Professional Identity Development Applied to Science Teacher Preparation: A Model

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Abstract

Becoming a reform-minded science teacher requires the development of a professional identity which does not reflect the common norm in the profession. Using concepts and findings from the literature on identity development, two basic design principles for science teacher preparation are identified: (a) the need for safe places and scaffolded ways for beginning science teachers to try on and develop their identities as reform-minded science teachers, and (b) the need for multiple opportunities to be recognized, by self and others, as reform-minded teachers. As an illustration of how these insights can be put into practice, the paper reports on the design of an innovative science teacher preparation program (Get Real! Science) that the author has developed based on these principles.

Introduction

There is considerable consensus in the field of science education that inquiry represents the capstone of quality science teaching (AAAS, 1993, Bybee, 1997; Goodrum, 1987; Krajcik et al., 1998; Matthews, 1994; NRC, 1996, 2000; Tobin, Treagust, & Frasier, 1988). Despite this growing consensus about the teaching practices we would like to see in science classrooms, it is still difficult to find science teachers who are committed to and engage in these reform-based practices (Anderson, 2002; Tobin, Tippins & Gallard, 1994; Wells, 1995). Given that reform-based teaching is not yet the norm in existing science classrooms, we are attempting to prepare beginning science teachers to go "against the grain" (Cochran-Smith, 1991), to be agents of change in addition to learning new teaching practices. It is not surprising, then, that we are struggling to design effective ways to prepare beginning science teachers (Windschitl, 2002).

The main goal of this paper is to address this challenge by using identity development as a theoretical lens. Becoming a reform-minded science teacher involves developing a new professional identity as a "reform-minded science teacher" (as opposed to other kinds of science teachers), with all the challenges and risks that such a process entails, especially when the identity sought goes against the current norm. Using what is known from research on identity development, two design principles intended to create more effective science teacher preparation programs are derived and discussed. To further the power of these design principles and of using identity development as a new lens in teacher preparation more generally, a concrete example is offered - the Get Real! Science program – an innovative science teacher preparation program, currently in its

fourth year of implementation, that was designed based on the insights gained from this analysis.

Unique Challenges of Preparing Reform-Minded Science Teachers

Though we have learned much about essential elements of successful teacher preparation (e.g. Borko & Putnam, 1996; Cochran-Smith & Zeichner (Eds.), 2005; Darling-Hammond, 1999; Darling-Hammond & Bransford (Eds.), 2005; Kagan, 1992; Richardson & Roosevelt, 2004), science teacher educators who want to prepare new teachers to be able to teach through inquiry and implement recommendations such as those articulated in the National Science Education Standards (NRC, 1996), continue to struggle with these core challenges:

1. *Most prospective science teachers have not personally experienced reform-based science education and thus lack the buy-in as well as confidence in this new approach.* Often beginning science teachers have experiences, beliefs, knowledge and identities related to science and science learning that are very different from, even contradictory to, those being advocated for in reform. (e.g. Marx, Freeman, Krajcik & Blumenfeld, 1998: Munby and Russell, 1998). While describing the wide range of complex and involved teaching practices essential to reform-based science teaching, Windschitl (2006) emphasizes the fact that this type of learning is often a foreign concept to many beginning science teachers.

2. As most science classrooms do not reflect reform-based practices, student teaching in traditional school settings is too limited. Many beginning teachers are reported to identify their "student teaching" experiences as the most valuable and influential component of their teacher preparation program (e.g., Northfield, 1996). Yet

the opportunities to engage in reform-based science teaching in these experiences is often very limited, especially when the culture of the student teaching placement is less than welcoming, supportive and therefore safe for the trying out of new ideas (Borko and Putnam, 1996). Sykes and Bird (1992) highlight this unique problem of apprenticing in a reform-based discourse that is not reflected in most classrooms:

> …the situated cognition perspective draws on the image of apprenticeship in a guild or a professional community as a powerful form of learning. But this image requires a stable, satisfactory practice that the novice can join. If the aim of teacher education is a reformed practice that is not readily available, and if there is no reinforcing culture to support such practice, then the basic imagery of apprenticeship seems to break down. Teachers' knowledge is situated, but this truism creates a puzzle for reform. Through what activities and situations do teachers learn new practices that may not be routinely reinforced in the work setting?" (p.501).

