and implemented. This can help to guide teacher learning toward opportunities for teachers to more easily implement policies that are meant to increase student learning.

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