Working Together to Prepare Teachers of Science and Language: Examining the Value of Collaboration Among Science and Language Faculty

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Abstract

This qualitative study examines the change in a preserve program as our faculty members systematically work together to change the culture of our college to one in which everyone assists future teachers to work with ELLs. The iTeach ELL Systems Framework has promoted understanding of the interconnected nature of student learning, which includes: university/school partnerships designed to impact that learning through more effectively prepared teacher candidates, school and university organizational features, and state statutes and policy regulations. One focus of this work is to infuse problem-based learning (PBL) and ELL strategies into science methods courses. This qualitative study of efforts and approaches to reform science methods courses has identified three themes: a) Value of Agreeing on Terms (b) Value of Integrating Content and Language Learning (c) Value of Presenting a Unified Message. Successes and challenges for supporting pre-service teachers to develop knowledge of both PBL and ELL strategies are discussed.

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Introduction

As a nation, it is crucial that a high quality science education is provided for English language learners (ELLs) in our schools. Too often, ELLs are clustered with all other groups of students who may need differentiation in standards that guide teacher preparation (e.g. CCSSO's

InTASC Standards, 2011). As educators of teachers of science, it is critical that we recognize that the teaching of science has many opportunities to develop language skills. As stated in the National Science Teachers Association (NSTA)'s position statement titled Science for English Language Learners, "all students, including those identified as English language learners (ELLs), can and should have every opportunity to learn and succeed in science" (NSTA, 2009, p. 1). By understanding how teaching science can work seamlessly with the development of English language skills, we can help this distinctive student population achieve academically while simultaneously developing English language proficiency.

Through the generous support of a Teacher Quality Partnership grant from the U.S. Department of Education, the Mary Lou Fulton Teachers College (Teachers College) at Arizona State University is preparing elementary teachers in content-based second language acquisition, beginning with a focus on science methods courses. In this paper, we report the findings of a qualitative study focusing on the perceptions of the value of the collaboration of two science methods professors and a second language acquisition professor.

Literature Review

English Language Learners

Students whose primary language is not English have been a part of the education landscape in the U.S. since the nation's earliest days (Crawford, 2004; Duran, 2008; Jimenez, Garcia, & Pearson, 1996; Lee & Luykx, 2005; Vaughn et al., 2006). Although most teachers have always had ELLs in their classrooms (even though students are not always labeled as such), the population of ELLs in schools has been increasing steadily for the last three decades (Shin & Kominski, 2010). From 1994 to 2010, the percentage of ELLs in the U.S. grew over 63% and has grown steadily since then (National Clearinghouse for English Language Acquisition, 2011). According to recent U.S. census data, nearly 40 million people, are foreign born and nearly 20% of the U.S. population report that they do not speak English well (Shin & Kominski, 2010). These data have important implications for schools and, consequently, for teacher education programs that prepare teachers who will meet the academic and linguistic needs of this growing population of students and their families.

The Arizona Context

In Arizona, the need to prepare content-area teachers to work with ELLs is especially critical. Currently, only 25% of ELLs graduate from Arizona high schools, a figure that is well below the 60% graduation rate defined by the U.S. Department of Education as a failing high school (Stetser & Stillwell, 2014). This achievement gap begins in elementary school. In the 2012-2013 school year only 40% of ELLs passed the Arizona elementary mathematics assessment and only 53% passed the reading assessment (Arizona Department of Education, 2013). As can be seen in Table 1, ELLs in Arizona also have not fared well on the National Assessment Education Progress assessments (NAEP) (Arizona Department of Education, 2015).

Table 1.
Arizona Students with Limited English Proficiency on NAEP

Achievement	Year	Below Basic	Basic	Proficient	Advanced
Mathematics Grade 4	2015	61	34	5	0
Reading Grade 4	2015	88	12	1	0
Science Grade 4	2009	84	14	2	0

To further complicate matters, students in Arizona who are identified as not proficient in English are removed from most content classes for four hours each school day to receive English language instruction (Jimenez-Silva, Gomez, & Cisneros, 2014). While perhaps well intentioned, this policy results in the unfortunate consequence of ELL students having restricted access to the general curriculum, especially science content (Lillie, 2011). Many ELLs in Arizona are not provided access to science content classes in Arizona until their middle childhood or adolescent years, a situation that creates unique challenges to science teachers. Hence, ELLs in Arizona may struggle to acquire science content knowledge and skills due to a lack of access. This coupled with limited English proficiency may present a formidable barrier to a strong science education. A comprehensive approach to better prepare our preK-8 preservice teachers to teach mathematics and science and to meet the needs of ELLs is needed.