3. Most prospective teachers perceive the learning of educational theory as essentially disconnected from practicing teaching experiences. Many current models of teacher preparation are composed of a collection of component parts leaving theory disconnected from practice (Goodlad, 1990) as courses and student teaching experiences usually occur in isolation. This model results in little connection or coordination between the two key ingredients to developing in the profession of teaching: the learning of educational theory and the art of teaching practice (Goodlad, 1990; Northfield, 1996). Though reflection has been shown to be a powerful aspect of teacher learning (e.g. Davis, 2006), teacher preparation programs do not yet fully capitalize on this. Given the tough challenges of reform-based science teaching, it is clear we need a system that effectively integrates the development of *understanding* of reform-based practices with opportunities to develop the *skills* in realistic circumstances.

Contributions of Identity Theory as a Lens to Science Teacher Preparation

Identity has been defined by many scholars in a number of diverse ways including as a set of reified, endorsable stories (Sfard & Prusak, 2005), a sense of self (Helms, 1998), long-term, lived relations within a community of practice (Lave & Wenger, 1991), and recognition by self or others as a certain 'kind of person' (Gee, 2005). Professional identity, especially in teacher learning and development, has emerged as a subfield of identity theory (e.g. Beijjard, Meijer & Verloop, 2004; Grossman & Stodolsky, 1994; Little, 1993; Siskin, 1994; Siskin & Little, 1995). Borrowing from and building on Gee's (2001) definition of identity, I define "teacher professional identity" as being recognized by self or others as a certain kind of teacher. More than what a teacher knows and believes about her practice, professional identity includes her professional beliefs, passions, commitments, ways of acting and interacting, values, and morals.

Grounded primarily in Gee's (2003) work on identity development in a new domain, an identity development framework broadens our understanding of teacher learning and offers the field of science teacher preparation insight that can help address the fundamental challenges of preparing reform-minded science teachers identifies in the previous section (Luehmann, in press). The following principles were derived from a careful consideration of science teacher education using this lens:

1. People approach learning situations with core identities in place that need to align with the new identity being considered.
2. Trying on a new identity within a community of practice (especially an identity that goes against the norm) involves assuming risks and will require support; a number of strategies to do so have been proposed in the literature on identity. For

example, Gee (2003) describes three essential components of identity "repair work." Applied to the domain of beginning science teacher learning, these steps are (1) a teacher learner must be *enticed to try* reform-based practices; (2) a teacher learner must be *motivated to put a lot of effort* into reform-based pedagogical practices; and (3) a teacher learner must achieve and experience some degree of *meaningful success* with reform-based pedagogical practices (pp.61-62) [emphases added].

3. Learning as professional identity development occurs while participating in the discourse. All forms of participation and engagement are not equal with respect to learning potential; some learning experiences afford more identity resources (such as access to feedback and opportunities to assume central roles) than others. For example, Nasir's (2004) study comparing the mathematical learning of high school boys in basketball versus in the mathematics classroom revealed a number of identity development resources that were available in the former but not the latter: many ways to display competence, a high level of agency, ways to solicit feedback, opportunity to be held accountable, and central positioning as the author and lead "actor" in the stories.
4. Though participation is essential for learning, learning as identity work occurs in the interpretation, narration and thus recognition of that participation (by self and others).

First of all, the first three principles derived from identity theory help us recognize that beginning science teachers often have core identities that are not aligned with reform-based pedagogy; supporting the shift or transformation to this new identity is a

delicate process that requires developmental support. The initiation process of trying out one's "wings" as a reform-based science teacher is a daunting and risky process that should be supported by offering motivating and safe places. Also, learning as identity development best occurs when one has multiple opportunities to display competence, receive feedback, exercise agency, and assume a central role in practice. Some of these opportunities might be found more easily in out-of-school settings – such as summer camps or after-school clubs – than in traditional science classrooms. This suggests the importance of *providing preservice teachers with the opportunity to participate in a carefully scaffolded sequence of reform-based science learning experiences, both as learners and as teachers, first in non-traditional and then in more traditional classroom settings* – the first design principle I am proposing.

