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Secondary Science Teachers' Translation of Professional Development through Affinity- and Institution-identity

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SECONDARY SCIENCE TEACHERS' TRANSLATION OF PROFESSIONAL DEVELOPMENT THROUGH AFFINITY- AND INSTITUTION-IDENTITY¹

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ABSTRACT

This study provides greater detail concerning how science teachers did, or did not, use a professional development model of a scientific classroom discourse community with their students. Two biology teachers, Cathy and David, from the same urban high school were the subjects of two case studies. Identity was used as an analytic lens to consider teachers in the dual contexts of their classroom environment and professional development. Over time, as Cathy adopted the inquiry-based instructional practices she learned at the professional development seminars, her professional identity became more aligned with the norms and affinity group teaching philosophy and instructional practices of the professional development. David seemed to enjoy his interactions with the professional development, but ultimately, as seen in observations of his science lessons, he adapted the professional development strategies to fit his prior, more traditional mode of teaching. Consequently, Cathy moved away from her pre-professional development institution identity that was more aligned with the high-stakes testing culture of her school where skill-and-drill, cookbook activities were valued for rote learning. David's affinity identity remained aligned with his institution identity and the professional development had little effect on his instructional practices.

Introduction and Purpose

The science teacher professional development research literature indicates that the community of teacher educators and in-service professional development providers understand very little about how teachers apply what they learn from professional development to their classrooms (Hewson, 2007). This lack of understanding stems from the challenge and complexity of studying the phenomenon of teachers' beliefs, learning, and stability and change in teaching practices. These variables are in a constant state of fluctuation, which complicates studying the ways teachers: (a) learn from professional development, (b) reflect on their teaching practices, and (c) implement professional development in their classrooms with their students.

While teacher professional development holds the promise of improving students' understanding

¹ This study and manuscript submitted to the 2011 NARST annual conference was derived largely from the text of the author's unpublished dissertation (Lewis, 2009) that is also referenced specifically in the text. A separate manuscript that summarizes the quantitative model (HLM) that was generated in part through the dissertation study is currently under review.

of science, without teacher fidelity to professional development models we cannot expect changes in student achievement.

Teachers are vital actors to bridging academic culture and the language of science, and students' everyday popular culture and personal identities, which are in turn influenced by gender, ethnicity, and socioeconomic status (Hand et al, 2003). This study was conceived to provide greater detail concerning the degree to which and how science teachers² did, or did not, use a professional development (PD) model of a scientific classroom discourse community with their students. One part of the study focused on modeling observations of a sample of science teachers (Lewis, Baker, Holding, Lang, 2010) and another focused on the qualitative perspectives and actions of two of these teachers. In this proposed paper I focus only on the qualitative findings from the case studies.

Curricular Stability and Teacher Change

Teachers, like students, do not exist in a vacuum and their knowledge, professional beliefs, identities, and resultant instructional practices are a reflection of how they orient themselves within the contexts in which they teach and participate in teacher communities. The phenomenon of teacher change or stability, through teachers' agency and affordances, is complex and situated in the larger contexts of schools (institutions) and, in this case, outside professional development settings. Cuban (1976, 1992) described curricular stability and change throughout the 20th century and the forces that affect it. He attributed this to the "socializing functions of schools" (1976, p. 4), national performance tests, educational legislation, and the conservative nature of teaching. Cuban (1992) described external and internal forces that contribute to curricular stability and change, what he described as producing "a broad array of

² Language arts and English as a second language teachers were also participants in the CISIP professional development as part of school-based teams with the science teachers, but their experiences with the professional development were not considered in this study.

incremental, rather than fundamental, changes in the intended curriculum and much less modification in what teachers teach” (p.217). So how does teacher professional development for science education reform fit into a social-cultural, historical system that encourages institutional stability? Does the culture of a school affect a teacher’s agency and does it affect all teachers in the same way? This study looks at two teachers undergoing professional development at their school, but also attempts to provide some broader insights into teacher change.

Teachers are called upon to act as bridges between students’ everyday popular culture and personal identities that are influenced by gender, ethnicity, and socioeconomic status, to name a few. As Gee (2005) asserts, “the fact that people have differential access to different identities and activities, connected to different sorts of status and social goods, is a root source of inequality in society” (p.22). Thus, schools and teachers are critical agents for designing students’ opportunities to learn science in the classroom and science education reform. Recent research on the nature of teachers’ practice and expertise has pointed to the fact that:

we are long past the era of so-called teacher-proof curricula...[that] teachers could be replaced by computers...what teachers do is not a formulaic following of rules, but nuanced, professional practice in which teachers constantly make important decisions and judgments in how they interact with their students to facilitate their learning. (Hewson, 2007, p. 1180)

Hewson (2007) also argued that we must recognize educational reform will not occur if teachers are not involved in efforts toward their professional development and growth. However, designing and implementing professional development experiences for practicing teachers requires proficiency and understanding of numerous factors such as adult learners, science content and pedagogical content knowledge, teacher change, and systemic factors (e.g.,

administrators, school boards). Without appropriate ongoing support and understanding the specific challenges teachers face in engaging with and implementing professional development, many workshops become little more than a pleasant experience for teachers to spend time with other teachers. The Council of Chief State School Officers (2008) reported that the most effective math and science teacher professional development programs have been sustained over longer periods of time.

Teachers' Professional Identities

How identity forms and functions has been studied from psychological, sociological, and anthropological perspectives. In psychology there are two traditions of studying the self and ones' identity from James (1890) and Erikson (1950). James' view focused more on the individual while Erikson's work centered on relationships between the individual and their socio-cultural environment, but both are concerned with the "construction of the psychological self" (Roeser, Peck, & Nasir, 2006, p. 392). Mead's (1934) work focused on the social and cultural conceptualizations of self and identity from the traditions of sociology and anthropology (Roeser, Peck, & Nasir, 2006, p.392). This perspective focuses on the construction of social identity.