English Proficiency

Further complicating an already complex issue are varying definitions of English proficiency, both in Arizona and across the nation (Linquanti & Cook, 2013), with proficiency criteria often tied to communication ability rather than the ability to use language for learning. This can result in a situation where teachers create lessons to enable development of science content not realizing that these lessons also need to include opportunities for the authentic use of academic language. The challenges for ELLs in Arizona are not unique; such issues arise in a number of states that have similar policies and procedures to establish English proficiency in ELLs (Wright, 2010). The result is that ELLs in many of the nation's schools often miss opportunities to acquire (a) science content knowledge and skills; (b) academic language skills required for learning (e.g., higher level vocabulary), and (c) higher level literacy skills (e.g., expository text comprehension) that are essential for academic success (Gándara & Orfield, 2010; Martinez-Wenzl, Pérez, & Gándara, 2010; Ríos-Aguilar, González-Canche, & Moll, 2010).

In sum, ELLs do not consistently have access to science experiences and therefore have restricted opportunities to develop knowledge and skills essential for high school graduation, to access postsecondary opportunities, and to be productive participants in the 21st century workplace. Further, teachers may not have the abilities to optimize student learning when they do experience science. Teacher education must address the assumption that "best teaching practices" used by general education teachers are best for all students. There are academic and linguistic needs of ELLs that are not always met, yet fortunately, specific instructional practices to promote science education as well as language and literacy skill development can benefit all students and should be part of every teacher's knowledge and repertoire.

English Language Learners and Science Learning

Science and mathematics classrooms that are based on inquiry, projects, and problem-solving hold exceptional promise for supporting English language development and content knowledge acquisition in literacy and STEM areas (Shaw, Lyon, Stoddart, Mosqueda, & Menon, 2014). Success in science content courses require a broad range of academic language (Wright, 2010). For example, scientific inquiry and mathematical problem-solving have myriad opportunities to access expository text and talk that includes questions, explanations, hypothesis generation, debates, clarifications, elaboration, verification, and sharing of results. Certainly the language demands in such classes may be considerable, but the potential is strong for students to learn critical English language skills while also building their STEM and literacy knowledge base (August, Branum-Martin, Hagan, & Francis, 2009; Buxton & Lee, 2014; Crawford, 1995; Freeman & Freeman, 2008; Gómez, Kurz, & Jimenez-Silva, 2011; Jimenez-Silva & Gomez, 2010; Lee, 2004; Quinn, Lee, & Valdez, 2012; Rosebery & Warren, 2008).

Extensive reviews of the literature identified a number of program factors and instructional characteristics that promote the academic success of ELLs (Genesee, 2005). Aggregating across the corpus of research, Genesee, Lindholm-Leary, Saunders, & Christian, (2005) report programs that were relatively effective in improving the academic achievement of ELLs shared the following characteristics:

1) a positive school environment (Battistich, Solomon, Watson, & Schaps, 1997; Berman, Minicucci, McLaughlin, Nelson, & Woodworth, 1995; Montecel & Cortez, 2002),

2) a curriculum that was meaningful and academically challenging, incorporated higher order thinking (Berman et al., 1995; Doherty, Hilberg, Pinal, & Tharp, 2003; Montecel & Cortez, 2002; Tikunoff, 1985), was thematically integrated (Montecel & Cortez, 2002), established a clear alignment with standards and assessment (Doherty et al., 2003; Montecel & Cortez, 2002), and was consistent and sustained over time (Ramirez, 1992),

3) a program model that was grounded in sound theory and best practices associated with an enriched, not remedial, instructional model (Montecel & Cortez, 2002),

4) teachers in bilingual programs who understood theories about bilingualism and second language development as well as the goals and rationale for the model in which they were teaching (Berman et al., 1995; Montecel & Cortez, 2002), and

5) use of cooperative learning and high-quality exchanges between teachers and pupils (Berman et al., 1995; Calderón, Hertz-Lazarowitz, & Slavin, 1998; Doherty et al., 2003; Montecel & Cortez, 2002; Tikunoff, 1985).

By creating cadres of teachers who understand and believe that all ELLs can learn academic content while simultaneously developing language, we can move towards creating positive school environments. Through STEM instruction that is meaningful, integrated, and has incorporated effective strategies for developing STEM knowledge and English language and literacy skills, teacher candidates will contribute to a number of factors that can lead to ELLs' academic and language development.

A College-Wide Effort to Prepare All Teachers on Content-based Second Language Acquisition

The Teachers College at Arizona State University set forth four goals to prepare elementary teachers on content-based second language acquisition. Goal One states that the Teachers College will implement a number of key reforms in PreK-8 certificate teacher preparation programs so our graduates will be measurably more successful in understanding and implementing strategies for teaching ELL students in mathematics and science content areas. Goal Two is re-designing methods courses in mathematics and science to include materials and instructional strategies that promote development of language (including academic language through science content instruction) and literacy skills. Goal Three focuses on using problem-based learning (PBL) pedagogy and design principles to establish knowledge and skills that teacher candidates can apply to classrooms. In Goal Four, we aim to integrate an understanding of evidence-based practice research related to the teaching and learning of ELL students including evidence-based assessment and data-driven decision-making within problem-based learning to improve content instruction that supports ELLs' content and linguistic development. These goals are reinforced in a recently implemented one-year of student teaching model providing ample opportunity for teacher candidates to develop and implement PBL lessons with ELL methods.