Second, identity theory suggests that learning as identity development requires the understanding, interpretation and recognition, by self and others, as a certain kind of science teacher. Beginning science teachers also need opportunities as well as support for engaging in this "recognition work." This, in turn, suggests a second design principle for science education programs, consisting of *providing on-going opportunities for interpretation and recognition of that participation through multiple forms of structured reflection.*

In the remainder of the paper I will show how these design principles can be operationalized by reporting on a specific science teacher preparation program informed by these principles.

The Get Real! Science Program: A Model in Practice

The Get Real! Science program is a program I designed four years ago to prepare reform-minded science teachers for urban settings by using the two principles derived at the end of the previous section – that is, (1) providing participants with safe spaces to try on their emerging identities as reform-based science teachers through a carefully scaffolded sequence of practice teaching experiences in both traditional and non-traditional school settings, and (2) providing participants with multiple opportunities for recognition work through assignments that invite and structure reflections on their participation in these experiences. In what follows, I will first briefly describe the key components of the Get Real! program, and then discuss in more depth how each of these two design principles played out in the program. While a few quotes from participants' work have been included to provide their perspective on specific experiences, please keep in mind this report is offered as an illustration of the new design principles proposed, not as empirical evidence of the effectiveness of these principles.

Overview of the program

The *Get Real! Science* program is a 15-month graduate program intentionally designed to foster the development of a professional identity as a reform-based science teacher in urban settings. The core of the program consists of a sequence of three atypical "science methods courses" and concurrent field experiences (See Table One).

The first methods course, EDU486, is a seven-week summer intensive course designed to support beginning science teachers in considering the appropriate role of technology in science classrooms. In this class, teachers use technology as they: 1) conduct authentic scientific investigations of a local ecology problem as learners; and 2)

facilitate a diverse group of middle school students in a similar experience through the implementation of a week-long "*Get Real! Science* Action Camp."

The second methods course is aimed at supporting beginning science teachers in developing a strong conceptual and theoretical grounding in and personal philosophy of reform-based pedagogy. This course, EDU 434, is a fourteen-week fall course in which candidates engage with a series of core readings while concurrently engaging in authentic, reform-based teaching experiences in non-traditional as well as traditional contexts. Consistent with the literature on learning to teach science, these experiences are intended to support beginning science teachers in developing their understanding of the nature of science, strategies for facilitating student-centered investigations, methods for accessing and building on students' current science understandings and identities, and ways to develop and integrate performance-based assessment to serve as an instructional as well as assessment tool for both students and teacher.

The final methods class is designed to synthesize the work done thus far in the design and implementation of innovative instruction in traditional school science classrooms. This fourteen-week spring course is concurrent with and complemented by three intense field-based teaching experiences: two traditional student teaching placements and a collaborative innovative unit project.

Throughout all three courses, participants engage in ongoing narrating, reflection, critique and recognition of their professional practice and growth. These opportunities include maintaining a personal, professional blog, engaging in collaborative post-teaching debriefing sessions, constructing a portfolio, and presenting at professional conferences.

Table 1. Course sequence and design elements of the Get Real! Science program. (See http://www.rochester.edu/warner/programs/courses/tccourses.html for official course descriptions that can provide additional information.)

Course	Overview of core experiences	Design elements
EDU 486: Integrating Science & Technology (summer)	▪ Conduct a scientific investigation of a local water ecology problem ▪ Design and implement an inquiry-based, middle school camp focused on the same local water ecology problem ▪ Begin a personal professional blog; engage in collaborative post-teaching debriefing sessions, and construct a program portfolio.	o Experience scientific inquiry as learners o Low-stakes, highly supported opportunity to try on identity as reform-based science teacher o Engage in ongoing and diverse forms of recognition work
EDU 434: Theory & Practice in Science Teaching and Learning (fall)	▪ Read and discuss foundational theoretical readings about inquiry-based science learning and teaching ▪ Design and facilitate an after-school inquiry club. ▪ Observe and teach in a traditional middle school setting. ▪ Maintain a personal professional blog; engage in collaborative post-teaching debriefing sessions; present at a professional meeting, and construct a program portfolio.	o Theoretical grounding and exploration of teaching practices through course readings and discussion o Collaborative engagement in low-stakes, reform-based science teaching of core curricular concepts in out-of-school settings o Engagement in scaffolded, authentic reform-based science teaching in traditional classrooms o Engage in ongoing and diverse forms of recognition work
EDU 448: Implementing Innovation in Science Education (spring)	▪ Four-week student teaching at local middle school and eight-week student teaching at local high school (often paired placements) ▪ Collaborative design and implementation of an inquiry-based innovative unit in a traditional classroom. ▪ Maintain a personal professional blog; engage in collaborative post-teaching debriefing sessions; present at a professional meetings, and construct a program portfolio.	o "Student teach" in traditional classrooms with associated accountability expectations (e.g. standardized tests) o Collaborative culminating experience of reform-based teaching (planning and facilitation) in an urban setting. o Engage in ongoing and diverse forms of recognition work