Gee (2001) has proposed using identity as an analytical lens for educational research. He outlined four ways to view identities: (a) "Nature-identity, a state of being developed from forces in nature; (b) Institution-identity, a position authorized by authorities within institutions; (c) Discourse-identity, an individual trait recognized in the discourse/dialogue of/with "rational" individuals; and (d) Affinity-identity, experiences shared in the practice of "affinity groups" (p.100). In this study I analyzed how two teachers viewed their professional practice and institutional and affinity identities through their experiences with professional development and

how this related to their classroom instruction. Using affinity and institution identities to analyze the phenomenon of teachers' engagement with professional development and their classroom instruction provides a bridge between the dual contexts of off-site professional development and teachers' classrooms.

Theoretical & Conceptual Framework

I employed two theoretical lenses to build a conceptual research framework. The first lens was Lave and Wenger's (1991) theory of situated learning through the process of legitimate peripheral participation within communities of practice. I also used identity as an analytic lens (Gee, 2001) to place teachers in the dual contexts of their school and classroom environments and PD. This lens can be used to analyze teachers' professional identities and discourse in both the PD and teachers' classroom and school contexts.

Figure 1 illustrates the integration of situated learning theory and identity within the multiple contexts of the PD, schools, and classrooms. As teachers move from the PD setting and community, with emerging affinity identities, to their schools, they use new ideas that can affect their classroom cultures and norms with their students. Teachers' classrooms are set within the larger culture and norms of their schools. Consequently, teachers bring their institutional identities, developed through social interactions at their schools with administrators, academic department chairs, other teachers, students, and parents, to the PD affinity group.

Teacher Professional Development Context

The goal of the National Science Foundation (NSF) funded grant, the *Communication in Science Inquiry Project* (CISIP), was to teach secondary teachers how to build scientific classroom discourse communities (SCDC) with their students in their science and English language arts classes (Baker, Lang, & Ozedemir, 2007). The CISIP model for a SCDC included

the following areas of emphasis: (a) scientific inquiry; (b) oral discourse; (c) written discourse; (d) academic language development; and (e) learning principles (NRC, 2000; NRC, 2005). The CISIP model of an SCDC as developed by the leadership group is shown in Figure 2. Student learning has been placed at the center of the model and is embedded in an inquiry environment that employs talking and writing as a means for scientific communication. Academic language development is an important component of learning science as there are many foreign terms and concepts that have different meanings from students' everyday understanding and use. The learning principles are from the current body of research in cognition. These principles emphasize the critical role of accessing students' prior knowledge, placing factual information within a conceptual framework, and embedding metacognitive opportunities within science topics for students to process their learning. The professional development occurred over the course of a year, beginning with a three-week summer institute. The 2007-2008 academic year was the pilot phase of the program, but numerous previous participants from the CISIP development phase acted as mentor teachers and PD facilitators to the new teacher cohort.

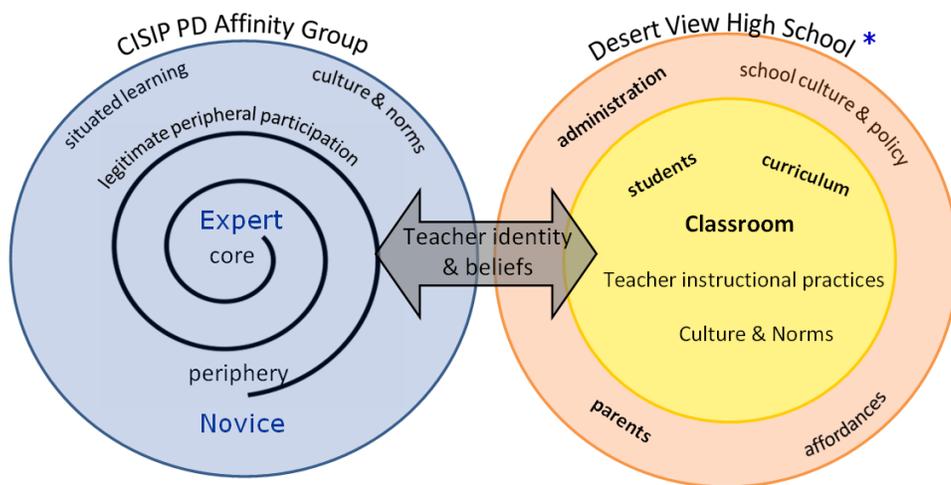
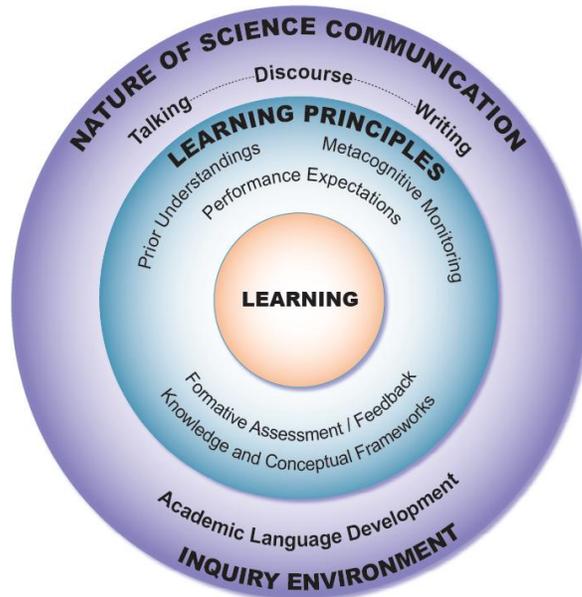


Figure 1. Conceptual research framework of dual contexts of CISIP professional development and teachers' classrooms. * All names are pseudonyms.