Research has identified a number of potential obstacles to engaging faculty members in collaborative efforts attempting to develop teacher educators' capacity to work together to prepare all teachers to work effectively with ELLs. These potential obstacles include (a) faculty members' autonomy, (b) faculty members roles' as experts, (c) limited time and scheduling challenges, (d) incentives, (e) available resources, and (e) differing levels of initial understanding and commitment (Costa, McPhail, Smith, & Brisk, 2005; Levine, Howard, & Moss, 2014; Nutta, Mokhtari, & Strebel, 2012). One suggestion by Levine, Howard, & Moss (2014) used in Project PREPARE-ELLs was to start small and capitalize on the power of peer coaching. The following recommendations they made for initiating and sustaining collective faculty professional development has informed our project work: (a) do a needs assessment and identification of learners' hopes, (b) differentiate options and opportunities, (c) balance clear expectations with flexibility to accommodate the reality of multiple demands on faculty members, (d) gather ongoing input, (e) stay focused on the mission, (f) have a planning team streamline the work, (g) schedule and use meeting time strategically, and (h) craft the project to match some of the institutional incentives and mission.

Enhancing Language through Problem-Based Learning

While ideas related to PBL can be traced back to Dewey (1938), PBL was established in the field of medical education in the 1970s, with origins at McMaster University (Barrows, 1996; Barrows & Tamblyn, 1980; Zubaidah, 2005). Challenging the existing lecture and memorize method, preservice medical doctors learned content and clinical reasoning ability by identifying symptoms in real patients, simulated patients, or written case studies (Barrows & Tamblyn, 1980); diagnosing medical conditions; and prescribing treatments (Barrows, 1996). From medical doctor education, PBL was used in other professional fields including nursing, architecture, engineering, advertising, physical therapy, and business administration (Barrows, 1996; Gould & Sadera, 2015; Quinn & Albano, 2008; Zubaidah, 2005). Research studies suggest that PBL is an effective means of learning content and skills in these settings (Barrows, 1996). PBL methods have also engaged K-12 learners (Kim et al., 2012; Trinter, Moon, & Brighton, 2015); however, more research is needed on student learning in K-12 classrooms (Rico & Ertmer, 2015). There is no one PBL method; a variety of methods fall under this term (Zubaidah, 2005). For this project, our operational definition of PBL is as follows: "Problem-based learning is an instructional approach where learners grapple with meaningful problems and collaboratively work toward their resolution" (Rillero, 2015, p. 2).

The potential of PBL to meet the needs of diverse students, including ELLs, is significant because it offers the opportunities for ELLs to be involved in science activities that offer long-term and meaningful learning, and it also provides a rich context for development of both basic and higher level skills in language and literacy (Jimenez-Silva, Hernandez, & Thibault, 2016). Furthermore, PBL provides the opportunity to incorporate strategies for supporting all students in their development of academic language, especially ELLs. For example, language acquisition can be supported through the development of questions (writing), sharing of solutions (speaking) and researching (reading) their topic. This echoes NSTA's Position Statement on ELLs in which it states that "it is important that educators who teach science to students identified as English language learners be well versed in science content and pedagogy, and also *skilled in pedagogical approaches for integrating language acquisition and science learning* [emphasis added]" (NSTA, 2009, p.1). However, it is critical that language development not be seen simply as a side note, one more mandate that teachers have to address. Rather, the key is to integrate a focus on language, moving from PBL to Problem-Based Enhanced Language Learning (PBeLL). The emphasis needs to remain on science content, however, we should prepare teachers to identify opportunities within PBL experiences where language development can be naturally integrated, hence PBeLL opportunities. Furthermore, PBeLL should go beyond just a vocabulary list or a few visuals, but capitalize on the rich opportunities that exist for genuine dialogue as well as for authentic and engaging reading and writing tasks. Consequently, PBeLL equally emphasizes content and language development. It is a unifying concept that reminds faculty members that all of us should be responsible for preparing teachers to develop content knowledge while simultaneously developing language.

Systems Framework and Theoretical Model

Our team adapted the National Institute for Urban School Improvement (NIUSI) Systemic Change Framework (Ferguson, Kozleski, & Smith, 2005) as a way to demonstrate the interconnected aspects of student learning, university/school partnerships and organizational features, and state statues and policy regulations.