Scaffolded series of reform-based science education experiences as learners and teachers

Throughout the *Get Real! Science* program, prospective teachers experience the following carefully sequenced series of experiences:

Conducting authentic science investigations as learners. During the first course in the sequence, the pre-service teachers experience the richness (e.g., excitement, challenge, frustration) of conducting personally-meaningful, extended authentic scientific investigations. These investigations include defining a research question and protocol, collecting and analyzing data, and drawing and reporting on conclusions. Specifically, they conduct an investigation to understand an aspect of the ongoing, ill-understood local problem, "Why is our local beach closed again, and what can we, as a community, do about it?" Preservice teachers study this authentic, community-based problem by collecting water quality data at different points along a pier or during different weather conditions. As a culminating experience, candidates report the results of their work to the local office of the Health Department. Tia wrote of the experience in her blog:

> Through the process of doing the investigation, organization of the 'proposal,' and collecting the data, we realized many things that we needed more research on and would improve on the next time, or that should be further investigated. Dealing with anomalous data, field access and instrument problems, interactions between groups of people, and time and resource constraints are all parts of science. Unfortunately, these are the parts of science that are never discussed. They are also the parts of science that can make science the most interesting, thought-provoking, and different than what is typically read in a textbook. I hope to be able to introduce my students to science, including these portions (July 14, 2005).

The diverse benefits of this experience (such as developing an identity as scientist, the connectedness of the resulting subject matter understanding, and the interest and passion evident from working on something perceived to be real and thus meaningful) serve to ground and motivate future discussions of the value of authentic

investigations as an approach to scientific teaching and learning. This investigation provides a foundation for considering how to modify this experience for students – both in similar out-of-school contexts and to fit typical classroom constraints such as limited class periods while maintaining the benefits of engaging in ill-structured investigations (e.g., enthusiasm, personal-relevance, depth-of-study).

Collaborative/reflective science teaching in low-stakes, out-of-school settings. After experiencing scientific investigations as learners (often, for the first time), candidates in the Get Real! Science program benefit from the opportunity to "try-on" their identity as reform-based science teachers in safe, supportive and motivating out-of-school contexts. First, as a way to try-on this new identity, preservice teachers work together in small groups to design and implement a week-long science inquiry camp for middle school students. The driving investigation question for this middle school camp is the same as the one the prospective teachers engaged with as science learners the previous month. The primary professor of the program serves as the mentor teacher for these out-of-school teaching experiences, thus affording participants mentorship that is both nurturing and challenging as well as informed by a reform-based pedagogy. Though time is still limited, many of the hurdles new teachers face when first experiencing inquiry pedagogy as teachers are removed in this camp setting: they work directly and intensely with fewer students; their teaching focuses on learning in the context of fun; they work with at least two peers; they daily debrief with university faculty; they implement a stand-alone curricular unit that does not need to build on or lead into something bigger, and authentic assessments (such as a final science conference) are established and integral aspects of the camp design.

Unlike most new teaching situations in which the beginning teacher must focus primarily on management issues in order to "survive," this non-traditional teaching opportunity allows beginning teachers to focus more on instruction and their students' experiences. Matthew, a participant from the 2005-06 cohort, used his web log (blog) to describe his impressions of facilitating the middle school summer camp:

> This was an exercise in facilitating inquiry-something I have never, ever done. I must say that I really enjoyed it. A lot. It was such a fun, exciting experience. Watching activities that we had planned actually work out was such a thrill, but it was even better when the kids took something we had done and took it in directions we had never thought of.