A Scientific Classroom Discourse Community



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Figure 2. CISIP model of a scientific classroom discourse community.

Teacher Learning Communities and Affinity Spaces

Cochran-Smith and Lytle (2003) define a teacher learning community as:

social groupings of new and/or experienced educators who come together over time for the purpose of gaining new information, reconsidering previous knowledge and beliefs, and building on their own and others' ideas and experiences in order to work on a specific agenda intended to improve practice and enhance students' learning. (p. 6-7)

All of these activity components were observed informally during the development and pilot phases CISIP workshops during the school year and at the 2007 three-week summer institutes. These teacher learning community elements are more apparent after teachers have spent more time with each other through the professional development events. This indicates that the CISIP

participants can be considered part of a teacher learning community. However, I did not set out to warrant this assertion as part of this study. Gee (2004) cautions researchers not to start with a label such as “a community of practice,” but to use an empirical approach to support such a classification. He suggests that one start with “affinity spaces” rather than groups. Gee argues that while people can be in the same space together they may take away very different meanings from that space (e.g., a professional development Saturday workshop, a science classroom) and the interactions that occur within it. Gee refers to these sites of interaction as “affinity spaces.” The question then becomes, is there a functional community of practice or not? Gee (2004) comments that “even if the people interacting within the space do not constitute a community in any real sense, they still may get value from their interactions with others and share a good deal with them” (p.78). Indeed Lave and Wenger (1991) acknowledged that how they frame legitimate peripheral participation is such that “there may very well be no such thing as an ‘illegitimate peripheral participant’ ...peripheral participation is about being located in the social world; changing locations and perspectives are part of actors’ learning trajectories, developing identities, and forms of membership” (p. 35-36). Consequently, in my observations of the teachers’ participation in, and interaction with, CISIP I paid attention to the way teachers: (a) expressed their understanding of the professional development model, (b) talked about their roles as colleagues in their school-based teams, (c) viewed their roles as teachers of their students, and (d) perceived support and barriers to implementing new teaching practices. These analyses of the data enabled conclusions about the interactions between the teachers and the affinity space of the professional development.

Research Approach and Methods

My research approach was a holistic, interpretivist view toward the phenomena of teacher experiences, views, and use of PD. I used my overall understanding of the PD context, teacher interviews, classroom observations, and teacher self-reports. I borrowed from the tools of grounded theory, e.g., open coding and building assertions from small pieces of data. To generate multiple means for understanding the phenomena, I employed both quantitative and qualitative interpretive approaches. This also allowed me to triangulate the data and build assertions. Generating two case studies allowed me to describe and compare the social and pedagogical actions in specific teachers' classrooms and what these actions meant to the teachers involved (Erickson, 1986).

As the study progressed, I hypothesized that the degree to which teachers used the PD model of a scientific classroom discourse community (i.e., their fidelity to the model) was connected to their professional identities as teachers, beliefs about how students learn, and how science should be taught. The greater the teacher's alignment with the PD model, the more likely she would adopt its instructional practices. By analyzing a teacher's professional identity through both institution and affinity identities I anticipated being able to reveal alignment or gaps between the two identities and between the dual contexts. For example, in the case where a teacher identified more strongly with the PD's philosophy and instructional approaches, and ultimately adopted that affinity identity, she would be more likely to adopt the PD-associated instructional practices. However, if a teacher expressed greater alignment with her school's culture, policies, and procedures that were not in alignment with the PD, her institutional identity, if aligned with the school, could present greater challenges in changing instructional practices. Consequently, I generated the following overarching research questions for this study:

1. How much, if any, of the PD do the case study teachers use in their teaching practice?
2. What factors supported and impeded teachers' implementation of the PD?
3. How are teachers' institution and affinity identities expressed through their beliefs about teaching and learning?

Data Sources and Methods of Analysis

In my larger study (Lewis, 2009) of science teachers' use of on-going professional development there were three levels of participation. The first sample level (Level 1, $n = 25$) consisted of the entire group of middle ($n = 11$) and high school ($n = 14$) science teachers who participated in CISIP. These teachers completed surveys on how often they used and would like to use specific CISIP strategies and on supports and barriers to implementing the PD. The second level (Level 2, $n = 15$) consisted of middle and high school science teachers who consented to regular classroom observations. The teachers' classroom activities were interpreted quantitatively using a classroom observation instrument, the *Discourse in Inquiry Science Classrooms* (DiISC), which was developed over three years and aligned to the CISIP PD. The DiISC scores were used to build 1- and 2-year exploratory longitudinal models using hierarchical linear modeling to determine what, if any, significant relationship existed between various teacher and systemic factors and teachers' degree of PD implementation (Lewis, 2009; Lewis, Baker, Holding & Lang, 2010). The details of this model have been presented at previous conferences and in the interest of space are omitted here, but we found that the rate of change in teachers' use of instructional strategies was only significantly affected by the length of time that they had spent in the PD; however the initial level of PD use was determined by the socioeconomic status (SES) of the school at which the teachers taught. This finding is also mirrored in the two case studies presented here.

I interviewed a subgroup of teachers (Level 2) about their PD experiences and their views of teaching and learning. From this group I generated additional classroom observations of two high school biology teachers from the same school, who became the case study teachers (Level 3). The choice of the two teachers, as nested case studies, was to purposefully connect the PD with the teachers' classroom activities. I selected the teachers based on divergent instructional practices despite their contextual and demographic similarities.