The iTeach ELL Systems Framework visually displays the levels and interconnected system features that combine and interact to impact student learning. The theoretical underpinnings of the iTeach ELL Systems Framework are derived from the work of Bronfenbrenner (1994) and Oliveira, Wilcox, Angelis, Applebee, Amodeo, & Snyder (2013). A key proposition of this framework is the argument that student learning and effort are directly influenced by the contexts within which the learners reside, indirectly influenced by outer spheres such as the school and university organizational levels, and also by the statutory and policy parameters that are in effect. Thus, one needs to think of the iTeach ELL Systems Framework as a nested set of spheres, each with the potential for direct proximal and/or distal effects that interact to promote student effort and learning of science content knowledge and enhance linguistic development (Figure 1).

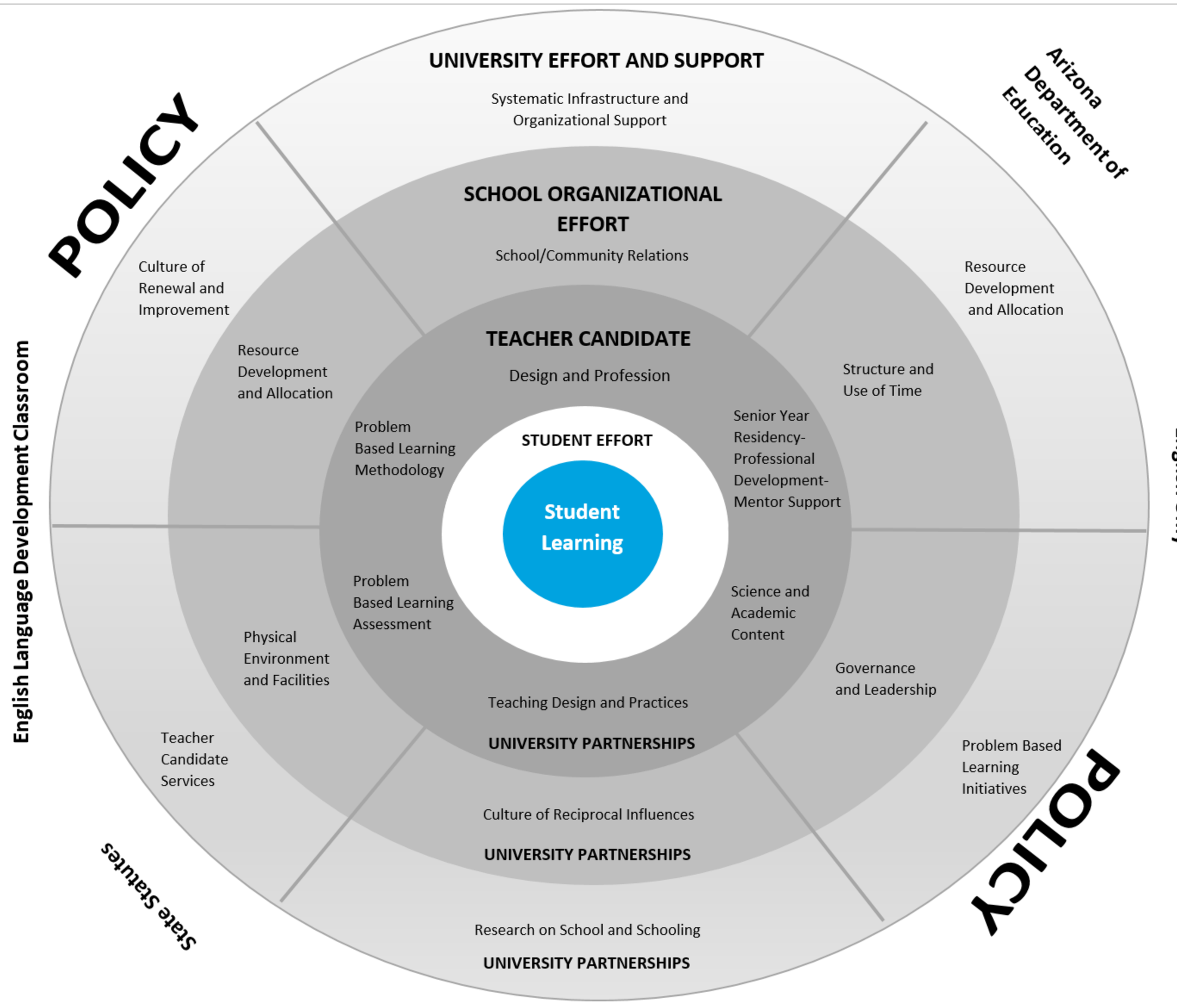

Figure 1. The iTeach ELL Systems Framework.