The unique affordances and contextual features of the camp offer beginning science teachers a safe and supportive place to "try on" their identity as inquiry-based science teachers, and through this experience, are intended to deepen their understanding of, appreciation for and commitment to reform-based philosophy.

The following semester, prospective teachers work collaboratively to implement inquiry-based lessons in an "after-school" program that is very similar in nature to the camp. Designed to transition beginning teachers from the open-ended experience of teaching in a camp to the more structured teaching in a traditional classroom, these after-school sessions are based in classrooms and occur within 45 minute periods. The university professor partners with the university supervisor to support beginning teachers in the development of reform-based pedagogy, language, and identity as well as management strategies.

The "Get Real! Science STARS Club" offers beginning science teachers the opportunity to see modeled, and then plan and implement, a series of three reform-based science experiences with each of two groups of urban middle school girls in an after-

school club. Candidates experience these lessons first as learners, facilitated by previous cohort members who are currently science teachers in the area. Then, as they run this after-school club for local urban youth, candidates receive support in planning, implementing and making sense of reform-based pedagogy. In these experiences candidates experience reduced pressure due to shared responsibility and lack of classroom accountability such as standardized tests and class scheduling. This gives them safe, highly supported, low-stakes opportunities to try out and develop new skills and understandings through reform-based teaching of school-aged students. These experiences also provide beginning science teachers with opportunities to develop personal relationships with a small number of students whose backgrounds (academic and otherwise) are often quite different from the teachers'. Though supported, candidates experience many of the complexities of teaching (e.g. absenteeism, tardiness, 45-minute class periods, limited resources, management and discipline) that were not present in the summer camp.

Karie, a member of the Get Real! Science 2003-04 cohort, describes her perceptions of the value of these nontraditional field based teaching experiences.

> Working with the Science STARS [after-school club of middle school girls] was truly a situation where we could explore instruction from an inquiry-based perspective, and provide the girls with an authentic scientific experience. Though we used the New York State standards to guide our instruction, we were not confined by state exams or assessments, and could therefore have the opportunity to engage students with not only hands-on activities but "minds-on" interactions…. Creating an environment where individuals feel comfortable to share ideas, teach and learn with each other, work collaboratively, and be respectful of their peers takes some practice. I am learning the techniques in fostering a community of learners setting in the classroom, and have employed several of the strategies we used during Saturday Science into my placement. Overall, I feel that this experience has changed me as an educator, and made me feel more confident in trying things in the classroom.

This second nontraditional, out-of-school teaching experience continues the identity "repair work" of supporting beginning science teachers in developing a reform-based teaching identity that is likely quite different from what they expected when they entered the program. Now confined to 45-minute time periods with a home base of a middle school science classroom, this after-school club teaching experience supports beginning science teachers in exploring the feasibility of reform-based practices in real constraints of classroom science teaching. Significant supports are still available in order to optimize the chance beginning teachers will experience meaningful success.

Formal, school-based teaching experiences. Throughout both the second and third methods courses, candidates have multiple opportunities to work in traditional classroom settings. During the second methods course in the fall, candidates begin by actively observing and working with small groups of students. They are required to conduct micro-investigations of the classroom and school context intended to challenge and ultimately alter their viewpoints of ethical and effective schooling and teaching. For example, shadowing a student for a day often makes explicit how little of a student's school day requires her active involvement and is focused on her interests. Documenting the numbers and types of teacher responses to different learners brings to the fore the reality of discrimination that students face in many school classrooms. Later in the semester, candidates are required to teach a minimum of one inquiry lesson, one nature-of-science lesson, and one community-as-context lesson, as well as a series of three lessons (that may or may not incorporate these other three lessons). These more isolated teaching experiences give candidates opportunities to take ownership of planning and implementing reform-based science teaching one day at a time. Because of their short

duration and required focus, school-based mentor teachers are usually supportive of candidates' experimentation with reform-based practices.