The variety of data sources, observations, interviews, and surveys, allowed me to triangulate within and across these sources with methods of constant comparison. My analysis involved detailed descriptive statistics of the survey results and quantitative observation measures. I used open coding with the transcripts of the two case study teacher interviews, generating over 200 individual codes and 16 code families to form themes relating to the teachers' PD experiences and beliefs about teaching and learning. The interpretative framework and associated methods allowed me to establish validity of my findings.

Results

School and Teacher Context

Cathy and David taught biology at the same urban high school in a large metropolitan areas of the American southwest with a high percentage of majority-minority (86% Latino/a) and socioeconomically disadvantaged students (59 % qualified for free or reduced lunch). They were both of middle-age, Western European descent, and had come to teaching later in their professional lives as a second career.

I had been in Cathy and David's school numerous times when the daily announcements were made over the intercom. During one observation, when I was in Cathy's classroom, the daily announcements came on and gave instructions to the students who were soon to take the

state-mandated assessments. The tone of the assistant principal demanded the students comply with the testing protocol. Testing was a major concern for Desert View High School. They received an “underperforming” state rating in the 2002-2003 academic year, “performing” in 2003-2004, “performing plus” in 2004-2007, and went back down to “performing” in the 2007-2008 academic year (Arizona Department of Education, 2008).

The 2007-2008 10th grade students had a 53% passing rate on the math portion of the state tests as compared to the 67% state-wide passing rate, a 57% passing rate in reading (state = 73%), and a 56% passing rate in writing (state = 68%) (Source: school district website). The school also had Saturday classes, during the school year before the state test, for students who had failed their state competency tests; they do this in order to meet the state’s annual improvement goals for the district.

My sense was that the larger school community was different from Cathy’s classes now that she had participated in the professional development while the culture of David’s classroom continued to be one of compliance, to skill-and-drill teaching strategies aimed at the lowest performing students in the hope that they will pass the state test. This assertion will be warranted as I present the data from the classroom observations.

Case Study Teachers’ Use of Professional Development

In response to the first research question, *How much, if any, of the PD do the case study teachers use in their teaching practice?* I assembled the data from classroom observations I made of Cathy and David’s science lessons. Cathy and David shared neighboring classrooms and conferred with each other on a daily basis. They were both active and positive participants at the CISIP workshops. However, upon observing them teach, it was apparent that David ($M = 19.22$, $SD = 9.90$) was not using the CISIP model to same degree that Cathy ($M = 32.54$, $SD =$

9.46) was enacting the instructional strategies, as measured by the observation instrument (Table 1 and Figure 3).

Table 1

Summary of Cathy and David's Raw Mean DiISC Classroom Observation Scores.

DiISC Scale	Cathy (n = 13)		David (n = 9)	
	Mean	SD	Mean	SD
Scientific Inquiry	0.56	1.00	0.24	0.51
Oral Discourse	1.28	1.01	0.67	0.74
Written Discourse	0.82	1.02	0.72	0.76
Academic Language Development	1.05	1.04	0.65	0.77
Learning Principles	0.86	0.88	0.44	0.64
Total DiISC score	32.54	9.46	19.22	9.90

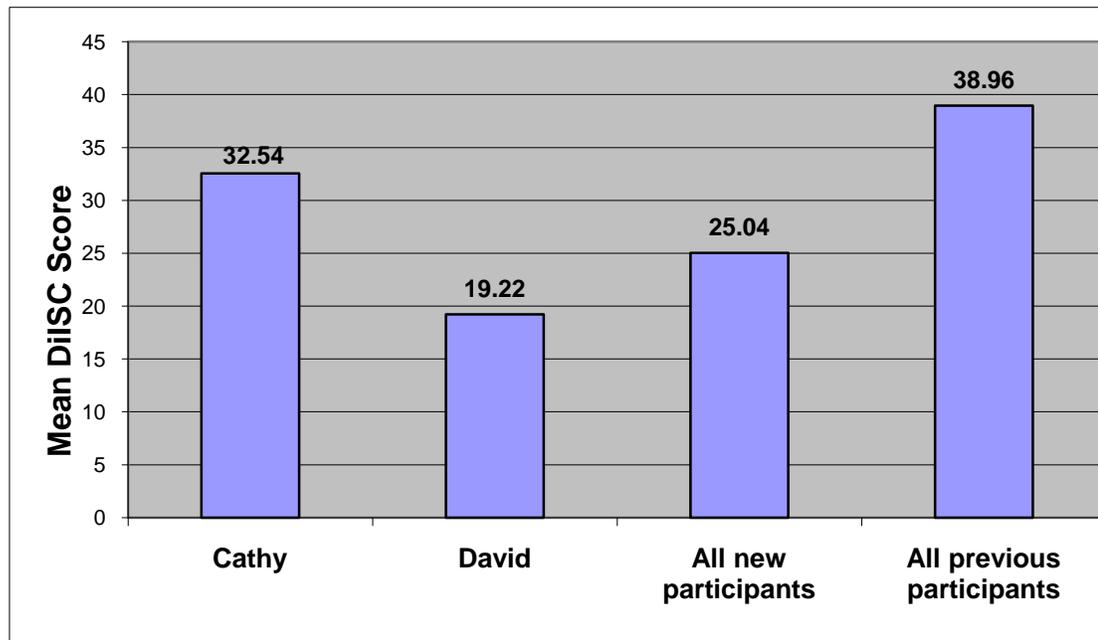


Figure 3. Cathy and David's average use of PD as compared to all new teacher participants and all previous participants.