In this systems model, the most inner sphere represents student learning and student effort. To more fully support ELLs' active participation and engagement in effort and learning, we have carefully chosen to prepare our science and mathematics education faculty members to employ PBL strategies with academic content language development with all of our teacher candidates in the Teacher Professional Preparation Program. This is reflected in the Teacher Candidate sphere where the five components of (a) Problem-based Learning Methodology; (b) Science and Academic Content Language; (c) Problem-based Learning Assessments; (d) Senior-Year Residency Professional Development and Mentor Support; and, (e) Teaching Design and Practices interact to positively prepare the teacher candidates for their professional roles within the context of University Partnerships with the local school settings (Ferguson, Kozleski & Smith, 2005). Changes in one or more of the elements of the *Teacher Candidate* sphere will likely interact to either enhance or hinder student effort and learning.

The interactive nature of the elements within each of the model's spheres are important variables to operationalize, measure, analyze, and more fully understand the differential effects on teacher and student success. Thus, for instance, what happens at the university level influences the district, school, and classroom levels due to the highly organized university/school partnerships that are in effect. The teacher candidates in all program areas are regularly engaged in numerous cycles of observations, assessments, and data feedback. These cycles of focused observations, assessments, and data discussions will be further enhanced with PBL Assessments that focus on the key elements of PBeLL and academic science content language use.

The *School Organizational Effort* and *University Effort and Support* levels share a culture of reciprocal influences where each entity is jointly focused on providing the resources, governance, and leadership to impact student effort and learning in science and mathematics via PBL strategies. PBL methodology combined with strong science academic content language require the university, district, schools, and classroom mentors and teacher candidates to rethink their curricular approaches and methods, how they structure classroom environments, and use of time within those classrooms. Clearly challenges and barriers exist that need to be investigated and understood in order to enhance sustainability of the iTeach ELL efforts. Research conducted on the iTeach ELL initiative will inform all of the partners as to the successes that are generated and celebrate a culture of renewal and improvement in closing the achievement gap for ELL children.

Finally, the state statutes and policy regulations that require instruction in English only within the K-12 environments influence all levels within the iTeach ELL Systems Framework. As noted earlier in this paper, children who enter school without proficiency in English are placed in English Language Development (ELD) 4-hour blocks, which are typically devoid of academic content language in science or math. Thus, these statutory and policy regulations limit many ELL children's access and opportunity to engage in rich academic content language in their native language, while they build their vocabulary and understanding in a second language (Jimenez-Silva, Hernandez, & Thibault, 2016).

A Close-Up View of Collaboration

In this section, we will describe and discuss a study conducted in the first phase of our plan to prepare science teachers to meet the content and linguistic needs of ELLs. Through this study, we sought to answer the question, "What is the value of collaboration between science and language faculty members when implementing a college-wide reform effort?" based on qualitative data from three key participants in the collaborative efforts.

We focused on three faculty members, co-authors on this chapter, because of the scope and exploratory nature of this study. Sudman (1976) states that a small, local study is appropriate for a researcher who is just beginning an inquiry into a particular topic, as is our case. Indeed, at the time of this study, there had been very little research conducted examining the challenges of working collaboratively across content areas in a teachers college given the complex political climate related to immigration and English-only state policies. This qualitative study of three participants allowed us to develop a deeper and more contextual understanding of perceptions about the value of collaboration than would be possible with a more superficial study of a larger group of participants (Matsumoto, 1991).

Setting

The Teachers College has one of the largest teacher preparation programs in the country, graduating approximately 1,500 new teachers each year. Situated in Arizona, a state where ELLs are among those with the poorest achievement outcomes (Annie E. Casey Foundation, 2013; Children's Defense Fund, 2014; U.S. Department of Education, 2014), the Teachers College has the opportunity to address the significant challenges associated with education for ELLs. In doing so, Teachers College can become a model for other teacher preparation programs, which struggle to meet the needs of these students.

Participants

Three faculty members, co-authors of this article, were participants in this study. The first participant, Dr. Jimenez-Silva, taught mathematics and science in middle school to ELL students in a newcomer program prior to earning her masters and doctoral degrees in Human Development and Psychology with an emphasis in Language and Culture. She is currently in her 19th year of teaching at the university-level and is an associate professor teaching courses on second language acquisition. She also serves as the program coordinator of the Bilingual/English as a Second Language Teacher Preparation program at the College.

The second participant, Dr. Rillero, began his career in science education in 1982 when he joined the U.S. Peace Corps and taught grades 8 to 10 in a rural school in Kenya for three years. He then taught high school physics, biology, and science research for four years in a public school in Bronx, NY, while earning a masters degree in science education and a masters degree in biology. After earning his doctoral degree in science education, he accepted a faculty position in science education at the Teachers College where he earned tenure. He is currently in his 21st year and teaches science methods at the elementary and secondary level.