Toward the end of the program, during the third methods course in the spring, candidates have the opportunity to try out and develop their identities as a certain kind of science teacher within the tight constraints of authentic classroom settings**.** Beginning teachers have the opportunity to consider and implement aspects of reform-based practices in classroom (middle and high school) settings that resemble contexts of likely future employment and learn strategies to be successful in existing culture while maintaining reform-minded vision. During this semester, candidates engage first in a four-week middle school student teaching placement, followed by an eight-week high school placement. Toward the end of the second placement, candidates work collaboratively in the context of the university course to design a reform-based innovative unit that is ultimately implemented by a subgroup of the candidates in one candidate's field-based classroom. This experience is intended to make explicit the challenges yet feasibility of implementing reform-based practices in high school classrooms thick with accountability measures. Though preservice teachers are still simultaneously taking classes and interacting with the university professor, the day-to-day teaching experiences and recognition of these experiences occurs largely separate from university support. These twelve weeks of student teaching resemble those common to most teacher preparation programs – assuming full responsibility of the classroom under the direct supervision of a practicing cooperating science teacher with limited observations, critique, and input from university personnel. These experiences mark an important end to the program's developmental trajectory in which preservice teachers continue to

develop their identities as reform-based science teachers with the least amount of support and the greatest amount of accountability.

Maya, a participant in the 2004-05 cohort, emphasizes the relationship between the continuum of field-based teaching experiences as she focused on one aspect of her development as a science teacher:

> I have had many good experiences with lesson planning and creation of curriculum. My first experiences came while designing lessons for the Get Real Science Action Camp in the summer and the Science Action Days [Science STARS club} in October. It was really refreshing to spend so much time planning and preparing for a more inquiry driven and open learning environment than I usually worked with at [her student teaching placement]. Many of the lessons I took away from these experiences I took into the classroom with me.

Giving beginning science teachers many authentic opportunities to engage in the practice of their new discourse (reform-based science teaching) aligns with a situated and social understanding of learning. Thoughtfully designing a *continuum* of these experiences respects the unique identity needs of our science teacher learners.

Opportunities for recognition work

It is clear thus far that Get Real! Science preservice teachers are given rich and extensive opportunities to participate in their new professional discourse and try out their new identities as reform-minded science teachers in progressively scaffolded contexts. However, I argued earlier that a new teacher's interpretation of this participation and recognition of it as evidence of becoming a certain kind of science teacher is the very process by which a new professional identity is developed. It is in the beginning science teachers' meaning-making of their practice where the theory of reform-based pedagogy becomes real and comes alive. Supporting this interpretative recognition work offers beginning science teachers help in reflecting on, narrating about and identifying essential elements, skills, beliefs, values and social and political negotiations of effective, reform-

based practices in their own teaching as well as that of their peers and colleagues. Throughout the *Get Real! Science* program, teacher learners are given a number of scaffolded ways to engage in this recognition work.

The Role of Readings. Theoretical readings, though introduced in the first methods course in the summer, are a more central focus of study during the first half of the second methods course in the fall. This scheduling puts experience before explanation, an approach consistent with reform-based practices. These readings serve a number of complementary purposes in the recognition work of reform-minded science teachers as they: 1) offer rich descriptions of classroom practice that enable and scaffold collaborative identification and interpretation of reform-based practices; 2) support the development and ownership of a new language of science teaching (e.g. student-centered teaching, project-based science, performance-based assessment, and inquiry); and 3) offer a consistent framework that serves as a foundation for critiquing and informing professional decision-making. Candidates use these new understandings and language as they self-assess course projects, compose reflective writings of their performance, offer critiques of peers' teaching, and define professional goals and aspirations for their developing sense of professional self. Specifically, the readings serve to direct and justify professional decision making. Equally important, concurrent teaching experiences (non-traditional as well as traditional) are used to judge the value and credibility of the research-based readings. Through this recognition work candidates are supported in developing a deeper understanding of, appreciation for and commitment to reform-based practices.