Factors that Supported Teachers' Implementation of Professional Development

The second research question, *What factors supported and impeded teachers' implementation of the PD?* revealed that the case study teachers' beliefs about students' academic abilities either encouraged and discouraged teachers to change their teaching practices

to be more aligned with the CISIP professional development. Teachers' survey responses provided insight into their perspectives and beliefs about teaching and learning.

Teacher Surveys

With the *CISIP Beliefs* survey I compared the difference between teachers current and desired instructional practices associated with the SCDC model. Overall, the science teachers expressed a desire to increase the frequency of how often students' had opportunities to engage in behaviors that contributed to building a SCDC. In her pre-PD survey, Cathy's overall desired change from her current teaching practices (pre-PD difference = 43) was calculated to be more than twice that of David's self-assessment (pre-PD difference = 21). This indicated that she desired, was more open to, or perceived greater agency for, change more than that of her colleague (Table 2).

Measure	Cathy		David	
Pre-PD Current	42	Difference: 84 - 42 =	55	Difference: 76 - 55 =
Pre-PD Desired	84	43	76	21
Post-PD Current	54	Difference: 81 - 54 =	49	Difference: 80 - 49 =
Post-PD Desired	81	27	80	31

Table 2.
Comparison of Cathy and David's Pre- and Post-PD Self-assessment of their Current and Desired use of PD.

The *CISIP Sources of Support and Barriers to Implementation* survey provided insights into teachers' views of six categories of sources of support and barriers to using the PD:

administrative actions, collaborative relationships, curriculum, instruction, students, and parents. Teachers rated each item as a minor or major support or barrier or as neutral to implementing the PD. Overall, many more items fell into the category of supports than barriers to implementing PD. However, all four items that high school science teachers identified as barriers were in the categories of students and parents. Similarly, middle school science teachers identified five of eight barrier items (63%) in the categories of parents and students, while the other three items concerned standardized testing, class size, and teacher team meeting and planning time. As can be seen in Table 4 and 5, Cathy and David differed in their views of barriers and supports to implementing the PD mainly in that Cathy viewed students more as a support than a barrier than did David.

David identified his students' parents' ability to help them with their written homework as a major barrier to his implementation of the PD strategies while Cathy view this as neither a barrier nor a support. Both teachers reported that their students' attitude toward the CISIP strategies was a support to their implementation of the PD. Cathy reported that three areas of students' attributes were a minor or major support to implementing the PD: their attendance, their ability to use metacognitive prompts, and their focus on academic oral discourse in small groups. David, however, indicated that the later two of these student areas were minor barriers to implementing the PD strategies while his students' attendance was neither a support nor a barrier. Overall, Cathy reported a greater percentage of major supports and fewer major and minor barriers to implementing the PD than did David (Figures 4 and 5).

Parents. There were only two items in the category of parents. Both Cathy and David viewed parents' attitudes toward the CISIP curriculum as neither a support nor a barrier to implementing CISIP. This was likely due to how infrequently they interacted with parents. Cathy commented

on how busy parents were in this working class, mostly Latino community, often working multiple jobs to make ends meet. Cathy taught mostly honors biology with two classes of regular biology. Consequently, she had fewer concerns that her students would not be able to do their biology homework without help. David had many special needs students and some English language learners in his classes. He mainly relied on class time for students to do their work and in a few classes he co-taught with a special education teacher.

Table 4
Percent of Barriers and Supports Survey Items by Case Study Teacher and Survey Category.

Percent of survey items per category							
Cathy	Admin. (4 items)	Collab. (9 items)	Curr. (5 items)	Instruct. (17 items)	Parents (2 items)	Students (8 items)	Total (45 items)
Major support	25.00	22.22	40.00	52.94	0.00	25.00	35.56
Minor support	25.00	22.22	0.00	17.65	0.00	25.00	17.78
Neither	25.00	11.11	20.00	17.65	100.00	25.00	22.22
Minor barrier	25.00	22.22	20.00	11.76	0.00	25.00	17.78
Major barrier	0.00	22.22	20.00	0.00	0.00	0.00	6.67
David							
Major support	25.00	55.56	0.00	11.76	0.00	0.00	17.78
Minor support	25.00	33.33	0.00	52.94	0.00	12.50	31.11
Neither	50.00	0.00	60.00	11.76	50.00	25.00	22.22
Minor barrier	0.00	11.11	40.00	23.53	0.00	62.50	26.67
Major barrier	0.00	0.00	0.00	0.00	50.00	0.00	2.22

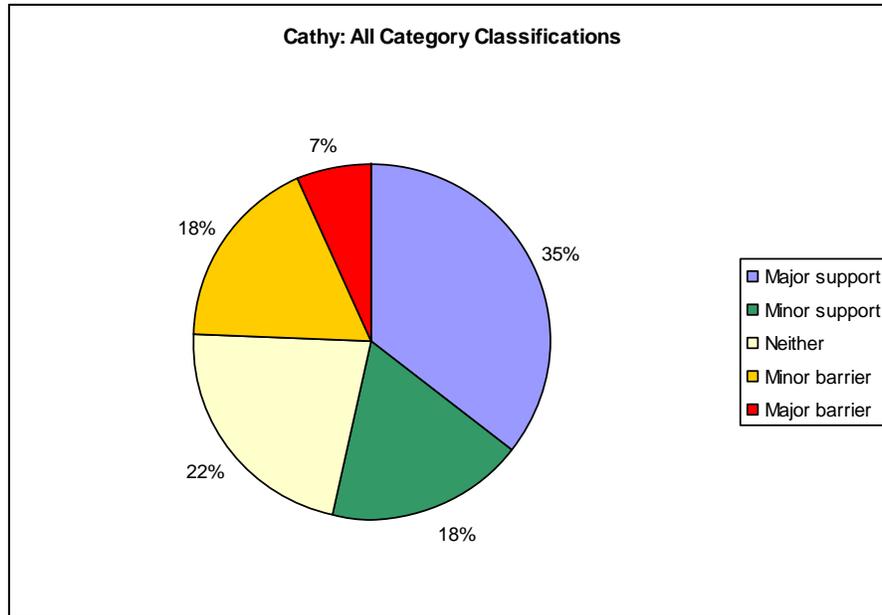


Figure 4. Graph of Cathy's survey items in all categories of minor and major barriers and support to implementing professional development.