Dr. Merritt began her teaching career as a high school chemistry and physics teacher. She received her bachelor's degree in chemical engineering. She then worked as a management consultant, developing graphical user interfaces for major energy companies in the United States and in Canada. She is currently an Assistant Professor at the Teachers College after having received her doctoral degree in Educational Studies (Science Education). She currently teaches sections of the pre-service elementary science method course.

Procedures

A case study approach was used to describe the value of collaboration as perceived by three faculty members as they began implementation of curricular reform across content areas in a college of education. The researchers hope that this type of documentation will "lead to a better understanding, perhaps better theorizing about a still larger collection of cases" (Stake, 1994, p. 237). Qualitative data were gathered throughout the spring, summer, and fall of 2015 school year. Given the specific college-wide curricular reform of PBeLL implementation across content areas, the case study approach is appropriate in seeking to describe and explain a particular phenomenon (Merriam, 1988). In this study, there was no manipulation of treatments or subjects, but rather, the goal of the researchers was to take things as they are (McMillan & Schumacher, 2001).

The core team, including the three faculty participants, met weekly throughout 2015. Detailed meeting notes documented the discussions among grant team members. In addition, Program Enhancement Team (PET) meetings, in which the three faculty members participated, were also documented through detailed notes. Furthermore, all meeting agendas and individual notes kept by the three faculty participants were collected. Materials including possible lesson plan templates for teacher candidates, lesson plans of PBeLL implementation with teacher candidates, and email exchanges were also collected and analyzed, as were artifacts from lessons taught by the participants in their respective courses.

Data Analysis and Coding

The analysis focused on the various meeting notes, individual notes, and other artifacts. We divided the analysis procedure into the five modes suggested by Marshall and Rossman (1999): (a) organizing the data; (b) identifying themes, patterns, and categories; (c) testing the emergent hypothesis against the data; (d) searching for alternative explanations of the data; and (e) writing the report.

Each set of notes and other artifacts were read multiple times. Through the course of each reading, the lead researcher analyzed the data for patterns and consistencies. Pattern matching was a method used to compare an observed pattern with a predicted one to strengthen or eliminate initial assumptions (Yin, 1984). The lead researcher then selected excerpts from the transcripts and placed them into broad categories in search of thematic connections within and among the transcripts (Seidman, 1998). Eight verification procedures for enhancing the trustworthiness of findings are discussed by Creswell (1998) and it is suggested that at least two of them are addressed by qualitative researchers in any given study. In this case study, four of the eight were addressed:

1. *Triangulation.* Multiple sources—meeting notes, individual notes, and lesson plans—were used and themes in the data were explored across data sources to check for convergence of information (Stake, 1994).
2. *Member checking.* Data, analysis, interpretations, and conclusions were reviewed with the other two faculty participants throughout the study.
3. *Peer review or debriefing.* Two colleagues, coaches on the grant, within the department in which the lead researcher is employed, served as peer debriefers and provided constructive feedback throughout the writing process.
4. *Clarifying researcher bias.* Peer debriefing and member checking provided multiple opportunities to check for and address researcher bias.

Findings

Three main themes emerged addressing the research question, "What is the value of collaboration between science and language faculty members when implementing a college-wide reform effort?" These three themes were (a) Value of Agreeing on Terms (b) Value of Integrating Content and Language Learning, and (c) Value of Presenting a Unified Message.

Theme One: Value of Agreeing on Terms

Terminology played a major role in the discussions, particularly in the first few months of meetings. When conversations began, the differences between project-based learning and problem-based learning had to be discussed as these terms are often used in similar ways in various circles beyond the grant narrative. One of the first collaborative tasks was developing an operational definition of problem-based learning. Dr. Rillero and Dr. Merritt, as science faculty, led the development of a whitepaper that was distributed throughout the college and outlined the key characteristics of problem-based learning. Dr. Jimenez-Silva, the ELL faculty member with limited experience with problem-based learning, asked many questions as a novice to the concept. In her notes on various versions of the whitepaper, there were questions listed in the margins regarding each of the nine identified components, specifically in how they related to ELLs. For example, she had specific questions about how collaboration was defined and how it could be scaffolded for ELLs with limited English proficiency. She also had many questions about further distinctions between problem-based learning and inquiry models.

Agreement on terminology went beyond the defining of the main approach of PBeLL. Each member of the team brings different strengths from their varying backgrounds to meeting the goals of the grant. Different education areas (mathematics, science, literacy, etc.) have different approaches for supporting student learning. With these approaches come different terminologies. For example, in science the phrase, "science for all" is used to encapsulate addressing the needs of all students when teaching science. However, other fields (including those focused on meeting the needs of culturally and linguistically diverse students) name the specific student populations (e.g. ELL, diverse learners). The ELL faculty member used the terms "science teacher" and "teachers of science" interchangeably in the groups' first collaborative article. The science educators explained the distinction of the term to her and she proceeded using the appropriate term depending on the context. Thus, it was important to not only understand the terminology we are supporting in the grant, but also the terminology and norms of the different areas the grant is aiming to address.