Group reflections after key experiences teaching reform-based science. After each of the core teaching experiences of the *Get Real! Science* program (for example, at the end of each day of camp, each after-school meeting, and each observed classroom lesson), each participant identifies what she perceives to be the "pluses" (strengths) and "arrows" (areas of needed growth) of her teaching experience, as well as how this experience helped her or him to grow professionally. Then each of the other professionals present (peers, professors, supervisors, cooperating teachers) shares her perceptions of the practice. From this discussion, the group generates a list of things learned, mistakes made, successes realized, and goals for the future. These debriefs have been recognized by participants as one of the most influential experiences of the program. It was in these meetings where recognition as reform-based practitioners, by self and others, was made public and explicitly accessible to the beginning science teacher.

Journals. One reflection practice of the Get Real! Science program that is common among many existing teacher preparation programs is the keeping of a 2-sided journal. Each pre-service teacher logs her experiences throughout the program on the right side of a written journal and her perceptions, reflections, emotions, and reaction on the left side. These journals are then used for personal reflection of growth over time. First, many excerpts from these journals are used as each preservice teacher works in the methods classes to construct her program portfolio. In addition, during field seminars as well as once a semester with the professor, participants are given the opportunity to talk and thus share their reasoning about significant events in their lives as if they were reading their diaries aloud (Levinson, 1996). Though these journals are then used as springboards for sharing and discussion with the instructor and other participants, they

are primarily private. Participants use this venue to wrestle with issues they are not yet ready to make public.

Individual professional web logs (blogs). As a complement to the private journals, each preservice teacher maintains a professional web log (blog) throughout their preparation program (as well as beyond); for an example of these blogs, see http://www.getrealscience.com/tspitzer-list/. While encouraging participants to use their blogs as they see most useful or desirable, participants in the Get Real! Science program are also given reflective assignments to include in their blogs. Minimally, beginning science teachers are required to post once weekly about an event they feel was significant to their professional growth. They often read each other's posts and offer comments. In addition cooperating teachers, supervisors, and professors are expected to read these blogs and offer the individual bloggers suggestions, tips, encouragement and praise. These blogs offer Get Real! beginning science teachers an ongoing place to consciously and deliberately engage in their professional identity development through the processes of collecting and composing stories and interacting with a unique professional community.

Participation in Professional Meetings. Beyond the group reflections, journaling, and blogging, Get Real! participants are required to work together to design and implement at least one inquiry-based teacher workshop for local science teachers that builds on lessons learned during the first or second methods courses. One local professional meeting occurs in September, a month after participants have run the middle school summer camp. A second one occurs in February, two months after the after-school club ends and middle school individual inquiry lessons have been taught. These

opportunities give beginning science teachers an additional opportunity to own their identities as reform-based science teachers by actively advocating for certain methods they found to be effective and engaging. Support for this recognition work by self and others at these conferences gives these teachers the opportunity to see themselves as contributing members of a community of practice.

After Kelly (2005-06 cohort) presented "Inquiry from Multiple Views" with her peers at a local science teacher meeting in the fall, she posted an image of their group at their talk followed by this entry:

> I'd like to take some time to thank [the university professor] for setting up these amazing resources and activities. I finally feel like I am making a difference and that my life has meaning. This is exactly what I have been missing. Thank you!!!

When taken together, the carefully scaffolded series of experiences of reform-based science learning and teaching and the multiple forms of recognition work Get Real! participants engage in provide them with unique opportunities for developing a reform-minded science teacher identity that are often missing in current science teacher preparation programs. This concrete example demonstrates that it is possible to design teacher preparation programs that better recognize and address the challenges of identity development faced by beginning science teachers. In addition, it is my hope that this model can encourage other science educators to capitalize on identity theory and research to strengthen their teacher preparation programs.

Conclusion

Preparing reform-minded science teachers with the skills and knowledge needed to engage in inquiry-based practices requires addressing some of core needs of one who is developing a new professional identity that goes against the norm. This article has

articulated and illustrated two design principles that could help address these needs, that is 1) providing preservice teachers with the opportunity to participate in a carefully scaffolded sequence of reform-based science learning experiences, both as learners and as teachers, first in non-traditional and then in more traditional classroom settings ; and 2) providing on-going opportunities for interpretation and recognition of that participation through multiple forms of structured reflection. Building on research in identity development, I hope that this work will inspire other science teacher educators to make use of these principles in their practice as well as spur ideas and interest in developing more research to further capitalize on identity theory as a source for conceptual tools as well as a new model for teacher preparation programs.

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