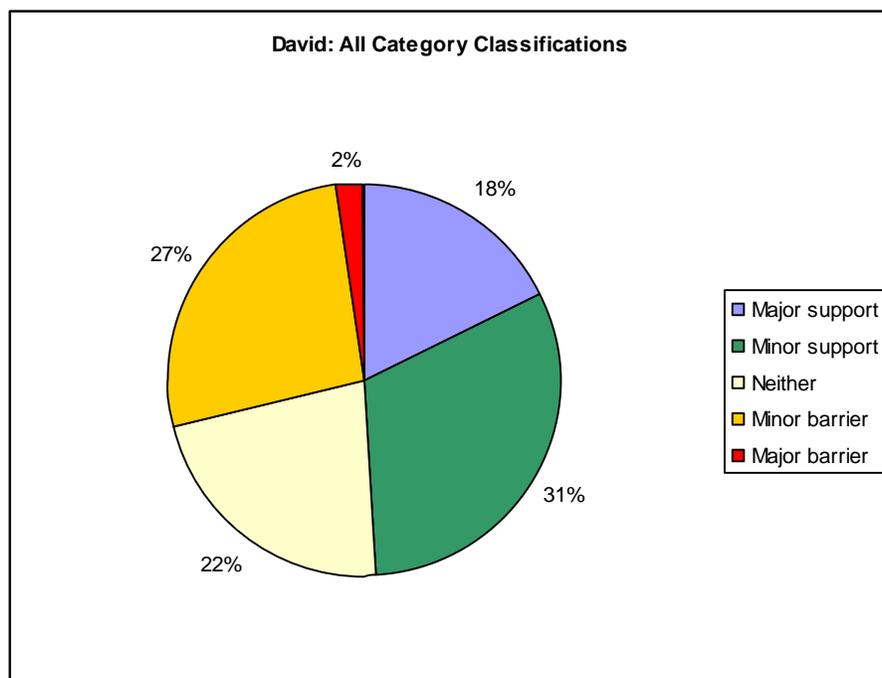


Figure 5. Graph of David's survey items in all categories of minor and major barriers and supports to implementing professional development.

Survey Item	Cathy	David	Cathy-David
Parents' ability to help my students with writing /discourse at home.	3	1	+2
My students' diverse language skills.	3	2	+1
My students' grade level background knowledge.	3	2	+1
My students' attendance.	5	3	+2
My students' ability to use metacognitive strategies.	4	2	+2
My students' attitudes towards the CISIP curriculum.	5	4	+1
My students' focus on academic oral discourse in small groups.	4	2	+2

Table 5. Cathy and David's barriers and supports survey responses in parent and student categories.

Students. This was one of the categories in which David and Cathy differed the most on in the entire survey. Overall, Cathy rated the student items higher than David. Cathy only viewed two (25%) of the student items as minor barriers whereas David rated five (62%) as minor barriers to implementing the CISIP professional development. The one item, #44 “My students’ writing and discussion skills,” that they did agree on as a minor barrier, was a barrier that Cathy seemed more willing to tackle throughout the school year than David did as she presented students with many more opportunities to practice these skills. Cathy viewed half of the student items, four (#41, 42, 43, and 45; 50%) as either minor or major supports while David only identified one of item (#43; 13%), “My students’ attitudes toward the CISIP curriculum,” as a minor support. Both teachers commented on how much the students liked using their notebooks and how they kept their work organized better than before. Cathy’s other three student areas of support included her: (a) students’ attendance (major), (b) students’ ability to use metacognitive strategies (minor), and (c) students’ focus on academic oral discourse in small groups (minor).

David scored all three of these items two points lower than Cathy and they were the items that they differed on most in the student category. While he viewed his students' attendance as neither a barrier nor a support, David viewed his students' ability to use metacognition and academically focused oral discourse in small groups as a minor barrier to implementing CISIP instructional strategies. This was consistent with my observations of his teaching, as he rarely allowed student to work together, for fear of them "goofing around," and as mentioned before, his low expectations of their writing ability.

Student Perceptions of Case Study Teachers' Classrooms

In the spring of 2008 Cathy and David's students were asked to respond to a survey that was developed by the co-principle investigator of the CISIP grant. The survey had 17 items on it and asked the students to rate each item based on the following scale: 1 = the statement *does not describe* what happens in this classroom, 2 = the statement describes what *sometimes happens* in this classroom, 3 = the statement describes what *often happens* in this classroom, 4 = the statement describes what *always happens* in this classroom. The survey was associated with a pre- and post-unit content test as part of another piece of the larger CISIP research efforts. I disaggregated this portion of the data to provide a students' perspective on the two case studies.

Cathy recruited 91 of her students from her six biology classes to participate in the pre-post test and survey; David only turned in eight students' surveys from his six biology classes. David commented that these were some of his better students and all, except for one student, were female. It could not have been considered a random sample that could have been representative of students' in his classes. Because of the tenfold difference in the two sample sizes, I did not use any statistical tests to see if the differences were statistically significant. However, I do present the descriptive statistics indicated that overall Cathy's students rated her

class higher ($M = 61.33$, $SD = 3.71$) than David's ($M = 55.0$, $SD 7.80$) for being a scientific classroom discourse community (Table 6).