Theme Two: Value of Integrating Content and Language Learning

Early on, academic language was identified as an important aspect for supporting students, especially ELLs, in learning content. We identified content language objectives as an approach for supporting ELLs in developing language specifically in science. This was for two reasons: 1) teachers are required to include language objectives in instruction and 2) the need to support ELLs in learning science. This emerged from several discussions.

The initial PBeLL template did not include language objectives. Through discussions during various meetings, it was realized that in order to support ELLs in mathematics and science classes, there is language that students will be learning as a result of teaching, but also there would be language that students would need in order to engage in an experience. Thus we identified two types of vocabulary: (a) operational vocabulary –language needed to introduce an experience and (b) conceptual vocabulary–language developed from the experience. The ELL faculty member consistently brought up the need to include sharing strategies for helping students to practice the language they were learning in meaningful and purposeful ways.

The core team, in reviewing past discussions, recognized the need to have explicit support for teacher candidates if we wanted them to be able to design their own experiences. Thus, in our current iteration of the PBeLL template, we included a content-language objective. By including content-language objectives, teacher candidates would have to be able to identify how students would be using language (e.g. writing, speaking, listening or reading), and the supports for aiding student development of language.

Hence, it was important to develop approaches for supporting science methods instructors to implement content-language objectives in their courses. For one of the science methods faculty members, the weekly meetings included discussions of how to write content-language objectives and methods for modifying lessons to include supports for the practice of language.

In developing a sample PBeLL experience for teacher candidates, the ELL faculty member insisted on including numerous techniques to the experience, which was concerning to one of the science methods professor who wanted to keep it as a science experience with some ELL enhancements. Since it was the latter professor's course, this approach is what prevailed. However, the experience was later implemented in an eighth-grade high ELL classroom with an ELL coach as the lead and significant input from the ELL faculty member. This provided an opportunity to try out other enhancements and explore interplays between science and language.

Value of Presenting a Unified Message

Since the reforms we are implementing are for all science and mathematics methods courses, it was important to present a unified message. Thus, the core team needed to come to agreement on not just terminology, but also how to communicate this information to faculty members. We identified the creation of whitepapers that explain our definition of specific terminology as one approach. Thus far, a whitepaper on problem-based learning has been completed and distributed to all early elementary and elementary methods instructors and two others are in progress, one on PBeLL and one on our Systems Model.

We also recognized the need to support faculty members, teacher candidates, and mentor teachers in implementing these reforms. Opportunities for supporting implementation of these reforms could take many different forms. The core team identified modules as an approach for supporting these different groups. The use of modules provides an opportunity to not only explain terminology, but also to show what these reforms look like. Moreover, it provides the opportunity to provide supports that they can develop and use in their classrooms. A unified message also is important because we have been tasked with providing professional development to faculty members in different forums. Before each opportunity to present to faculty members, core team prepared, in part, by agreeing to the content of the presentation. In addition, we intentionally reminded ourselves of the value of our collaboration, mutual respect, and the common goal of preparing all teachers to provide access to science content and develop English language skills for their ELLs.

Discussion

We are currently embarking on Year Two of an ambitious plan to impact ELLs in terms of their science content knowledge and linguistic development. In reforming our teacher education program, our first step was to develop a common understanding among our science and mathematics faculty members of PBL and strategies for supporting ELLs' content knowledge and linguistic development. In order to proceed with this step, we as core faculty members also needed to first develop a common understanding. Findings from our data analysis demonstrated that this has been an ongoing effort throughout our meetings.

In the 2014-2015 school year, we created PBeLL teams comprised of mathematics and science faculty members alongside experts in second language acquisition. A series of professional development opportunities were provided with various encouraging results. Through surveys, it was determined that faculty members were generally enthusiastic about integrating PBL and strategies for supporting ELLs. Furthermore, through collaborative efforts, a PBeLL lesson plan template was developed and several science education faculty members wrote PBeLL lesson plans integrating strategies for supporting ELLs recommended by second language experts. Moreover, syllabi for science methods courses have been revised to deliberately include PBeLL as a means of supporting ELLs' science content and linguistic development. An intentional impact of these efforts is to create a culture in our college that embraces the idea that we are all language teachers, regardless of content expertise. As teachers of science, our students will have an opportunity through PBeLL to "effectively help language learners in science classrooms simultaneously gain language proficiency and conceptual understanding," as stated in a recent call for chapters for an upcoming Association for Science Teacher Education monograph titled *Science Teacher Preparation in Content-Based Second Language Acquisition* (Oliveira & Weinburgh, 2015).