About half of the items showed little difference (defined as less than .40) between the two teachers. Students scored both teachers low, in the "sometimes happens" range (Cathy $M = 1.99$; David $M = 1.86$) for the first item, "We design our own scientific investigations," and this matched what I found in my analysis of the DiISC scores from classroom observations. Cathy and David used mainly guided inquiry activities that had set procedures for students to follow. This item went hand-in-hand with the third item, "We ask our own scientific questions," which scored a bit higher, as something that "happens often" in their classes. Students may have taken this question to mean, do they ask questions in class, as opposed to the item on the DiISC for students generating their own questions for investigations. Consequently, I was somewhat skeptical of this higher score as I would have anticipated a lower mean from my observations.

Learning new vocabulary (Item #5) was comparable across both teachers' classrooms at the "always happens" level. This was not surprising as vocabulary dominated David's science lessons and Cathy used a lot of scientific words with her students. Both teachers also received one of their highest scores on the survey item (#6) that asked students about notebook use. Cathy and David's students reported that they always used their notebooks to record their data. This matched up with my observations of science activities. Even if students were using worksheets, these ended up in the notebooks as David and Cathy had their students put everything in them. Cathy and David's students said that they often write scientific arguments using their data (Item #9) (a .37 difference, Cathy's students indicate a higher frequency). They also reported that their teachers often give them opportunities to learn how to write (#11). Both groups of students reported that they always knew how their teacher expects them to behave as a classroom

community (#12). Both teachers had made an effort to foster a sense of belonging in their classrooms.

Table 6.
Cathy and David's Students' Responses to "My Classroom Survey."

Survey Statement	Cathy <i>n</i> = 91		David <i>n</i> = 8		Mean Diff
	Mean	SD	Mean	SD	
1. We design our own scientific investigations.	1.99	0.97	1.86	0.90	0.13
2. We all participate in class activities.	3.90	0.30	3.38	0.74	0.53
3. We ask our own scientific questions.	3.08	0.81	3.00	0.93	0.08
4. We discuss our data after scientific investigations in small groups.	3.80	0.40	2.75	1.28	1.05
5. We learn new scientific vocabulary.	3.78	0.42	4.00	0.00	-0.22
6. We use science notebooks to record our data.	3.99	0.10	4.00	0.00	-0.01
7. We reflect on our own learning.	3.68	0.49	3.25	0.71	0.43
8. We get feedback from the teacher about our learning.	3.74	0.44	3.25	0.71	0.49
9. We write scientific arguments using our data.	3.37	0.68	3.00	1.07	0.37
10. We discuss our data as a whole class after scientific investigations.	3.73	0.52	3.13	0.64	0.60
11. We learn how to write.	3.59	0.58	3.25	0.89	0.34
12. We know how the teacher expects us to behave as a classroom community.	3.96	0.21	3.63	0.52	0.33
13. We revise what we write.	3.63	0.55	2.88	1.13	0.75
14. We have pictures and diagrams that help us learn.	3.52	0.60	3.63	0.52	-0.11
15. We know what the teacher expects us to learn.	3.82	0.38	3.50	0.76	0.32
16. We are a discourse community.	3.88	0.33	3.25	0.71	0.63
17. We use science notebooks to record our thoughts.	3.96	0.21	3.50	1.07	0.46
Total:	61.33	3.71	55.00	7.80	6.33

Note. The mean differences were not compared statistically due to greatly unequal sample sizes. Positive differences indicate that Cathy's mean score was higher than David's and negative mean differences indicate that David's score was higher than Cathy's item mean.

David and Cathy's students reported that they very often had pictures and diagrams to help them learn (#14). They also said that they nearly always knew what the teacher expects them to learn (#15). David's DiISC scores reflected my interpretation that his directions were always clear, but sometimes he did not communicate the objective of the lesson as clearly as he

might have. Consequently, I sometimes thought that students were doing activities for the sake of doing activities rather than to achieve a particular learning outcome.

Eight items showed greater mean differences (more than .40); these were items 2, 4, 7, 8, 10, 13, 16, and 17. The greatest mean difference (1.05) on the survey items between Cathy and David's classes as reported by their students was on item #4, "We discuss our data after scientific investigations in small groups." As I discuss in the sections on the classroom observations of Cathy and David, Cathy frequently put her students in small groups while David was less likely to do so. There was less of a difference (.60) between the two teachers on a related item (#10), "We discuss our data as a whole class after scientific investigations," but Cathy's rating was higher and I confirmed that she regularly engaged her students in these types of discussions. The next largest mean difference (.75) was on item #13, "We revise what we write." Cathy's students appeared to revise their writing more frequently than David's did. These items were particularly important in the CISIP model of a discourse community. Item #16 asked students to rate the frequency that they would consider themselves to be a discourse community. Cathy's students rated their classroom .60 higher than David's students with a mean of 3.88.

Increased student participation was an overall goal for CISIP teachers. The second item, "We all participate in class activities" yielded a .53 difference between Cathy and David's students' perceptions of their participation in biology class. Through my numerous visits to both teachers' classes I verified that this was indeed the case. According to her students, Cathy almost always provided feedback to them about their learning (#8), whereas David often provided feedback (a .49 mean difference). Cathy's students said that they always used their science notebooks to record their thoughts (#17). David's students said that they used their notebooks to do this very often (a .46 difference). Upon inspection of the two teachers' notebooks I saw the

difference in that Cathy gave them more opportunities to reflect upon what they have learned and this comes out in the student survey as well. Cathy's students said that they almost always reflect on their own learning (#7) whereas David's students said that they often engage in reflection (a .43 difference).