In the second theme from our data, valuing the integration of content and language learning, we identified and discussed a shift in culture that needs to happen as we see all faculty members as models of how to teach content and language. In preparing for this shift in the culture of the college regarding how we view our roles in supporting ELLs in content classes, a larger framework for systematically changing the college culture and taking into account all of the stakeholders both within and outside of the college had to be put in place. Thus, it is critical that we address the third theme that arose, presenting a unified message. Returning to our Systems Framework, it is critical that as faculty participants we keep in mind how our roles impacts all other aspects of the Framework. Our agreement on key concepts, mutual respect of each of our areas of expertise, a shared responsibility of teaching content and language, and presenting a unified message are all critical aspects of meaningfully impacting teacher education in our college and ultimately, across the state.

Purposeful Partnerships

To achieve educational reform, we recognized the need to work collaboratively across disciplines to reform and enhance coursework by creating a change in culture. This process started by engaging faculty members on the PET. We used the principles of the professional learning communities' framework to cultivate a culture of change for how we prepare teacher candidates to meet the needs of ELLs (DuFour, Eaker, & DuFour, 2005). The team consists of mathematics and science instructors, ELL methods instructors, course coordinators, student-teacher supervisors, and ELL coaches (discussed later). Teachers College has engaged the team to be able to integrate evidence-based practices for language and literacy skill development in mathematics and science methods courses. The PET provides the forum for faculty members to work together around the common goals of iTeach ELLs, where all faculty members will have ownership and contribute to program reforms and enhancements. The team meets approximately four times each semester to: (a) establish a culture of change; (b) understand academic vocabulary, literacy and language acquisition strategies; (c) develop PBeLL lessons; and (d) share experiences in developing and implementing PBeLL lessons. Thus, through the PET meetings, faculty members have been able to model PBeLL lessons for pre-service teachers. These opportunities have been developed keeping in mind the suggestions made by Levine, Howard, and Moss (2015) for initiating and sustaining collective faculty member professional development.

Furthermore, to aid in implementing these reforms, we added enhanced expertise in the form of coaches. Ultimately, we plan to hire coaches to support faculty members in development of skills in relationship to the two key features of the reform – practices for English language learners and problem-based learning. Thus far, we have brought on two coaches with expertise in ELLs. Along with their involvement in the PET meetings, the coaches are also working with faculty members to infuse ELL strategies for supporting ELLs. Moreover, they have co-taught with our college's faculty members in targeted science method courses, as well as other research related support. In the future, coaches will co-teach with site coordinators who teach and supervise teacher candidates in partner schools. Finally coaches will support faculty members and students in the implementation and evaluation of these practices.

Next Steps

The goal of our college is to infuse PBeLL experiences and methods throughout pre-service education. Because PBeLL is a natural fit for mathematics and science education, the mathematics methods course, science methods course, and mathematics content courses were targeted with the initial PBeLL infusion. A PET consisting of instructors in the aforementioned areas, as well as ELL methods instructors, course coordinators, student-teacher supervisors, and ELL coaches are meeting approximately four times each semester to (a) share ideas and results for PBeLL experiences and (b) to improve methods for preparing our students to work with ELLs. This work has spread PBeLL into mathematics and science methods and content courses.

To be fully effective the PBeLL experience needs to be an important part of our one-year student teaching program. All faculty members involved with teacher education participated in a PBeLL experience with bears and foil boats. All student teaching coordinators additionally participated in the PBELL pendulum experience. The production of online modules in ELL methods and PBeLL has begun. Summer plans include working with teachers who accept student teachers from our partner districts. The goal is to have our student teachers implement PBeLL in their student teaching experience with the support of their mentor teachers and university supervisors.

Conclusion

The Teachers College is situated in a state with cultural and linguistic diversity. Thus we have recognized the need to prepare content-area teachers to work with ELLs as especially critical to addressing the achievement gap. The iTeach ELL Systems Framework has helped to understand the interconnected nature of student learning, which includes: university/school partnerships designed to impact that learning through more effectively prepared teacher candidates, school and university organizational features, state statutes, and policy regulations. This has meant a culture of change for the Teachers College, starting with the key faculty participants and then taking shape through the formation of the PET. Piloting of ELL strategies in science methods courses has also helped to identify strategies for supporting preservice teachers to develop knowledge of PBeLL strategies. In addition, we have identified challenges that remain, such as the time it takes to implement these lessons and additional supports needed for preservice teachers to write objectives. The hiring of ELL coaches has also helped to further this progress, as they have played a vital role in helping to identify strategies, support members in implementing these strategies, and identifying where additional supports are needed.

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