Case Study Teachers' Professional Identities

In response to the third research question, *How are teachers' institution and affinity identities expressed through their beliefs about teaching and learning?* I compared multiple sources of information about the professional development characteristics, school culture, classroom observations, teacher perspectives from interviews and their survey data. By comparing the information I generated with Cathy and David I determined that Cathy demonstrated greater alignment with the PD than David did. While both teachers could explain what new instructional strategies and modes they had learned at the PD, Cathy demonstrated that she was using much more of the CISIP model than David did and that her beliefs about teaching and learning were more aligned with the PD. David's discourse indicated that he was only able to accommodate the professional development into his teaching practice in ways that did not disrupt his institutional obligations and thus he demonstrated a stronger alignment with his school culture in his institutional identity than his affinity identity did with the PD. David's affinity identity was not as strongly aligned with the CISIP professional development and therefore his position in the affinity group was more peripheral than Cathy's as her discourse allowed her to be recognized as a teacher undergoing change in her teaching practices. In the framework of Lave and Wenger's legitimate peripheral participation, over time and experience with the professional development Cathy shifted her initial position as a new teacher in the affinity group toward a role in which she could mentor other new teacher members and speak

with more authority and conviction of her experiences of trying new ways to teach science. In the following sections I describe evidence to support my interpretation of Cathy and David's teaching perspectives and actions through the lens of identity.

Greater Alignment with Affinity Group: Stronger PD-Aligned Affinity Identity

Cathy reported that CISIP was a vehicle for becoming “a better teacher for her students.” For example, Cathy commented that before the PD she had never had students do an inquiry-based research project or give presentations in class. Over time, Cathy's professional identity became more aligned with the norms and affinity group teaching philosophy and instructional practices of CISIP than the high-stakes testing pressure-infused culture of her school where skill-and-drill, cookbook activities were valued for rote learning. However, after a year of PD there were still aspects of Cathy's former teaching that indicated her teaching practices were in a transition phase; she still used directed lab activities, but she repackaged them with instructional strategies such as metacognition and writing-to-learn prompts. Cathy also distinguished between college prep and honors biology students and limited the degree of the PD ideas she used with her non-honors students, but still adopted more of the PD than David did, even with these students. Cathy's professional identity reflected aspects of both her institution identity, including the culture and expectations of her school (e.g., ensuring that students performed well on state tests), and her affinity identity as a teacher who embraced and regularly used CISIP. This use of the PD was confirmed by her students, who viewed their classroom as a place where they often or frequently had opportunities to be part of a scientific classroom discourse community.

Greater Alignment with Institution: Stronger Non-PD Aligned Institution Identity

From the formal interview and informal conversations I had with him, David seemed to enjoy his interactions with CISIP as part of a team from his school, but ultimately, as seen in

observations of his science lessons, he adapted the PD to fit his usual mode of teaching. This suggested that his institutional identity limited his emerging PD affinity identity. His responses on the surveys triangulated with this finding. While he could speak knowledgeably about CISIP ideas, David's perception of student capabilities as barriers and his school's institutional tracking dominated his institutional identity. In his biology classes David taught many students with identified special needs, a characteristic that he viewed as a barrier to implementing inquiry-based elements of the PD. These students were more likely to fail compulsory state exams and there was administrative pressure that constrained the curriculum. Without perceiving the freedom to change, David maintained his pre-PD institutional identity over adopting a more CISIP-aligned affinity identity. Despite his interest in CISIP, David only accommodated those instructional strategies that he could fit into his overarching paradigm of training students to follow directions and learn vocabulary words so that they could pass district and state tests.

Conclusions and Implications

The science teacher professional development and science education community needs a deeper understanding, and can benefit from these understandings, of how teachers develop instructional knowledge and translate PD to their classrooms with their students.

School Culture and Professional Development

The more a school's culture and instructional paradigm differ from a PD model, presumably the greater the challenge is for teachers to make the leap between a traditional school model and PD practices. External factors, e.g., school culture and climate, can unwittingly block a teacher from implementing PD. Internal factors, such as teachers' beliefs about student learning, as well as their professional identities, have the potential for being either a barrier or a support to implementing PD.

Teacher Perceptions and Expectations of Student Learning

Teachers who had high expectations for student learning were more open to using the CISIP model of a scientific classroom discourse community. Teachers who differentiated between students (e.g., honors and non-honors) used more of the professional development with the students they perceived as being more capable of CISIP inquiry-based strategies. Ultimately, through the professional development, teachers must view their students as capable of learning in the CISIP model or they will not use the professional development strategies as intended. Both David and Cathy viewed their lower-tracked students as less capable of “doing CISIP” and consequently avoided nonprocedural elements of inquiry with those students. Conversely, Cathy ventured into a project with her honors biology students that required them to generate and justify their own questions, explore information about genetics, and finally make class presentations containing various points of viewpoints. This type of activity demonstrated Cathy’s ability to construct a scientific classroom discourse community with her students after years of relying on more traditional instructional practices. However, she still restricted her inquiry-based teaching practices with those students she perceived as less able and motivated.

Future Research Questions

Science teacher professional development providers can benefit from broader conceptions of teaching and learning in science, e.g., constructing scientific classroom discourse communities as opposed to a science content-only approach. Also, as a phenomenon, it benefits from a better understanding how teachers develop new instructional knowledge and translate professional development in their classrooms. External factors, e.g., school culture and climate, can unwittingly block a teacher from implementing professional development. In particular, the pressures on teachers of low-performing students and state mandated testing can hobble a

teacher's efforts to enact inquiry-based science curriculum and instruction. Internal factors, such as teachers' beliefs about student learning, have the potential for being as much barrier as support to implementing a professional development model.

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